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Guide to Road Safety Part 5

Road Safety for Regional and Remote Areas

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Guide to Road Safety Part 5: Road Safety for Regional and Remote Areas

Austroads

Sydney 2019

Guide to Road Safety Part 5: Road Safety for Regional and Remote Areas

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Abstract

Road trauma in regional and remote areas of Australia and New Zealand are a major road safety problem. Drivers and riders in regional and remote areas are at an unacceptably greater risk of road deaths and injuries than those living in major cities.

This updated version of the Austroads *Guide to Road Safety Part 5: Road Safety for Rural and Remote Areas* provides practical guidance on the most effective responses to reduce road trauma in regional and remote areas in Australia and New Zealand.

The guide examines the characteristics of crashes on regional and remote roads through analyses of casualty crash data and identifies causes and risks associated with regional and remote crashes in the existing literature. Closely aligned with the Safe Systems holistic approach to eliminating harm on the road network, the guide concludes with a discussion of evidence-based countermeasures and new initiatives that are urgently needed to eliminate fatalities and serious injuries in regional and remote areas.

Keywords

Road safety, regional, remote, safe system

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Edition 2.0 of the Guide includes updates throughout:

- Section 1 Introduction new and updated content
- Section 2 Crashes in Regional and Remote Areas updated with 2012-2016 statistics and a new section on trends and issues.
- Sections 3 and 4 restructured on Safe System Principles with new and updated content
- New Appendix A Fatal and Injury Crash Data Tables.

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About Austroads

Austroads is the peak organisation of Australasian road transport and traffic agencies.

Austroads' purpose is to support our member organisations to deliver an improved Australasian road transport network. To succeed in this task, we undertake leading-edge road and transport research which underpins our input to policy development and published guidance on the design, construction and management of the road network and its associated infrastructure.

Austroads provides a collective approach that delivers value for money, encourages shared knowledge and drives consistency for road users.

Austroads is governed by a Board consisting of senior executive representatives from each of its eleven member organisations:

- Transport for NSW
- Roads Corporation Victoria
- Queensland Department of Transport and Main Roads
- Main Roads Western Australia
- Department of Planning, Transport and Infrastructure South Australia
- Department of State Growth Tasmania
- Department of Infrastructure, Planning and Logistics Northern Territory
- Transport Canberra and City Services Directorate, Australian Capital Territory
- The Department of Infrastructure, Regional Development and Cities
- Australian Local Government Association
- New Zealand Transport Agency.

Acknowledgements

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Summary

Road trauma in regional and remote areas of Australia and New Zealand are a major road safety problem. Drivers and riders on regional and remote roads in Australia and New Zealand are at an unacceptably greater risk of road deaths and injuries than those living in major cities. In 2016, 65% of all road fatalities in Australia and 78% in New Zealand were in regional and remote areas. Regional and remote areas provide a very challenging environment for road safety with low population density, vast road networks, significant socio-economic issues, lack of alternative transport options and inadequate resources. Consequently, developing solutions to road safety problems in these areas is also a significant challenge as measures designed to improve road safety in urban areas may not be feasible in regional or remote areas.

This edition of *Guide to Road Safety Part 5: Road Safety for Rural and Remote Areas* provides practical guidance on the most effective responses to reduce road trauma in regional and remote areas in Australia and New Zealand. The purpose of this guide is to examine the characteristics of crashes on regional and remote roads, identify the people who are most at risk of being involved in crashes in these areas and identify measures and initiatives to eliminate harm on regional and remote roads. The Austroads research report *National View on Regional and Remote Road Safety* (Austroads, 2019b) forms the basis for the development of this guide.

The guide is closely aligned with the Safe System approach in road safety which is to design and manage travel speeds, road infrastructure, vehicles, road users and the interactions between them to eliminate the harm from road crashes. As a result, the guide is structured around the four pillars of the Safe System (Safe Roads, Safe Speeds, Safe Vehicles, Safe People) and consists of three major components:

- An analysis of regional and remote casualty crash data from Australia and New Zealand to understand current issues and trends
- A review of relevant Australian, New Zealand and international literature to determine current causes and risks associated with regional and remote road crashes and injuries
- Identification and discussion of evidence-based countermeasures and new initiatives to eliminate harm on regional and remote roads.

Note that more detailed information is located in the research report (Austroads, 2019b). Based on the research findings, key road safety issues in regional and remote areas were identified including:

- High incidence of single vehicle and head on crashes
- High levels of alcohol and illicit drug use, unlicensed driving, non-use of seat belts and driver fatigue
- Increased risk of crashes at higher speeds and disparity between speed limits and the quality of the road and existing infrastructure
- Higher burden of road trauma among Aboriginal people
- Increasing incidence of crashes involving motorcyclists
- High incidence of older, less crashworthy vehicles
- Delays in post-crash emergency response.

For each of the key issues, a series of evidence-based countermeasures (rated by the strength of evidence) and new initiatives to eliminate fatalities and serious injuries on regional and remote roads are discussed incorporating all four pillars of the Safe System. Given the expansive but lower quality regional and remote road network, strategic planning across all components of the system is necessary to allocate resources and eliminate harm. It is acknowledged that road safety solutions for regional and remote areas need to be supported across all three tiers of government in a working partnership with sustainable commitment and investment to achieve the desired outcomes. Importantly, local ownership of road safety issues and solutions need to be created and fostered through community engagement and involvement in the delivery of initiatives.

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1. Introduction

1.1 Background

Road trauma in regional and remote areas is a major national road safety problem. Drivers and riders on regional and remote roads in Australia and New Zealand are at an unacceptably greater risk of road deaths and injuries than those living in major cities. Based on road crash data for 2016, 65% of all road crash fatalities occur on regional and remote roads in Australia while, for New Zealand, the proportion is markedly higher at 78%. In Australia, 837 people were killed on regional and remote roads in 2016 while over the same period in New Zealand, 257 people were killed on rural roads.

The higher rate of fatalities and injuries from crashes on regional and remote roads and the road safety issues affecting these communities are clearly deserving of attention and require identification of the most effective evidence-based countermeasures.

In recognition of the serious road safety issues in regional and remote areas, Austroads developed a Guide to Road Safety dedicated to understanding the nature and causes of crashes in these areas, and to identify measures to reduce future road trauma. This second edition of the Austroads Guide to Road Safety has been rewritten to incorporate the Safe System approach and include the most recent crash data, road safety research literature and evidence-based countermeasures for regional and remote areas in Australia and New Zealand.

1.1.1 The Safe System and national road safety strategies

The Safe System approach to improving road safety involves a holistic view of the road transport system and the interactions among roads and roadsides, travel speeds, vehicles, road users and post-crash care solutions. The underlying key principles are that people will always make mistakes and may have road crashes but the system should be forgiving and those crashes should not result in death or serious injury. This System approach implies a shared responsibility among those who design, build, manage and use roads and vehicles, and those who provide post-crash care to prevent crash outcomes resulting in serious injury or death. Effectively, the objective of the safe system approach is to eliminate harm on the road network.

Both Australia's *National Road Safety Strategy 2011–2020* (NRSS) and *Safer Journeys, New Zealand's Road Safety Strategy 2010-2020* recognise shared responsibility for achieving a safer road transport system, the clear value of promoting community understanding and endorsement of the Safe System approach, and the importance of research to identify cost-effective interventions (Australian Transport Council, 2011; Ministry of Transport, 2010).

In the context of regional and remote road safety, the Australian NRSS acknowledges that the fatality rates per population are significantly higher in both regional and remote areas and highlights the importance of developing interventions in response to the different circumstances in regional and remote Australia. The strategy also recognises that there will be differences in needs for each jurisdiction. In 2015, Australia's Transport and Infrastructure Council developed a *National Remote and Regional Transport Strategy (*NRRTS) (2015) to provide a national strategic and coordinated approach to addressing transport infrastructure, service delivery and regulation challenges distinctive to regional and remote Australia.

In recognition of the continuing road safety problem in regional and remote areas, Australia's current *Road Safety Action Plan (2018-2020)* (Transport and Infrastructure Council, 2018) specifies two priority actions that directly target regional and remote roads:

- 'Review speed limits on high risk regional and remote roads, in consultation with the community'
- 'Target infrastructure funding towards safety-focused initiatives to reduce trauma on regional roads'

The *Road Safety Action Plan* also identifies remote road safety, and the investigation and implementation of key interventions, as a critical action for which all jurisdictions should work together to address. This action also highlights that efforts should be consistent with the National Remote and Regional Transport Strategy and consider whole of government approaches to remote transport issues.

The Australian federal government commissioned an independent inquiry into the NRSS (Woolley & Crozier, 2018). The inquiry selectively focused on high order governance and management issues. Many of the key findings are broadly relevant to regional and remote road safety including centring on strong senior leadership, setting long term and interim strategies and targets for the future (target dates to reach zero), commitment to harm elimination policy, scaling up of proven interventions, accelerating deployment and uptake of proven vehicle safety technologies, and adopting speed management initiatives.

New Zealand's *Safer Journeys Road Safety Strategy 2010-2020* (Ministry of Transport, 2010) does not specifically focus on regional and remote road safety. However, under the Safe Road and Roadsides section, an area of high priority and concern, there is an action to 'focus safety improvement programmes on high-risk rural roads'. There is also an action under the Safe Speeds plan concerning speed zone management on high-risk rural roads. In addition, there is emphasis on other key road safety issues in regional and remote areas including reducing alcohol/drug impaired driving, reducing the impact of fatigue, increasing the level of restraint use and reducing the impact of high-risk drivers (including unlicensed drivers). The current action plan has specific actions to implement a national program of lower cost safety improvements on high-risk local rural roads and the continued implementation of a state highway road safety improvement program on rural roads.

1.2 Regional and Remote Areas

1.2.1 Regional and remote areas: The context

Regional and remote road safety faces a number of challenges including travelling over vast distances to towns and cities, low population density, extreme climate and difficult geography. More specifically, there are a number of transport, economic and social challenges unique to regional and remote areas that impact on road safety:

- Low traffic volumes which influence investment in infrastructure when using traditional assessment methods
- Lower quality transport infrastructure and roads due to long road networks and limited resources
- Limited telecommunications service coverage and infrastructure
- Low population density resulting in diseconomies of scale
- Vast distances to travel to major service centres and cities
- Limited access to health, education, social services and employment opportunities
- Long distances to travel to receive treatment at trauma centres and rehabilitation services
- Limited public transport options with existing services relatively expensive and infrequent
- Lack of all-weather access to communities and services
- Isolation from the rest of the country due to geographical and seasonal constraints.

1.2.2 Defining regional and remote areas

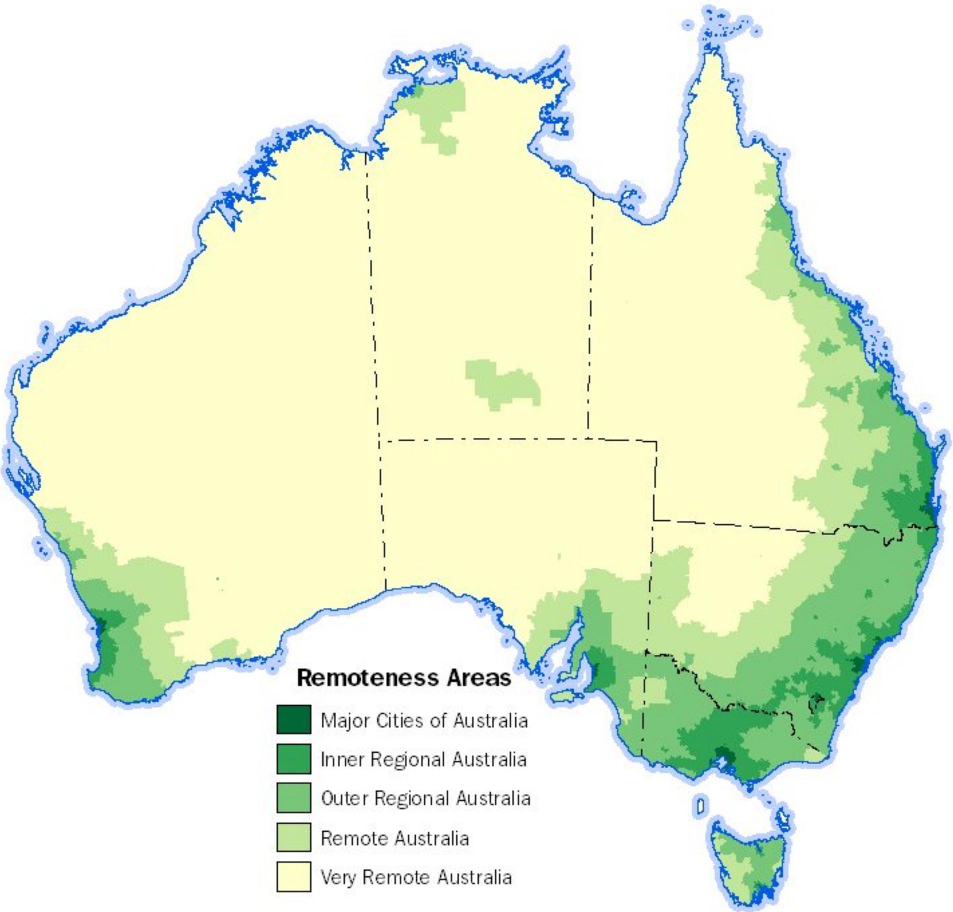
Across Australia and New Zealand, each jurisdiction applies their own definition of urban, regional and remote areas in relation to where a crash occurs. These definitions may be based on speed limits, population densities, roadside development, or distance to goods and services (including access to emergency and medical services). In an effort to overcome these discrepancies, an existing uniform indicator that defines urban, regional and remote areas was used in this study to stratify Australian crash data.

Relative remoteness is measured in an objective way using the Accessibility and Remoteness Index of Australia (ARIA+) which is derived by measuring the road distance from a point to the nearest populated localities and service centres (Australian Bureau of Statistics, 2018). It is essentially a measure of distance or accessibility to goods and services. Using the ARIA+ methodology, remoteness changes over time with changes in population centre size and improvements in road networks. As a consequence, remoteness areas are reclassified every five years, with the latest remoteness structure revision in 2016 (Australian Bureau of Statistics, 2018).

The Australian Statistical Geography Standard (ASGS) uses the ARIA+ methodology to define Remoteness Areas using five classes of relative remoteness across Australia (see Figure 1.1):

- Major Cities of Australia
- Inner Regional Australia
- Outer Regional Australia
- Remote Australia
- Very Remote Australia.

Figure 1.1: Australian remoteness areas, ABS Australian Statistical Geography Standards (ASGS), 2016



Source: Australian Bureau of Statistics, 2018

While the ASGS classification of remoteness areas provides a measure of access to services (goods and medical), it is acknowledged that it only provides one aspect of the measure of the differentiation between urban ‘major cities’ and regional and remote environments. The characteristics of the road environment in which a crash may occur, including the speed limit, type of infrastructure and sparseness of roadside development, may also be used to classify the crash location. In addition, due to the nature of the remoteness measure (i.e. distance from services), Hobart and Darwin are currently classified as inner regional. With respect to road safety, the road environment (including infrastructure and speed limits) in these capital cities more closely reflects those of built up major cities. Unfortunately, it was not possible to reclassify these cities in the crash data.

While acknowledging the limitations, this classification of remoteness areas is regarded as the best means of urban/rural differentiation currently available and used for national road trauma statistical summaries in Australia. Even though there are changes to the boundaries, using an objective and consistent process for classifying remoteness areas allows comparisons between data published over time.

New Zealand does not use the same classification system for determining regional and remote areas. Instead, for road safety crash statistics, classification of the location of a crash is based on the speed limit of the road (i.e., a speed limit of 80km/h and over is indicative of regional/remote). Therefore, to achieve consistency in classification between the two crash data sets, an approximate equivalent categorisation was applied to the New Zealand crash data in this analysis. In consultation with the New Zealand Transport Agency, the seven major cities or ‘territorial local authorities’ (i.e. Auckland, Christchurch, Wellington, Hamilton, Tauranga, Lower Hutt, Dunedin) classified as major urban areas by the *Statistical standard for geographical areas 2018* (Statistics New Zealand, 2017) were categorised as ‘major cities’ and the rest of New Zealand considered as ‘regional/remote’. These major cities primarily have populations greater than 100,000. It is recognised that this definition considers the characteristics of the area (i.e. population density, distance to goods and medical services) rather than characteristics of the road (i.e. speed limits, infrastructure). A future project could investigate the most appropriate definition of ‘regional and remote’ in Australasia for road safety purposes, one that accounts for aspects including the road environment, speed limits, infrastructure and distance to services.

In order to be consistent with the original *Guide to Road Safety Part 5* (Austroads, 2006) and the current classification of the New Zealand crash data, the regional (i.e. inner regional, outer regional) and remote (i.e. remote, very remote) categories for Australia have been combined for the crash analysis.

1.3 Purpose and Scope of the Guide

Based on the Safe Systems approach and structured using the four pillars (Safe Roads, Safe Speeds, Safe Vehicles, Safe People), this guide provides guidance on the most effective responses to reduce road trauma in regional and remote areas in Australia and New Zealand.

Specifically, the purpose of this guide is to:

- Quantify the current road safety issues on regional and remote roads
- Determine the characteristics of crashes on regional and remote roads
- Examine the factors that contribute to the incidence and severity of crashes on regional and remote roads
- Identify the people who are most at risk of being involved in a crash
- Identify measures and initiatives to reduce the incidence and severity of crashes

The guide consists of three major components:

- An analysis of regional and remote casualty crash data from Australia and New Zealand to understand current issues and trends
- A review of the literature to determine current causes and risks associated with regional and remote road crashes and injuries
- Identification and discussion of evidence-based countermeasures and new initiatives to eliminate harm on regional and remote roads

The Austroads publication *National View on Regional and Remote Road Safety* (Austroads, 2019b) forms the basis for the development of this guide.

2. Crashes in Regional and Remote Areas

This section describes current trends in regional and remote road trauma in Australia and New Zealand. The analysis of national regional and remote crash data is not simple as the definition of 'regional and remote' differs by state and territory. This is also the case for Australian and New Zealand crash data. Consequently, a definition for regional and remote crashes has been developed based on the location of the crash, distance or access to services and population density (see section 1.2).

Around one third of Australians live in regional or remote areas, but two thirds of fatal crashes occur in these regions. In 2016, there were 837 people killed on regional and remote Australian roads representing 65% of all road crash fatalities (see Table 2.1). In regional and remote areas, the fatality rate is 12.2 deaths per 100,000 population in Australia, which is almost five times greater than the rate for major cities, at 2.6 deaths per 100,000 population.

While just under half of New Zealanders live in regional and remote areas, three quarters of fatal crashes occur in these areas. In 2016, there were 257 fatalities in regional and remote areas within New Zealand representing 78% of all road crash fatalities. Similar to Australia, the fatality rate in regional and remote areas of New Zealand (13 deaths per 100,000 population) is five times greater than the rate for major cities (2.6 deaths per 100,000 population).

Table 2.1: Population and fatal crash statistics by location, 2016

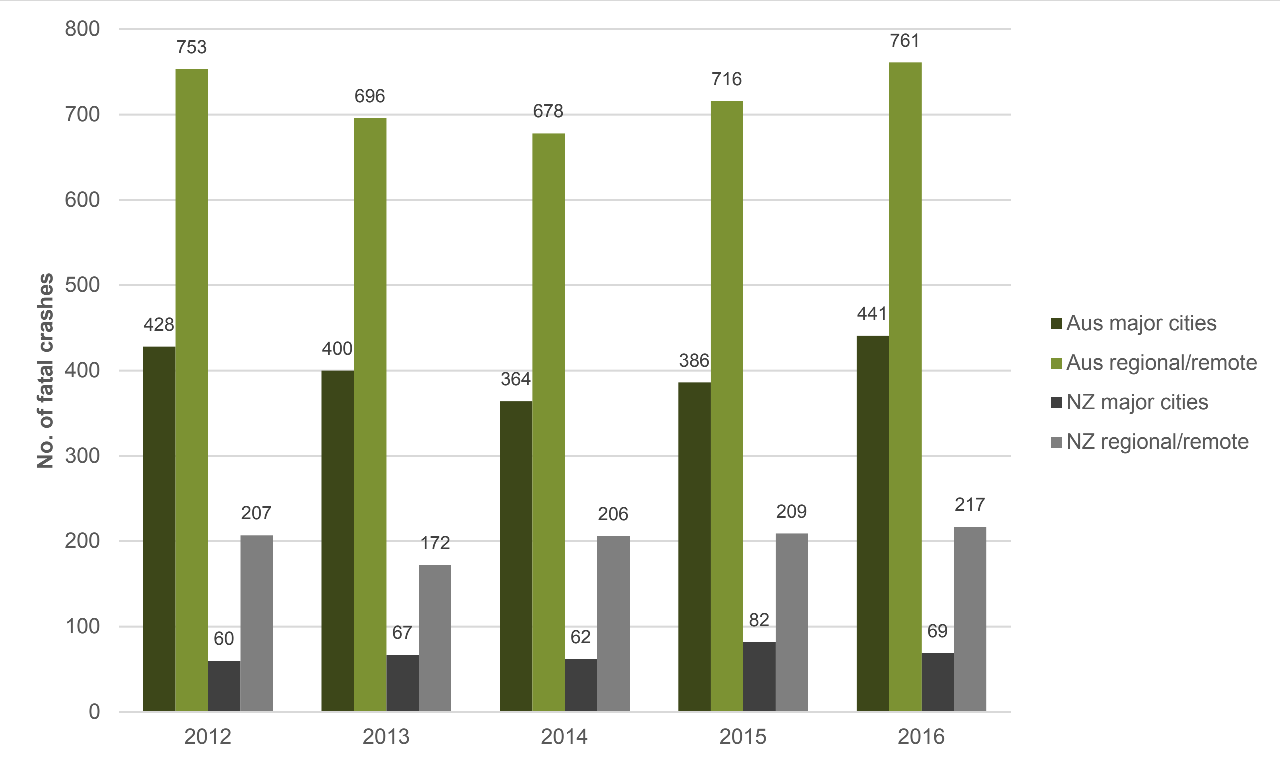
Location	Population [a]		Fatalities[b]		Fatality rate per 100,000
	N	%	N	%	
Australia					
Major Cities	17,331,653	72.7%	458	35.3%	2.6
Regional/remote	6,879,156	27.3%	837	64.7%	12.2
Total [c]	23,850,784	100%	1,296	100%	5.4
New Zealand					
Major cities	2,716,700	57.9%	71	21.6%	2.6
Regional/remote	1,976,500	42.1%	257	78.4%	13.0
Total	4,693,200	100.0%	328	100%	7.0

[a] *Source: Australia: ABS, 2017a, New Zealand: Statistics New Zealand, 2016*
[b] *Source: Australia: BITRE 2018a, New Zealand: Ministry of Transport, 2017a*
[c] *Includes unknown remoteness area.*

2.1 Crashes on Regional and Remote Roads

Figure 2.1 presents the numbers of fatal crashes occurring each year during the period of 2012 to 2016 by remoteness category in Australia and New Zealand. It can be seen that in both countries there was a higher number of fatal crashes in regional and remote areas than in major cities. There was a slight decrease in fatal crashes in both regional/remote areas and major cities of Australia from 2012 to 2014, after which the numbers increased in 2015 and returned to being roughly the same in 2016 as they were in 2012. Despite some variance from year to year between 2012 and 2016, there were no discernible trends in the numbers in New Zealand for either regional and remote areas or major cities.

Figure 2.1: Regional and remote fatal crash trends (2012 to 2016)



The number of casualty (i.e. fatal and injury) crashes occurring each year during the period of 2012 to 2016 by remoteness category are displayed in Figure 2.2. In Australia, there was a higher number of casualty crashes in major cities compared to regional/remote areas. This was also the case in New Zealand, although the differences between the numbers for major cities and regional and remote areas were smaller. Between 2012 and 2016, there have been consistent reductions in casualty crashes in regional and remote areas of Australia, as well as in major cities. There were also reductions in regional and remote areas and major cities in New Zealand between 2012 and 2014, but the numbers increased in 2015 and 2016 to be higher than they were in 2012.

Table 2.2 compares fatal, serious injury (i.e. admitted to hospital) and other injury (i.e. seen by private doctor or hospital treated but not admitted) crashes in regional and remote areas of Australia and New Zealand. Major cities are also included for comparison. Values represent average annual crash numbers over five years (2012 to 2016). Crashes with a higher severity of injury (i.e. fatal, serious injury) were less frequent than crashes with a lower severity of injury (i.e. other injury) for both Australia and New Zealand and both major cities and regional and remote areas. However, fatal and serious injury crashes represented larger proportions of the average total casualty crashes in regional and remote areas (4% fatal in both Australia and New Zealand, 37% serious injury in Australia and 22% serious injury in New Zealand) compared to major cities (1% fatal in both Australia and New Zealand, 27% serious injury in Australia and 16% serious injury in New Zealand) in both countries.

Figure 2.2: Regional and remote casualty crash trends (2012 to 2016)

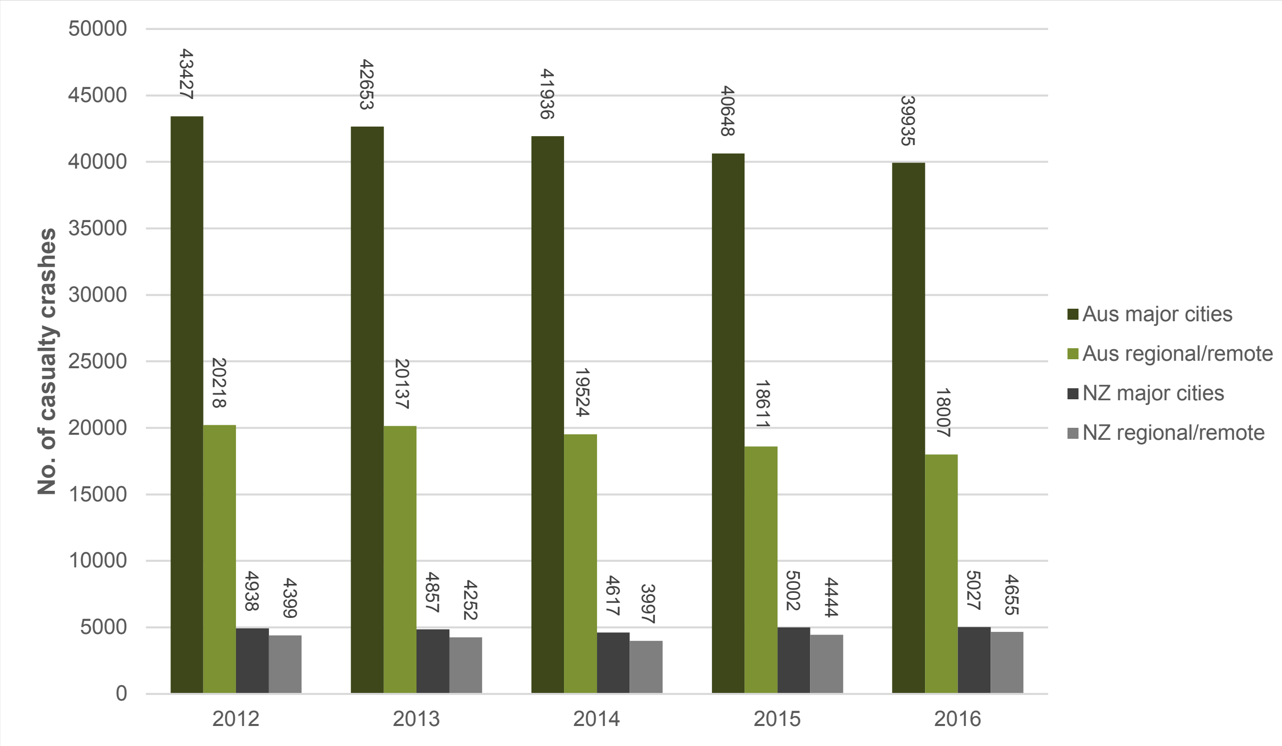


Table 2.2: Average annual casualty crashes (2012 to 2016) in regional and remote areas by severity

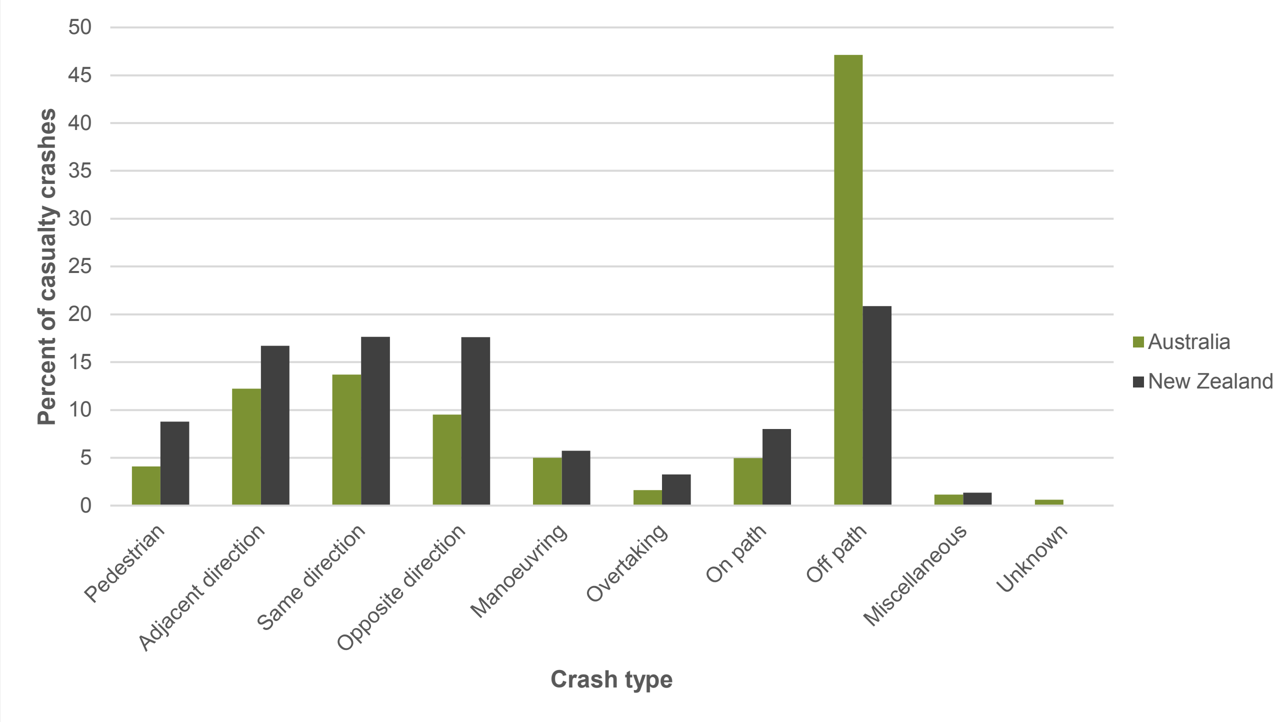
		Fatal crashes		Serious injury crashes		Other injury crashes		Average total fatal and non-fatal injury crashes
		N	%	N	%	N	%	
Australia	Major cities	404	1	11,242	27	30,074	72	41,862
	Regional/remote	721	4	7,165	37	11,413	59	19,299
New Zealand	Major cities	69	1	817	16	4,118	82	5,005
	Regional/remote	200	4	1,008	22	3,366	74	4,575

In the following figures, the average annual (2012-2016) percentages of fatal, serious injury (i.e. admitted to hospital) and other injury (i.e., seen by private doctor or hospital treated but not admitted) crashes are presented for regional and remote areas in both Australia and New Zealand. The corresponding average annual casualty crash numbers are provided in Tables A1-A10 in Appendix A.

The percentages of average annual regional and remote casualty crashes by crash type between 2012 and 2016 are presented for Australia and New Zealand in Figure 2.3. Values represent the percentage of the total average annual number of casualty crashes. Off path (e.g. hit fixed object and run-off road), same direction (e.g. rear end, side-swipe), adjacent direction (e.g. intersection crashes) and opposite direction (e.g. head-on, right turn in front) crashes account for a large proportion of casualty crashes in regional and remote areas of both Australia and New Zealand.

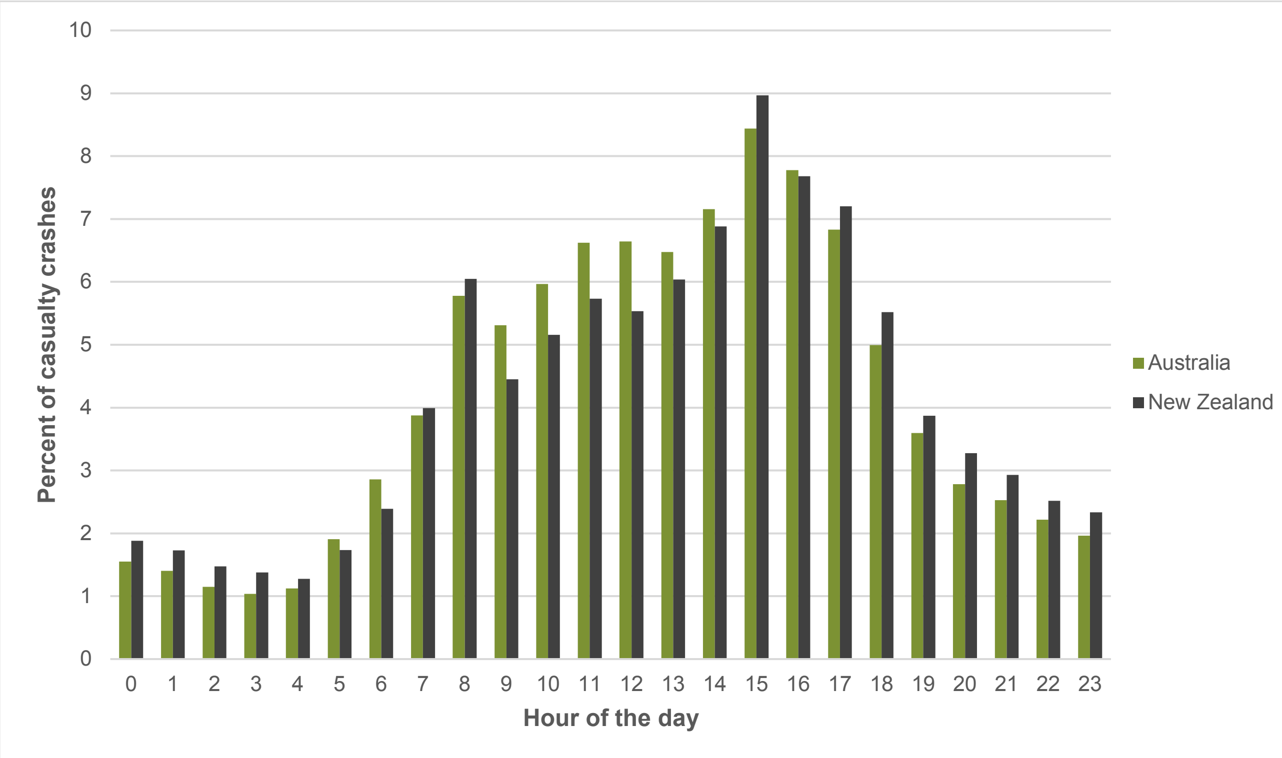
Subsequent analysis of fatal crash data only was undertaken for two crash types associated with a high crash risk in regional and remote areas. This analysis revealed that the average annual number of fatal single vehicle crashes between 2012 and 2016 on regional and remote roads was 380 in Australia or 52.7% of fatal crashes and 100 in New Zealand or 49.5% of fatal crashes. For fatal head-on crashes, the average annual number between 2012 and 2016 on regional and remote roads was 160 in Australia or 22.2% of fatal crashes and 58 in New Zealand or 28.7% of fatal crashes.

Figure 2.3: Percentages of average annual casualty crashes (2012 to 2016) in regional and remote areas by crash type



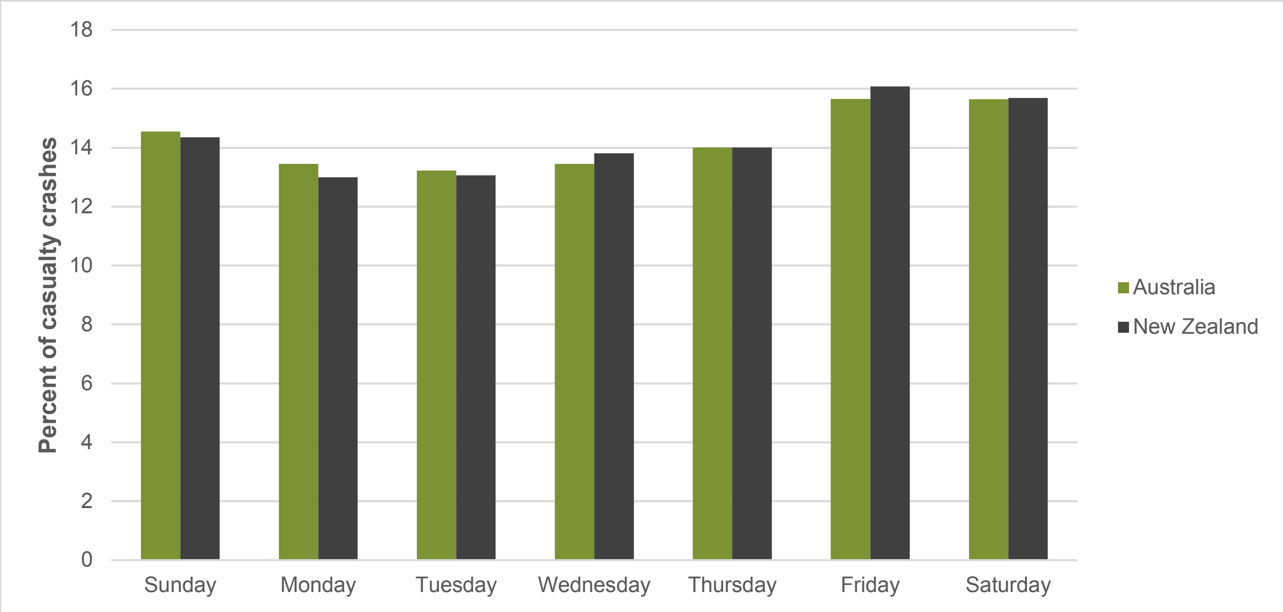
As shown in Figure 2.4, the largest proportion of regional and remote casualty crashes in both Australia and New Zealand occurred during daylight hours (roughly 8am to 7pm). The numbers for both countries peaked at around 2 pm to 6 pm.

Figure 2.4: Percentages of average annual casualty crashes (2012 to 2016) in regional and remote areas by hour of the day



The percentages of average annual regional and remote casualty crashes by day of the week are presented in Figure 2.5. The proportions were slightly higher on Fridays and Saturdays in both Australia and New Zealand and slightly lower during the rest of the week.

Figure 2.5: Percentages of average annual casualty crashes (2012 to 2016) in regional and remote areas by day of the week



The percentages of average annual regional and remote casualty crashes by the month of the year are shown in Figure 2.6. Despite variances from month to month, there was a slight reduction in the percentages for Australia and New Zealand around winter to early spring or the 'dry season' in Northern Australia (June to September).

Figure 2.6: Percentages of average annual casualty crashes (2012 to 2016) in regional and remote areas by month of the year

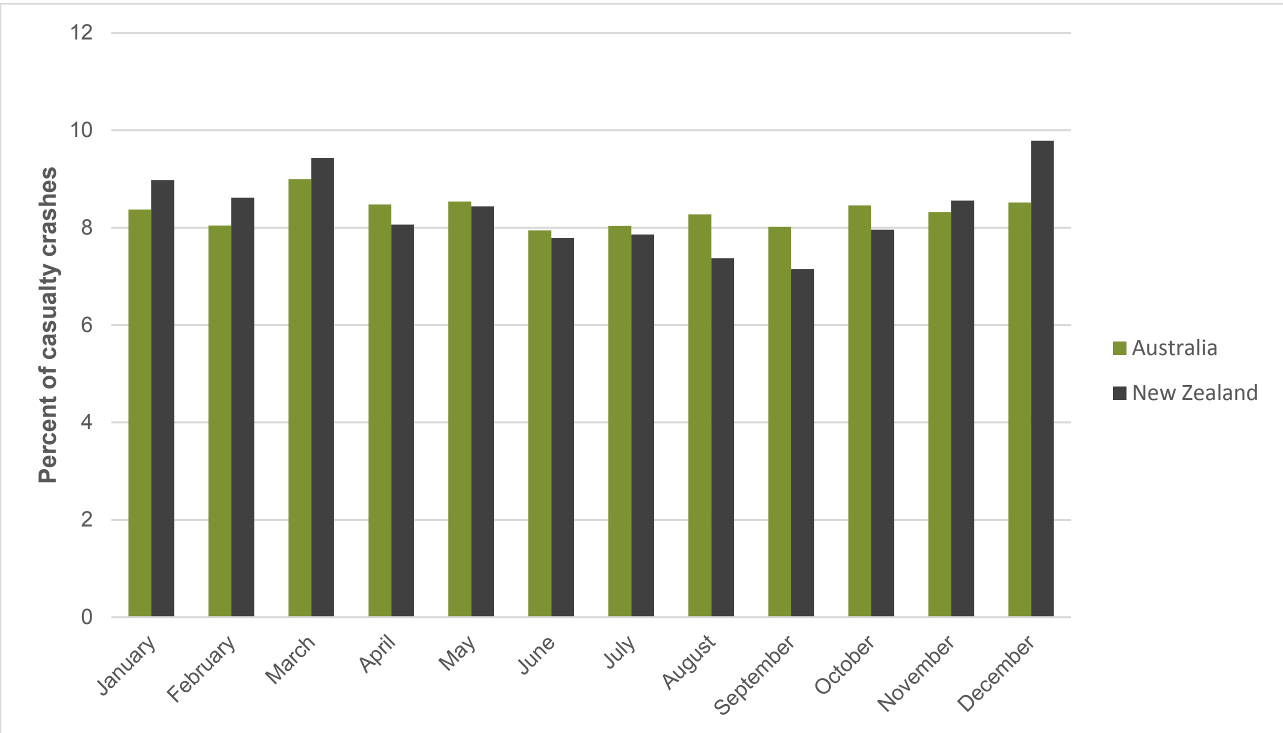
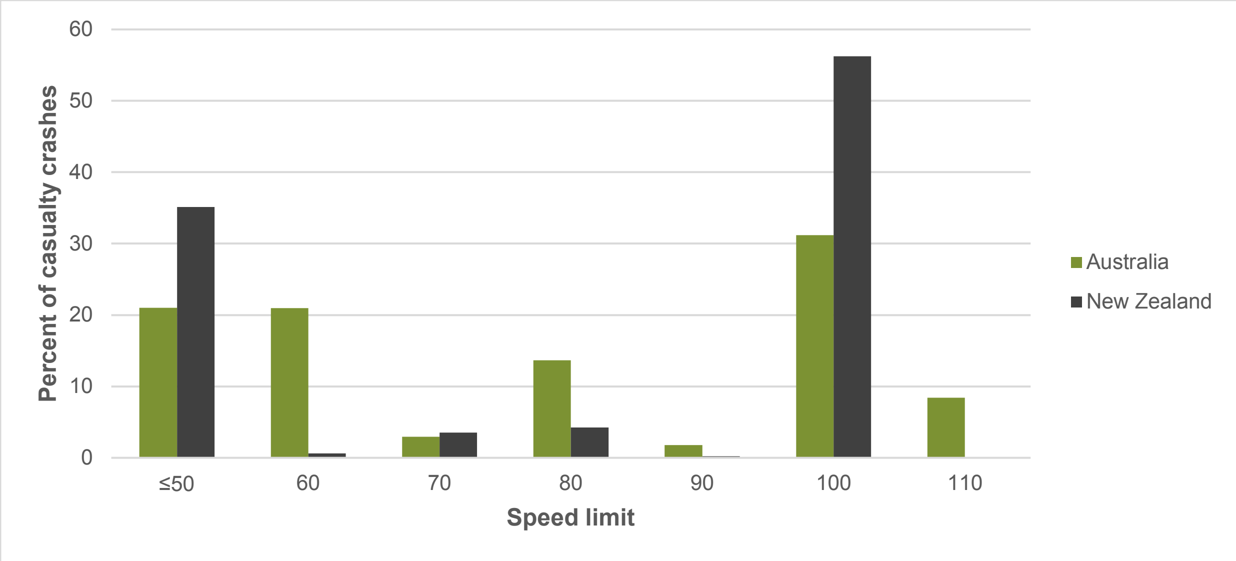


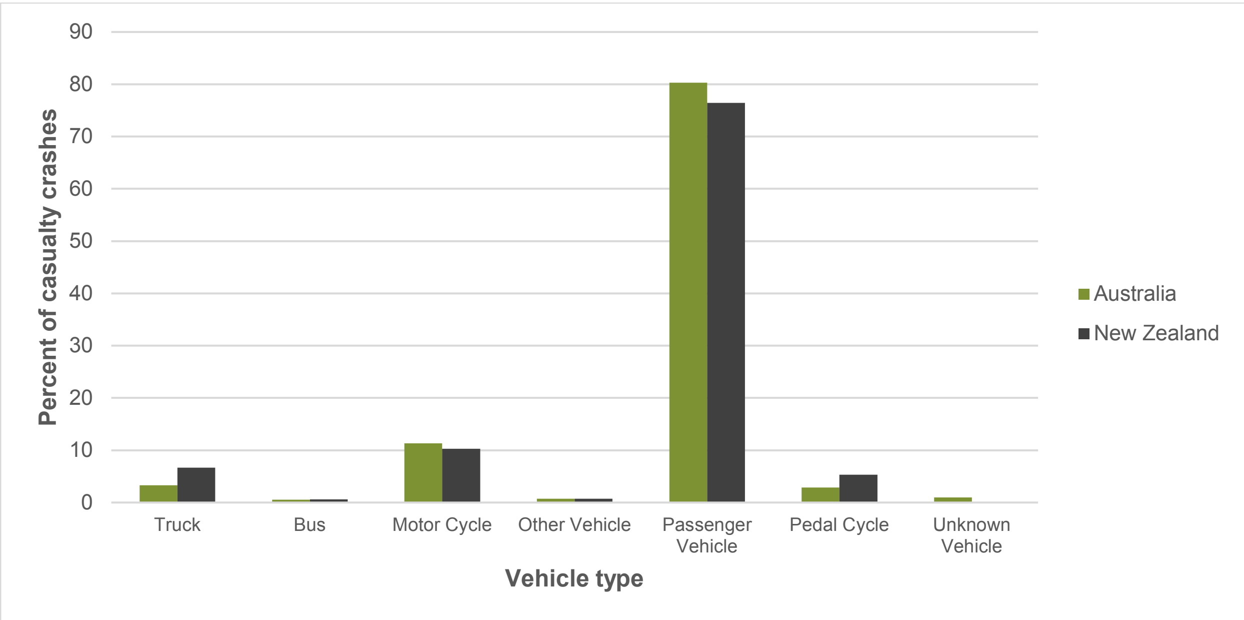
Figure 2.7 displays percentages of average annual regional and remote casualty crashes by speed limit zone. The largest proportion of crashes in both countries occurred in 100 km/h speed limit zones. The lack of crashes in some speed zones (e.g. 60km/h,110km/h in New Zealand) is likely to represent differences between the countries in commonly applied speed limits. Around 36% of crashes in New Zealand and 42% of crashes in Australia occurred in 50 and 60 km/h speed zones, suggesting a substantial proportion of crashes also transpire in regional/remote towns.

Figure 2.7: Percentages of average annual casualty crashes (2012 to 2016) in regional and remote areas by speed limit zone



Percentages of average annual regional and remote casualty crashes by vehicle type are presented in Figure 2.8. Passenger vehicles were involved in almost 80% of casualty crashes in both Australia and New Zealand, while motorcycles were involved in around 10% and trucks and pedal cycles were involved in less than 10%.

Figure 2.8: Percentages of average annual casualty crashes (2012 to 2016) in regional and remote areas by vehicle type



Note: Articulated truck and heavy rigid truck combined for the Truck category. Light commercial vehicles included in Passenger Vehicle category.

2.2 Casualties on Regional and Remote Roads

Similar to the data for casualty crashes, this section examines the proportions of average annual casualties (fatal and injury) from crashes in regional and remote areas across Australia and New Zealand for the years 2012-2016. The percentages of average annual casualties by age group are shown for males in Figure 2.9 and females in Figure 2.10. The distributions by age group were very similar for males and females. In New Zealand, young males aged 17-25 accounted for the greatest proportion of injuries followed by males aged 40-59 years; in Australia the greatest proportion of injuries were for males aged 40-59 followed by young males (17-25 years). In both Australia and New Zealand young females aged 17-25 accounted for most injuries, followed closely by females aged 40-59. Note that the total number of casualties was highest for males in both countries for each age group (see Tables A7 and A8 in Appendix A).

Figure 2.9: Percentages of average annual male casualties (2012 to 2016) in regional and remote areas by age group

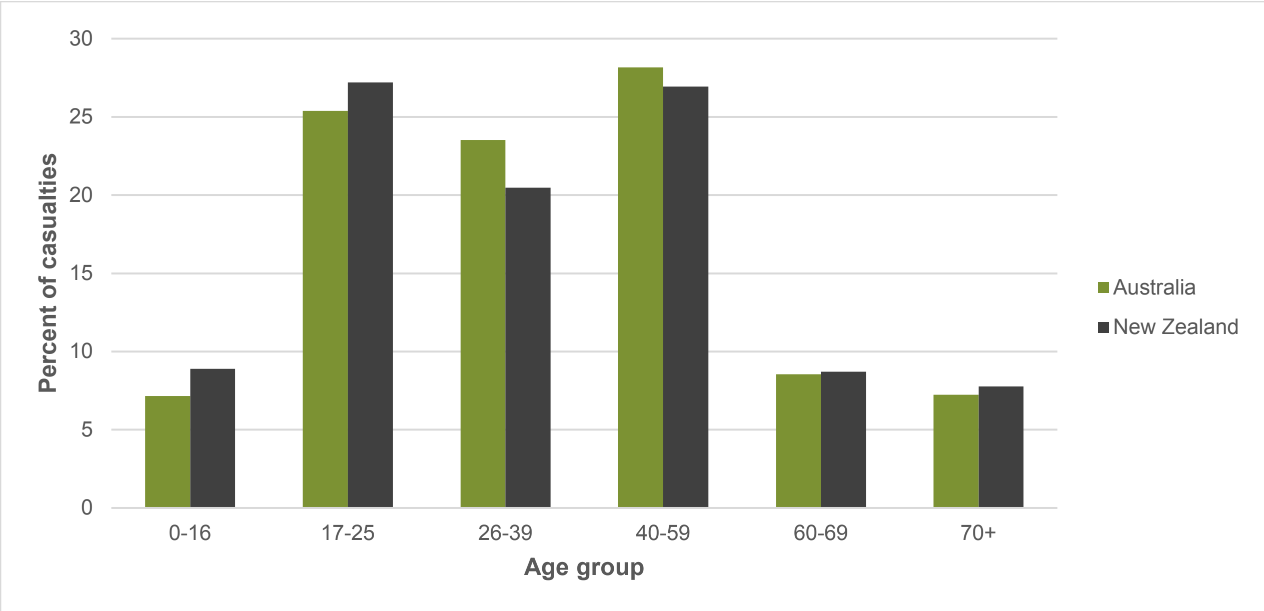


Figure 2.10: Percentages of average annual female casualties (2012 to 2016) in regional and remote areas by age group

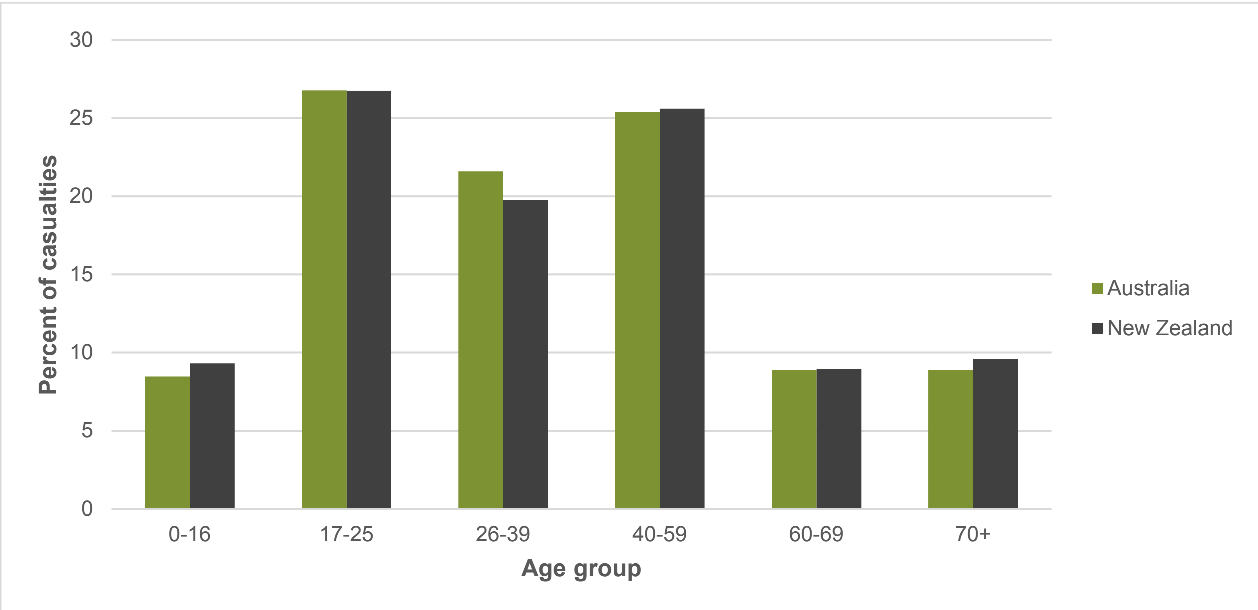
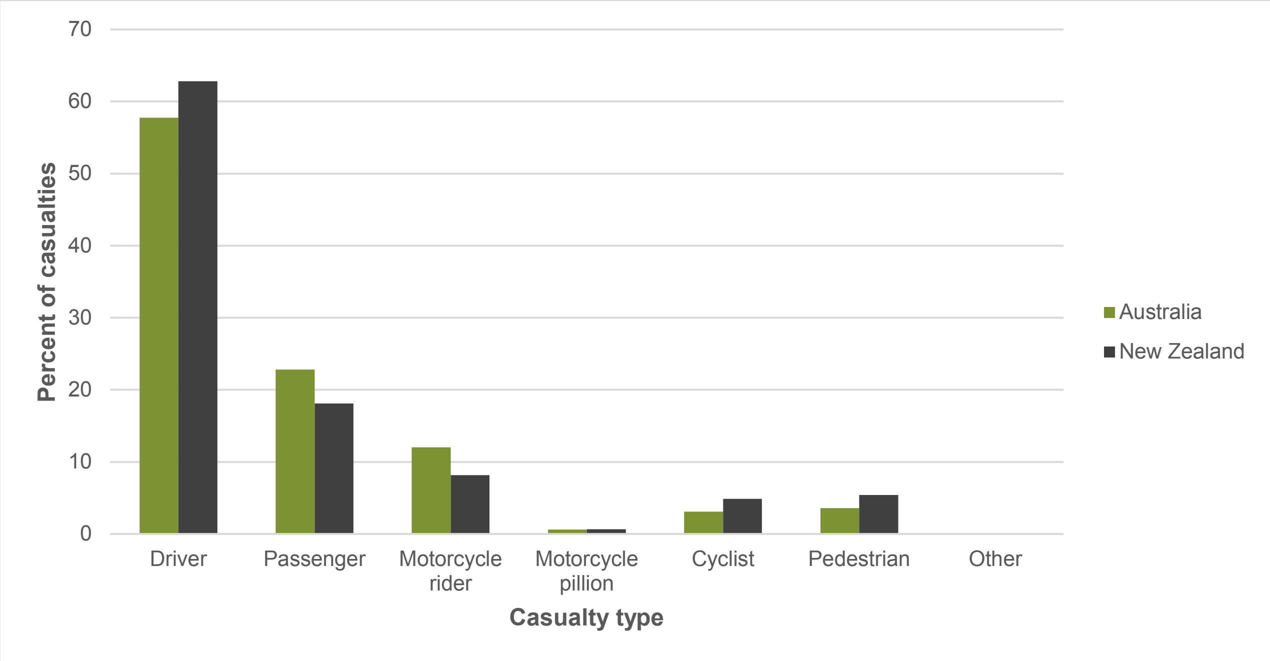


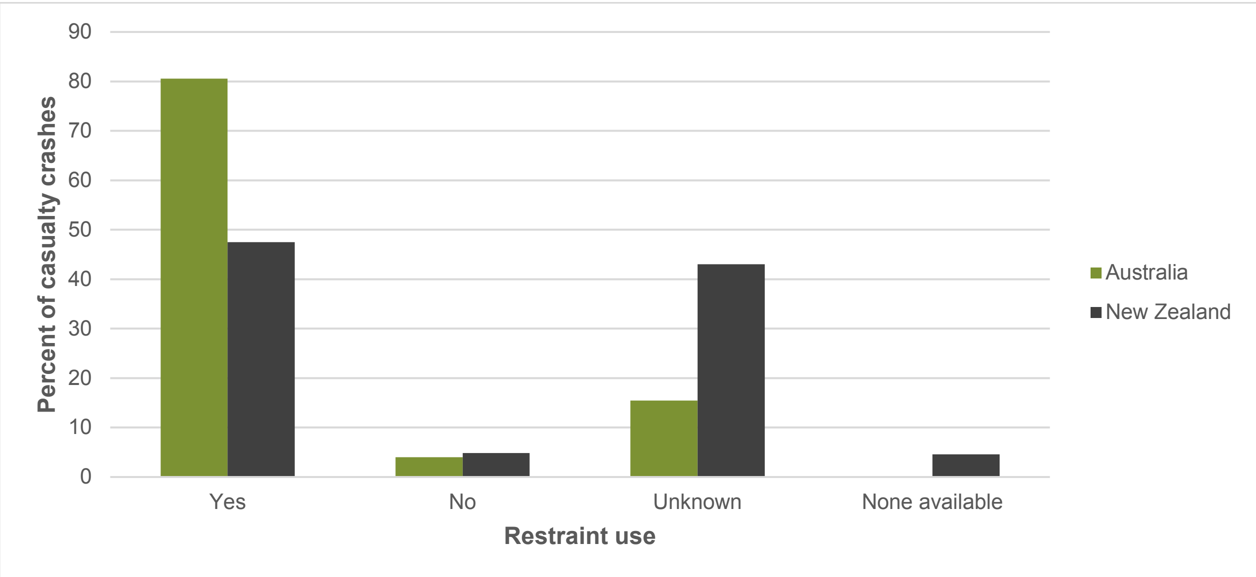
Figure 2.11 shows the proportion of average annual regional and remote casualties by casualty type. Drivers accounted for the largest proportion of casualties in both countries, followed by passengers and motorcycle riders.

Figure 2.11: Percentages of average annual casualties (2012 to 2016) in regional and remote areas by casualty type



The percentages of average annual regional and remote casualties (drivers and passengers) by restraint use are presented in Figure 2.12. It can be seen that 80.6% (95.3% of those with known restraint use status) of casualties in Australia and 47.5% (90.7% of known restraint use status) in New Zealand were restrained, while 4.0% (4.7% of known restraint use status) and 4.9% (9.3% of known restraint use status) respectively were unrestrained. The category of 'None available' was not present in the Australian data.

Figure 2.12: Percentages of average annual casualties (2012 to 2016) in regional and remote areas by restraint use



Notes: 'None available' was not a category in the Australian data.

It was not possible to obtain data on the number of casualties by type of location of the crash (e.g. cross intersection, T intersection, roundabout or midblock). Instead, the data that were available were the number of casualties from crashes at intersections. These data showed that the average annual number of casualties from crashes at regional and remote intersections between 2012 and 2016 was 8159 in Australia or 31.6% of total casualties and 1261 in New Zealand or 21.7% of total casualties.

2.3 Summary of Findings

Analyses of regional and remote crash and casualty data, based on the average number of crashes occurring over the period 2012 to 2016, identified the following trends or issues:

- Injuries are skewed towards higher severity in regional and remote areas in both Australia and New Zealand, with higher proportions of fatalities and serious injuries observed than in major cities
- In Australia, off path regional and remote casualty crashes are a significant problem. In New Zealand the main crash types are more evenly distributed between same direction, adjacent direction, opposite direction, and off path crashes
- There is a peak in regional and remote casualty crashes in both Australia and New Zealand between 2pm and 6pm
- The proportion of regional and remote crashes in both Australia and New Zealand are slightly higher over weekends and lower through the week
- In Australia and New Zealand there is a lower proportion of regional and remote crashes over the winter months and early spring
- In both Australia and New Zealand, a substantial proportion of regional and remote casualty crashes occur on high speed roads, particularly those with a speed limit of 100 km/h or above, but also in regional/remote towns (i.e. speed limit 50-60km/h)
- Passenger vehicles are most commonly involved in regional and remote casualty crashes in both countries
- Overall, a greater number of males were injured in regional and remote areas than females. In both Australia and New Zealand, males in the 40-59 and 17-25 age groups account for the greatest proportion of regional and remote casualties
- In both Australia and New Zealand young females aged 17-25 account for most casualties in regional and remote areas, followed closely by females aged 40-59
- In both countries, drivers account for a substantial proportion of regional and remote casualties
- Of those for whom restraint use status was known, 4.7% of driver and passenger casualties in regional and remote areas were unrestrained in Australia, and 9.3% of driver and passenger casualties in New Zealand.

3. Regional and Remote Road Safety Risk Factors

This section comprises a condensed review of the peer-reviewed and 'grey' literature to identify current road safety issues in regional and remote areas. The literature is presented in greater detail in the accompanying research report *National View on Regional and Remote Road Safety* (Austroads, 2019b). Under each of the four pillars of the Safe System, key regional and remote road crash and injury risk factors are discussed.

3.1 Safe Roads

The Safe System approach to road safety recognises that humans will make mistakes or take risks while driving. Designing roads that are 'forgiving', self-explaining, and which provide protective infrastructure has the potential to encourage safe driving and reduce the incidence of crashes and lessen the severity of injury in the event of a crash. The design and maintenance of safe roads is particularly important in regional and remote areas, which are characterised by a high incidence of run-off road and head-on crashes and severe injury outcomes (Austroads, 2015b).

3.1.1 Road condition

The National Road Safety Strategy 2011-2020 (Australian Transport Council, 2011, p.51) makes the following comments about the condition of Australia's roads, many of which are pertinent to regional and remote roads:

> *There are many uncontrolled accesses to the arterial high-speed network per kilometre.*
>
> *A low proportion of the network is fitted with median barriers to separate opposing flows and side barrier protection.*
>
> *There are many high-speed intersections in regional and remote areas and limited use of roundabouts and raised platforms at intersections.*
>
> *There are many narrow traffic lanes and unsealed and narrow shoulders on many routes.*
>
> *There is limited use of tactile line treatments (rumble strips) on road medians and edges.*
>
> *Many roads have insufficient clear zones, which can be treated with increased clear zones, sealed shoulders and/or appropriate barriers.*
>
> *Roads in Aboriginal communities are generally not included in government road construction and maintenance programs. Many of these roads are of a very poor standard, which is one of the contributors to the higher rates of road trauma for Aboriginal people.*

In addition to these issues, there is a greater likelihood of encountering livestock and wildlife on regional and remote roads as well as heavy agricultural vehicles, mining vehicles and road trains. Also, a high proportion of roads in regional and remote areas are unsealed which increases the risk of skidding and losing control and can cause visibility issues as a result of dust and flying pebbles. Surfaces may also be unpredictable as a result of the type and volume of traffic and weather conditions such as heavy rain and seasonal flooding.

The default speed limit of 100km/h on regional and remote roads in all states and territories, other than WA and the NT where it is 110 km/h, together with a lack of road infrastructure means that vehicle occupants are at greater risk of fatal or serious injury if they should crash.

Further information on the condition of the Australian road network is provided by the Australian Road Assessment Program (AusRAP) which examined 21,921 kilometres of national highway with a speed limit of 90 km/h or above during 2013 and awarded star ratings from 1 (poor) to 5 (high quality) based on safety (Australian Automobile Association, 2013). The majority of roads fell into the 2-star or 3-star category.

Examination of crashes on regional and remote roads indicates that there are a disproportionately high number of fatal and serious crashes on regional and remote roads in comparison to the proportion of the population that live there, and that there are some predominating crash types. Australian national data shows that 65% of fatal crashes occur on regional and remote roads, compared to 39% of serious injuries and 28% of other injuries (Austroads, 2019b). Furthermore, in 2016, 81% of fatal head-on crashes, 78% of fatal single vehicle crashes, and 37% of fatal intersection crashes occurred in regional and remote areas (Table 2.2, Austroads, 2019b).

The different features of roads and their surroundings have individually been shown to affect crash risk. The following section reviews how each aspect of road design may reduce or increase the risk of a crash.

3.1.2 Road design

A lack of energy management design features to manage the forces on a human body, should a crash occur, can result in fatal or serious injury. This is discussed in relation to speed in section 3.3.1. The main geometric elements impacting on safety include (Austroads, 2015b):

- Cross-section (e.g. widths of lanes, shoulders, medians and verges)
- Horizontal curves
- Vertical curves and gradients
- Intersections.

Results of an earlier data analysis conducted by Austroads showed that during 2005-2009 most regional and remote casualty crashes occurred on mid blocks, and those on straight road sections slightly outnumbered those occurring on curves. However, as curves are relatively rare in relation to mid-blocks, this indicates that curves represent a greater risk. There were fewer intersection crashes and these were dominated by those at T intersections and then cross-intersections. This reflects the most common types of intersections in regional and remote areas (Austroads, 2015b).

Road cross-section

Sealed pavement width, lane width and shoulder width have been shown to have an effect on the risk of a run-off-road crash. Narrow pavements (< 6m), narrow lane width (2.5m) and narrow shoulders (< 0.5m) have all been shown to be associated with a higher crash risk (Austroads, 2014b).

Casualty crash risks are also higher on undivided regional and remote roads as opposed to divided roads. Increasing median width is associated with crash reduction of up to 54% in rural areas (Elvik et al., 2009).

Traffic volume

Data from New Zealand for the time period 2000-2009 shows that fatal and serious injury run-off road and head-on crashes increase with traffic volume (New Zealand Transport Agency, 2011). However, the fatal and serious injury rate decreases rapidly for run-off road crashes from around 10 crashes to 3 crashes per 100M VKT (Vehicle kilometres travelled) as AADT (Average annual daily traffic) increases from 500 to 5500, probably as a result of reductions in excessive speed. The rate is fairly stable for head-on crashes at around 2.5-3 per 100M VKT across all traffic volumes, reflecting the necessity for an opposing vehicle to be present for this type of crash, (New Zealand Transport Agency, 2011).

Intersections

Most regional and remote intersections in Australia are priority-controlled and tend to have a relatively high crash rate (Austroads, 2017). Regional and remote roundabouts have been shown to be less safe than urban roundabouts. This is thought to be a result of higher approach, entry and circulating speeds (Austroads, 2017).

Road alignment

Horizontal curves increase the casualty crash risk, particularly if associated with high approach speed and speed change across the curve (Austroads, 2015b). Casualty crashes also increase with increasing grade, particularly with downhill grade and grade greater than 6% (Austroads, 2015b).

3.1.3 Roadside environment

Roadside features

Clear zones of greater than 2m at the side of the road are associated with a decreased risk of run-off-road crashes (Austroads, 2011b, 2014a) but a small increase in crash severity with increasing clear zone width has been reported by Doecke and Woolley (2011) as a result of an increased risk of high severity rollover crashes. Steep roadside slopes (gradient 1:3.5) compared to a flat road side (1:6 or flatter) have been shown to double the rate of run-off road casualty crashes (Austroads, 2011b). Hazard density of greater than 50 per 100m of roadside compared to less than 25 per 100 m is also associated with an increased risk of casualty run-off-road crashes (Austroads, 2014a).

Animals on the road

In addition to vehicles colliding with immovable roadside objects, vehicles are at risk of colliding with wildlife and livestock, which can behave unpredictably and appear on roads without warning. Crashes may also occur as a result of vehicles swerving to avoid colliding with an animal (Rowden, Steinhardt, & Sheehan, 2008). The majority of animal/vehicle collisions in Australia occur on regional and remote roads and most often take place around dawn and dusk or during the darker hours. Data from motor vehicle insurers in Australia indicate that upwards of 80% of animal collisions on Australian roads involve kangaroos (e.g., 83% in NSW), with wombats, dogs, cats, and cattle also commonly hit by vehicles (AAMI, 2018; NRMA Insurance, 2018; RACV, 2016). Rowden et al., (2008) reported a significant over-representation of motorcyclists compared to other vehicle occupants in animal-related crashes.

3.2 Safe Vehicles

3.2.1 Vehicle age and safety

Gradual improvements in the structural engineering of vehicles to create ‘crumple zones or ‘safety cells’ and the introduction of seat belts and airbags to reduce the exposure of occupants to impact forces that result in injury (Khalil, 2015), have significantly contributed to a reduction in road injuries. This is especially so in first world, highly motorised countries. In more recent times, these improvements have been supplemented by developments in vehicle technologies that help mitigate the occurrence of crashes in the first instance. These features refer respectively to the secondary and primary safety of the vehicle; vehicles that have a high level of both are known collectively as Safe Vehicles, to use Safe System terms. The use of Safe Vehicles is especially important in the high speed road environment of regional and remote areas. This is because primary safety features can help mitigate the increased occurrence of particular crash types that characterise regional and remote area crashes such as single vehicle, run-off road crashes; head-on crashes (Siskind, Steinhardt, Sheehan, O’Connor & Hanks, 2011; Palamara, Kaura & Fraser, 2013) and fatigue-related crashes (Palamara, 2016). Furthermore, safe vehicles with a high level of crashworthiness can also reduce the comparatively high risk of death and serious injury associated with regional and remote area crashes (Siskind et al., 2011; Palamara et al., 2013).

Vehicle age and safety are intrinsically linked. Crash data from Australia and New Zealand shows that, for crashes occurring during the period 1987-2014, the risk of a driver being killed or seriously injured has declined by around 75% during a 50 year manufacturing period (Newstead, Watson & Cameron, 2016). Other data from the Australian New Car Assessment Program (ANCAP) (2017) shows that vehicles manufactured up to and including the year 2000 and during the period 2001-2005 were over-represented in Australian fatality crashes occurring in 2015 for their registered vehicle numbers compared with more recently manufactured vehicles. These two investigations highlight the general premise that crash involved occupants of newer, recently manufactured vehicles are less likely to be seriously injured compared with crash involved occupants of older vehicles.

The safety of vehicles has been improved by more recent advancements in vehicle technologies that mitigate the occurrence of crashes in the first instance. These primary safety features are a mix of both active and passive technologies, meaning that drivers must either actively respond to the technology (e.g., apply the brakes) or that vehicle systems will automatically respond to avoid a forward or lateral collision (e.g., adjust power and braking to the wheels to mitigate a loss of control, run-off road crash or crash with a vehicle in front). Other examples of these passive technologies include, but are not limited to, Electronic Stability Control (ESC); Autonomous Emergency Braking (AEB), and Lane Departure Warning (LDW) and Lane Keeping Assist (LKA) (Palamara, 2018). The technologies began to emerge in the Australian new car market in the mid to late 2000's with ESC and in the last three to five years for the latter technologies. These features are described in more detail in the section on safe vehicle countermeasures (section 4.2).

Two important sources of information about safe vehicles are the Australian New Car Assessment Program (ANCAP) (www.ancap.com.au) and the Used Car Safety Ratings (UCSR) guide (www.howsafeisyourcar.com.au). The star ratings provided by these programs define the safe vehicle status of new and second-hand crash involved vehicles in Australasia. They provide important consumer-level information that can be used to guide the purchase of a vehicle by government, corporates and personal buyers alike. Further details on these programs are presented in section 4.2 on safe vehicle countermeasures.

In 2017, around 41% of light passenger vehicles registered in Australia were manufactured up to and including 2007 (Australian Bureau of Statistics, 2017b) with the average age of the registered light passenger vehicle fleet being 9.8 years (Australian Bureau of Statistics, 2017b). These figures suggest that many Australian drivers and their occupants are travelling in vehicles fitted with less than optimal primary and secondary safety features. No data has been published to date showing the distribution of the age of the registered vehicle fleet or the distribution of safe vehicle rating by region. Nor has national data been published on the age of crash involved vehicles by region of crash. In the absence of these data it is difficult to quantify the extent to which vehicle factors contribute to the disparity in regional road injury trauma. At a population level, there is some information to show that certain drivers in regional and remote areas, compared with major cities, may be more likely to drive older-age, less crashworthy vehicles with none of the contemporary crash avoidance features. Analysis of crash data and other qualitative research indicates that these drivers are more likely to be younger in age from middle to low socio-economic status (e.g., Raftery & Anderson, 2012) and Aboriginal people (Helps, Moller, Kowanko, Harrison, O'Donnell & de Crespigny, 2008; CARRS-Q, 2016).

3.3 Safe Speeds

3.3.1 Speed limits

The association between higher vehicle speed, increased crash rates and injury severity is well established (Aarts, Van Nes, Wegman, Van Schlagen, & Louwerse, 2009; Nilsson, 2004). Nilsson (2004) modelled the relationship between speed and crash risk and showed that a 5% increase in mean speed leads to around a 10% increase in all injury crashes and a 20% increase in fatal crashes. Kloeden et al., (2001) showed that there is a greater than exponential increase in the risk of a casualty crash for vehicles travelling above the mean traffic speed on regional and remote roads in South Australia with a speed limit of 80km/h or more.

Within the Safe Systems approach, it is acknowledged that humans will continue to make mistakes and that road infrastructure and vehicles should be designed to minimise the effect of a crash. Similarly, speeds should be set such that they minimise the effect of a crash, given the prevailing road infrastructure. Research studying the biomechanical tolerance of humans in crashes suggests speed limits should ideally be set within these tolerance limits. For poor quality undivided roads, the target speed limit should be around 70 km/h, as currently used in Sweden (Fildes, Langford, Andrea, & Scully, 2005). A more recent model proposes an alternate relationship between speed and fatality or serious injury (Jurewicz, Sobhani, Woolley, Dutschke, & Corben, 2015). Based on this model critical impact speeds were estimated at which 10% of people aged 15-55 years may be seriously injured. This model indicated ideal speed limits should be even lower than those proposed by Fildes et al., (2005).

There are clear differences between regional and remote roads, and urban roads. First the default speed limit on regional and remote roads is 100km/h in all states and territories other than WA and the NT where it is 110 km/h. In urban areas the default speed limit is 50 km/h but can range from 25km/h to 90km/h. Irrespective of whether drivers follow the law or exceed the speed limit, higher travel speeds increase both the likelihood that a crash will occur and the severity of injuries in crashes. An analysis of speed related crashes in regional and remote Australia for the period 2003-2007 suggested that speed contributed to around 28% of fatal crashes and 20% of injury, although there was considerable variation by jurisdiction, probably as a result of reporting practices (Austroads, 2014). Fatal injuries were greatest when the speed limit was 110 km/h. Factors increasing the risk of a speed related crash in regional and remote areas included the road being curved, the road being flat and not hilly, wet road conditions, and occurring mid-block. Speed-related crashes at intersections were most likely to occur at T-junctions. Speed is a major contributor to “off-path on curve” casualty crashes, which form 78% of speed-related casualty crashes (versus 20% of non-speed crashes) and 63% of fatal speed-related crashes (versus 14% of non-speed related crashes) (Austroads, 2014). Males, young drivers (17-24 years old), motorcyclists, and rigid truck drivers are also over-represented in regional and remote speed-related crashes (Austroads, 2014).

The effects of higher travelling speeds in regional and remote areas are exacerbated by other factors, particularly the characteristics of the driving environment. Many regional and remote roads are undivided, of poor quality, and there is a higher share of unsealed roads in regional and remote areas. Furthermore, roadsides can be more hazardous due to lack of, or narrow or unsealed shoulders, limited or no clear zones, and other features such as embankments, culverts, and trees at the side of the road. Road geometry may also be more challenging due to poor curve alignment and changing gradient. For these reasons, many roads in regional and remote areas would be better suited to a lower speed limit. In addition to the nature of regional and remote roads, there is also a greater likelihood of encountering livestock and wildlife, and heavy vehicles, including mining vehicles, agricultural vehicles, and road trains (National Rural Health Alliance, 2015). Undivided regional and remote roads are known to have higher fatal crash rates than other road types (Austroads, 2010).

Vehicles can also moderate the relationship between travel speed and crash outcome. Compared to vehicles in metropolitan areas, vehicles in rural and remote areas are generally older, less well maintained, and have fewer safety features (e.g., ESC). As such, vehicles in regional and remote areas are less crashworthy and able to ameliorate the consequences of high-speed crashes.

Enforcement plays an important part in speed management in general but faces a number of challenges in regional and remote areas, including low traffic volumes and limited resources. Police in regional and remote areas are also responsible for general duties and may have limited time to dedicate to traffic enforcement. Also, due to geography, large road networks with low traffic volume, and personnel limitations, police presence may not be economically justifiable. Other factors that impact on enforcement include size of regional and remote communities, which means that information about the location of speed enforcement spreads quickly via word-of-mouth, and some police officers may be reluctant to enforce unpopular road rules for fear of being ostracised from the community in which they live. Nevertheless, lower speed limits on regional and remote road will not get compliance unless there is significantly increased enforcement.

3.4 Safe People

Unsafe road use contributes to crashes across urban, regional and remote environments, though the crash risk and injury severity associated with performance failures or risk taking can be more severe in non-urban areas because of unique geographic factors (e.g., high speed road environment; unprotected roadsides). This section summarises various road user factors that increase the risk of crashing (e.g., drink and drug driving; fatigue; unlicensed driving; at risk driving populations) and the risk of injury in the event of a crash (e.g., non-use of seat-belts and child restraints). Whilst certain drivers are more inclined to engage in excess or inappropriate travel speed, the issue is considered as a 'network' problem and is addressed under safe speed countermeasures (section 4.3).

3.4.1 Alcohol and illicit drug use

Alcohol and illicit drugs are two commonly used substances that have the capacity to impair drivers and increase the risk of crashing and injury. In regard to alcohol, Australians residing in remote and very remote areas (36.7%) compared with major cities (24.2%) consume alcohol at very risky levels on a monthly basis (i.e., 11 or more standard drinks in a single session in the preceding 12 months) (AIHW, 2017).

National survey data show that particular regional and remote groups are more likely to drink at risky levels: these groups include males, younger age persons and Aboriginal people (National Rural Health Alliance, 2014). In relation to Aboriginal people, a risky level of drinking translates to a high incidence of drink driving offending, which is strongly associated with increasing remoteness (Fitts, Palk, Lennon & Clough, 2013). Using data from a variety of sources, the Australian Transport Council (2011) estimated that illegal levels of alcohol were the main contributing factor in the crashes of approximately 30% of Australian drivers and riders killed, and 9% of total serious injuries during the 2008-2010 base-line period for the 2011-2020 National Road Safety Strategy. Other data indicates that these percentages were higher for drivers and riders killed in regional (11.2%) and remote (14.7%) areas, compared with major cities in Australia (8.3%) (Table 2.4: Austroads, 2019b).

Within regional and remote Australia, it is clear that certain population groups also have a high risk of involvement in an alcohol-related crash. For example, up to 65% of Aboriginal road fatalities in the Northern Territory were reported to be alcohol related compared with 35% for non-Aboriginal (Job & Bin-Sallik, 2013). Though age (17-39 years), gender (male) and licensing status (unlicensed) have been found to be significant risk factors for involvement in an alcohol related fatal/serious injury crash across all Western Australian regions, the odds ratios were somewhat higher for all three groups who crashed in regional and remote WA during the period 2005-2009, compared with those who crashed in metropolitan Perth (Palamara, et al., 2013).

Illicit drugs are reportedly used less frequently than alcohol in the general Australian population (AIHW, 2017), though their use by drivers is now widely recognised as a source of potential impairment and risk factor for crash involvement and injury (OECD, 2010). There is also evidence to show that illicit drugs are used in combination with illegal levels of alcohol (Palamara, Broughton & Chambers, 2014; Wundersitz & Raftery, 2017), a pairing which can exacerbate the driver's level of impairment (OECD, 2010).

At the jurisdiction level, illicit drugs in fatally injured drivers has been reported to be as high as 24% in South Australia (2012-2016) (Department of Planning, Transport and Infrastructure, 2017); 23% in Western Australia (2000-2012) (Palamara et al., 2014), and 20.6% in NSW (July 2015-June 2016) (NSW Centre for Road Safety, 2017). In New Zealand, the presence of illicit drugs in fatal crashes is reported in association with alcohol. For the period 2014-2016, the combination was judged to be a factor in approximately 29% of fatal crashes (Ministry of Transport, 2017b).

Unfortunately, there is limited, incomplete data at the national level on the incidence of illicit drugs among fatally injured drivers by region of crash. In select jurisdictions, the incidence of illicit drugs in fatally injured regional drivers varies between 20% for regional Western Australia compared with 25.6% for metropolitan Perth (Palamara et al., 2014) to 68% in all other areas outside of Sydney, Newcastle, Wollongong (NSW Centre for Road Safety, 2017). In New Zealand, approximately 20% of fatal injury crashes occurring on open roads are reported to involve a combination of alcohol and illicit drugs (Ministry of Transport, 2017b).

As is the case for drink driving, certain drivers have a greater risk of involvement in a fatal, illicit drug related crash. This includes males and drivers less than 40 years of age; drivers with a BAC in the range of 0.050gm% - 0.149gm%; unlicensed drivers, and drivers positive for the use of opioids and benzodiazepines (Palamara at al., 2014). These findings have been adjusted for region of crash.

3.4.2 Driver fatigue

Despite the noted difficulties in defining driver fatigue and quantifying its involvement in crashes (i.e. difficult to measure), it is widely acknowledged as a significant source of driver and rider inattention, impairment, and crash risk (Phillips, 2015). The Australian Transport Council (2011) speculates that fatigue may be a contributing factor for between 20% and 30% of casualty crashes in Australia. Other Australian estimates for the involvement of fatigue in fatal crashes vary between 9.3% in Queensland (Department of Transport and Main Roads, personal communication, February 2019) and 17.5% of fatalities for the period 2009-2013 in Western Australia based on a combination of police assessments and the application of the ATSB proxy measure (Dobbie, 2002) for fatigue (Palamara, 2016). Historically, fatigue has been identified as a regional and remote road safety problem because fatigue-related crashes were more commonly ‘observed’ on high speed roads in these areas (Haworth & Rechnitzer, 1993). These observations consequently influenced the development of the ATSB proxy measure (Dobbie, 2002) to be restricted to particular single vehicle and head on crash types on roads rated ≥80km/hour (as well as other factors such as time of day of the crash and excluding certain driver conditions).

A number of driver risk factors have been noted for fatigue-related crashes (Palamara, 2016). The incidence appears to be higher among younger to middle age drivers (i.e., 16 to 39 year of age). There is also reasonable evidence to conclude that males are more likely than females to be involved in fatigue-related crashes. Fatigue or sleepy/drowsy driving has also been noted to be a significant factor in the crashes of heavy vehicle drivers. The risk of fatigue driving among heavy drivers is thought to be due to a range of factors. These include work place practices that result in long working hours; long driving distances; late night/early morning driving; extended periods of wakefulness and poor quality sleep, and a high incidence of untreated obstructive sleep apnoea (see Palamara, 2016, for a review).

3.4.3 Unlicensed driving

Unlicensed drivers are a well-known risk taking group (Watson, Watson, Siskind, Fleiter & Soole, 2015) who feature prominently in fatal and serious injury crashes, particularly in non-urban areas (Siskind et al., 2011; Palamara et al., 2013; Austroads, 2013). They are known to engage in behaviours that increase their risk of crash involvement due to their increased incidence of drink driving (Palamara et al., 2013; Watson et al., 2015), drug driving (Palamara et al., 2014), and high range speeding (Watson et al., 2015). If involved in a crash, unlicensed drivers have a high risk of being killed or seriously injured (Austroads, 2013) because they also have a high likelihood of being unrestrained (Palamara et al., 2013).

Unlicensed drivers are also generally more likely to be involved in crashes that occur outside urban areas of Queensland (Siskind et al., 2011) and Western Australia (Palamara et al., 2013). Australian data (Table 2.4: Austroads, 2019b) highlights the higher incidence of unlicensed driving in fatal crashes in remote areas (18.5%) in 2016, compared with fatal crashes in major cities (9%) and regional areas (3%).

The circumstances leading to unlicensed driving may vary and, as a consequence, have implications for the countermeasures that are likely to be most effective. For example, approximately 43% of unlicensed drivers involved in a crash resulting in death or serious injury in remote Western Australia during the period 2005-2009 had never held a licence as opposed to having a licence suspended or cancelled. This could be associated with Aboriginal status, given that this population group in regional locations has considerable difficulty in obtaining a licence (see section 3.4.5) and secondly, that Aboriginal people are significantly more likely to be involved in fatal and serious injury crashes occurring in regional areas of Western Australia compared with metropolitan Perth (Austroads, 2009).

Barriers to obtaining a driver's licence for Aboriginal people were identified by Cullen et al., (2016) as individual and family (financial, literacy issues, language, lack of confidence), and systemic (proof of identity documents, meeting requirements of graduated driver licensing, justice system, culturally responsive and aware service provision and cycle of licensing adversity). Many of these are also applicable to other socially disadvantaged groups of the population.

3.4.4 Seat belt and child restraint use

The use of seat belts and other restraints by adult and child vehicle occupants is a key element of the secondary safety system of vehicles to reduce crash related injury severity (Kent & Foreman, 2015) and is thus central to reducing regional and remote road injury. Research into the effectiveness of seat belt use has estimated that the risk of fatal injury for front-seat occupants in light vehicles could be reduced by 45% to 50% and by about 25% for rear-seat passengers (Elvik & Vaa, 2004). Child restraint systems have similarly been shown to be highly effective in reducing injury severity for crash involved children. Klinich, Manary & Weber (2012) reported that death and serious injury could be reduced by 54% and 82% respectively, depending on the type of restraint used and its configuration (e.g., forward versus rearward facing child seat; boosters used in conjunction with adult belts).

Unrestrained vehicle occupants travelling on regional and remote area roads have an increased risk of death or serious injury in the event of a crash because of the higher speeds at which crashes are likely to occur. Nationally, approximately 35% of vehicle occupants fatally injured in remote area crashes in Australia in 2016 were unrestrained compared with 16% in regional area crashes and 7.9% in crashes occurring in major cities (Austroads, 2019b). While national data also shows that the proportion of fatally injured unrestrained occupants has declined since the baseline period of 2008-2010, the larger percentage change was recorded for major city crashes (41% reduction) compared with a 26% reduction for remote area crashes and a 17% reduction for regional area crashes. Failure to use restraints thus continues to be a major issue in regional and remote areas.

Jurisdiction level research has identified a range of non-region specific risk factors for adults being unrestrained in the event of a crash. These include male gender and occupants aged 17-39 years (Austroads, 2009; CARRS-Q, 2016); low socioeconomic status which also coincides with regional and remote residential status and the observed lower use among Aboriginal people (Austroads, 2009); passengers rather than drivers, particularly those occupying a back seat position (Austroads, 2009); drivers of older vehicles, 4WD and utility variants (Austroads, 2009), and drivers who drink and drive and drive unlicensed (Palamara et al., 2013). Other factors contributing to lack of seatbelt use include overcrowding due to a lack of vehicle ownership together with large distances to be travelled which make it inefficient to do multiple trips (i.e. socioeconomic and remote factors). Many community leaders also have a casual attitude to seat belt use and fail to reinforce the message that they are required to be worn (B Niemeier, personal communication, 12 December 2018). In addition, travel within the community is often at low speed and vehicle occupants hold a mistaken belief that seatbelt use is unnecessary when travelling at low speeds.

Compared with adult seat belt use, there is an absence of national information on the prevalence of the non-use of restraints among children and the known risk factors by region. At the jurisdiction level, nearly all children aged 0-12 years observed travelling in vehicles across New South Wales in 2008 were noted to be restrained, though more than three-quarters of ‘restrained’ children were noted to be using restraints that were incorrectly installed or inappropriate for their age/size (Brown et al., 2010). These findings underscore the notion that child restraint systems can be considerably more complex to install and use (Klinich et al., 2012), particularly for parents/caregiver of low socioeconomic, non-English speaking groups (Keay, Hunter, Brown, Bilston, Simpson, Stevenson & Ivers, 2013; Hall et al., 2018).

3.4.5 At-risk populations

Many of the road safety issues in regional and remote areas are a product of the environment and remoteness and, as such, directly impact on the people who live in those areas. There are some populations that have an increased risk, including Aboriginal populations, motorcyclists, international visitors, and local residents. Heavy vehicle drivers are also considered, as they have been reported to be a high risk group in the past (Austroads, 2006).

Aboriginal people

Aboriginal people are a special consideration for regional and remote road safety and, while they face the same issues as all other regional and remote residents, there are a number of issues of particular concern for this population (Thomson, Krom & Ride, 2009).

Henley and Harrison’s (2013) analyses of road injury rates in Australia by remoteness and indigenous status indicate that both fatal and serious injury rates increase with remoteness for both Aboriginal and non-Aboriginal populations (see Table 3.1). The rate of fatal land transport injuries is significantly higher in the outer regional, remote and very remote Aboriginal population than in the non-Aboriginal population. However, rates of serious land transport injury are significantly lower in the Aboriginal population in regional and very remote areas. A similar lower (but non-significant) rate of serious land transport injury exists among the Aboriginal population in remote areas. The latter findings may due to the lower rates of non-traffic land transport injuries in the regional and remote Aboriginal population compared to the non-Aboriginal population (Henley & Harrison, 2013). Further research is required to disentangle this relationship.

Differing patterns in road use by Aboriginal people are partially a result of low socioeconomic status, which impacts upon the ability to gain a driving licence, to drive legally and safely, and to access and maintain safe vehicles. Aboriginal people often travel large distances to attend cultural events with family members (Helps & Moller, 2007; Watson, Elliott, Kinsella, & Wilson, 1997). Travel commitments, combined with the regional and remote residence of a large proportion of Aboriginal people, result in travelling greater distances on roads with higher speed limits that are not as well maintained, and in cars that may be overcrowded, lacking modern safety features as well as being poorly maintained (Thomson, Krom, & Ride, 2009).

A recent report by Austroads on Aboriginal driver licensing programs highlighted the high level of transport disadvantage in Indigenous people occurring as a result of socio-economic, geographic and historical factors (Austroads 2019a). Transport disadvantage perpetuates disadvantage by resulting in reduced access to education, training, employment and services. Barriers to obtaining a driving licence are also documented. These have been described in section 3.4.3.

Table 3.1: Age-standardised fatal and serious land transport injury rates by remoteness area of usual residence and Indigenous status, 2005-06 to 2009-10

ASGC Remoteness area of usual residence	Age-standardised rate[a] (95%CI)					
	Indigenous Australians			Other Australians		
	Males	Females	Persons	Males	Females	Persons
Fatal injury						
Major cities	13 (10-17)	7 (5-10)	10 (8-12)	9 (9-10)	3 (3-3)	6 (6-6)
Inner regional	21 (16-28)	11 (8-16)	16 (13-20)	20 (19-21)	7 (7-8)	14 (13-14)
Outer regional	33 (27-41)	12 (9-17)	22 (19-26)	24 (23-25)	8 (7-9)	16 (15-17)
Remote	63 (51-79)	37 (28-50)	50 (42-56)	32 (28-37)	11 (8-14)	22 (20-25)
Very remote	67 (56-79)	31 (24-40)	48 (42-56)	33 (27-41)	14 (9-20)	25 (20-30)
Overall[b]	**27 (23-31)**	**13 (10-15)**	**20 (18-22)**	**11 (10-11)**	**4 (3-4)**	**7 (7-7)**
Serious injury						
Major cities	289 (270-308)	146 (133-160)	216 (205-228)	266 (265-268)	124 (123-126)	196 (195-197)
Inner regional	395 (368-421)	180 (161-199)	288 (272-305)	450 (445-454)	192 (189-195)	322 (320-325)
Outer regional	425 (424-480)	192 (175-210)	320 (304-336)	536 (529-543)	220 (215-224)	383 (379-387)
Remote	613 (562-664)	300 (268-333)	453 (424-483)	697 (677-717)	270 (256-283)	496 (483-508)
Very remote	586 (548-623)	283 (258-308)	432 (409-454)	857 (816-897)	436 (404-468)	667 (641-694)
Overall[b]	**425 (412-438)**	**200 (191-208)**	**311 (303-318)**	**331 (329-332)**	**148 (147-149)**	**240 (239-241)**

(a) Per 100,000 population per year, adjusted by direct standardisation to the Australian population in June 2001.
(b) All remoteness areas combine. Age-standardised; not standardised for remoteness.
Note: The geographic scope of this table is the Northern Territory and all Australian states except Tasmania (see Appendix A)

Source: Henley and Harrison, (2013)

International drivers

The most comprehensive review of crashes involving international drivers remains that of Watson et al., (2004), which showed that the proportion of international driver crashes occurring in regional and remote areas was higher than in the metropolitan area. Overall, international visitors represented a small proportion (0.7%) of fatal and serious injuries in Australia, apart from the Northern Territory where they represented over 13% of fatalities and 8% of serious injuries. Factors that may increase the risk of crashing for those unfamiliar with Australian regional and remote roads include travelling long distances and fatigue; sub-optimal road conditions, particularly with regard to unsealed roads; the need for a four wheel drive vehicle with which they may also be unfamiliar; and left-hand side driving and disorientation (Dempsey, 2016). There are also anecdotal reports of road safety issues concerning interactions between international and interstate drivers towing caravans, and heavy vehicle drivers. Drivers towing caravans may not be accustomed to overtaking large road trains (double, triple, and quads) or understand the time and distance required for such a manoeuvre.

Local residents

Contrary to commonly held beliefs among residents in regional and remote areas, it is local residents who are involved in the majority of crashes in regional and remote areas. Sticher and Sheehan (2006) conducted a focus group study to look at risk factors for regional and remote crashes, and compared the opinions of their participants with 290 control drivers and the findings from a study of 143 patients hospitalised following a road crash in Far North Queensland. They found that, contrary to the opinions of the focus group members, most crashes involved local residents as opposed to visitors from within Queensland or Australia. In fact, 60% of crashes involved drivers also from Far North Queensland, 19% from Cairns, 9% from other areas of Queensland and 6% from other states (place of residence was missing in 6% of cases). In addition, a recent media campaign ‘Saving Lives on Country Roads’ by Transport for NSW states that more than 70% of fatal crashes on country roads involve country residents (NSW Centre for Road Safety, 2018).

Heavy vehicle drivers

While heavy vehicles may be quite prevalent in regional and remote areas, they tend to be under-represented in crashes when considering vehicle kilometres travelled (VKT).Table 3.2 shows that the fatal crash rate per 100 million VKT is slightly lower outside of greater capital cities for heavy rigid truck crashes and much lower for articulated truck crashes whereas the passenger car fatal crash rate is higher (BITRE, 2016).

Table 3.2: Fatal crashes, VKT and rates of fatal crashes per 100 million VKT, 2014

	Greater Capital City			Rest of State		
	10^8 VKT	Fatal crashes	Rate per 10^8 VKT	10^8 VKT	Fatal crashes	Rate per 10^8 VKT
Heavy rigid truck-involved	5.0	40	0.8	4.9	35	0.7
Articulated truck-involved	1.5	23	1.6	6.4	78	1.2
Passenger car-involved	104.6	274	0.3	67.9	408	0.6

Source: BITRE, 2016 (Table 17)

A study of heavy vehicle crashes in Western Australia during 2001-2013 by Zhang et al., (2014) showed fewer crashes of articulated heavy vehicles occurring in regional and remote WA compared to metropolitan WA. Around 68% of fatal crashes and 58% of crashes requiring hospitalisation occurred in regional and remote areas compared to around 35% of property damage and 38% of medical attention (not hospital) crashes.

Motorcyclists

Over the previous ten years, motorcycle riding has grown in popularity, primarily for daily commuting and leisure/recreation, which has subsequently resulted in significantly increased exposure for this road user group. Despite the growth of motorcycle ownership and riding during the past decade, there has been improvement in national trends in motorcyclist fatality rates per registered vehicle and per kilometre travelled. However, the number of deaths of motorcycle riders in Australia is similar to that of 10 years ago (BITRE, 2017). There appears to have been a shift in the proportion of fatal crashes involving motorcyclists from urban areas to regional and remote areas. For instance, 59% of crashes involving a motorcyclist fatality occurred in regional and remote Australia during the four-year period 2012-2015, which is an increase from 53% for the period 2008-2011 (BITRE, 2017). National data from Australia indicated that, while motorcyclist deaths decreased in major cities, they increased in regional and remote areas in 2016 compared to the baseline period, 2008-2010 (Table 2.3: Austroads, 2019b). The largest increase in motorcyclist deaths was observed in remote Australia where there was a 49.3% increase in 2016 compared to the baseline period, 2008-2010.

The typical motorcycle fatality or hospitalisation in regional and remote areas is a male motorcyclist who is riding recreationally during daylight hours on the weekend and is involved in a single-vehicle crash (ACRS, 2012; BITRE, 2017; Johnston, Brooks, & Savage, 2008; Motorcycle Safety Review Group, 2015; Parliament of Victoria, 2012).

3.4.6 Post-crash emergency response

Post-crash emergency response involves a series of events including crash discovery, emergency notification and activation, on-scene time, transport, and pre-hospital medical care (BITRE, 2018b; Wall, Woolley, Ponte, & Bailey, 2014). Considering the importance of time from the trauma to initial prehospital care, the vastness of the Australian regional and remote road network presents obvious issues for emergency response and trauma management in the post-crash phase (Croser, 2003; Fatovich, Phillips, Langford, & Jacobs, 2011).

Emergency response and retrieval times are significantly longer in regional and remote areas than in urban areas (BITRE, 2018b; Fatovich et al., 2011). Fatovich et al., (2011) compared retrieval times for major trauma in metropolitan Perth by ambulance to retrieval by the Royal Flying Doctor Service for rural patients transferred to a tertiary hospital in Perth. Average time of trauma to first provider input for rural versus metro (55 minutes vs 18 minutes), average time of first provider input to time of arrival at tertiary hospital (10.1 hours vs 43 minutes) and average time of trauma to time of arrival at tertiary hospital Emergency Department (11.6 hours versus 59 minutes) were all significantly longer for the rural group of patients. However, this example represents one of the more extreme cases and is based on data from 1997-2006. Retrieval time impacts on crash outcomes with delays until discovery or delays in accessing the trauma system increasing the risk of mortality following major trauma (Fatovich et al., 2011). Time till ambulance arrival has been found to be a significant predictor of the risk of death from major trauma, after adjusting for age and injury severity (Fatovich et al., 2011).

4. Regional and Remote Road Safety Countermeasures

Following the identification of factors associated with an increased crash risk in regional and remote areas in the previous section, this section discusses a suite of evidence-based countermeasures and initiatives for key issues under each of the four pillars of the Safe System. For each of the key issues in regional and remote areas, a summary of the countermeasures is highlighted in a table (see Tables 4.1-4.11), with each of the countermeasures rated according to the strength of the evidence base (low, medium, high).

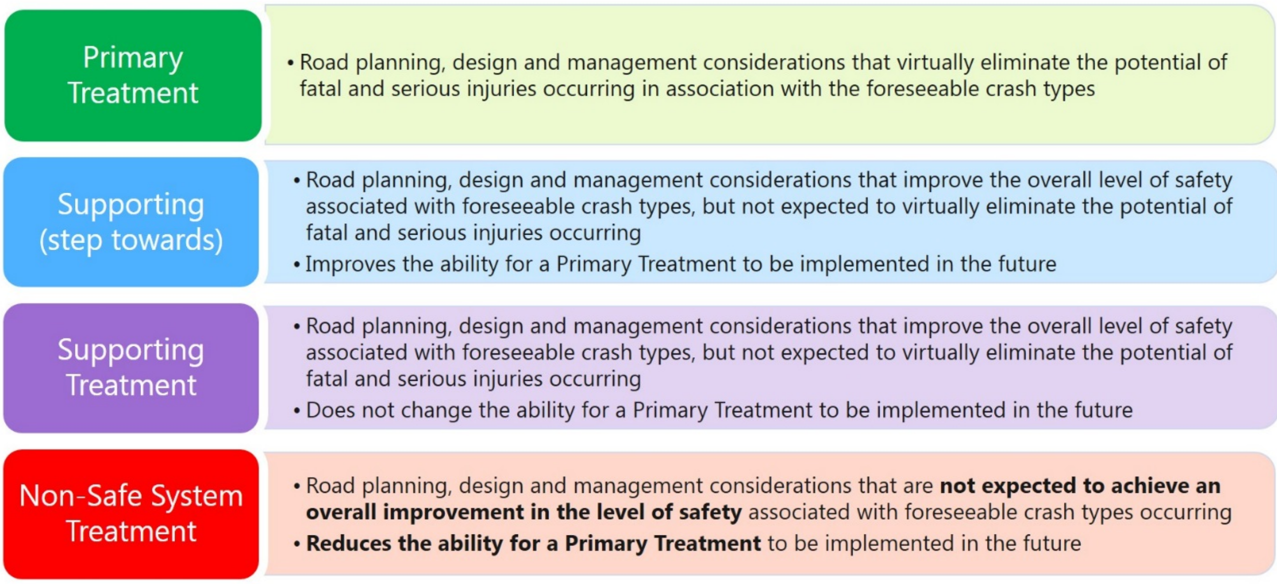
4.1 Safe Roads

4.1.1 Improved road design and infrastructure

The Safe System response to road design aims to focus on treatments and countermeasures that make roads safer by reducing the severity of crashes, rather than focusing on optimum conditions for the mobility and movement of traffic. The long term goal is to transform the road system so that it is inherently safe and harm due to death and serious injury are eliminated. To achieve this, road improvements and new projects should all be aligned with the Safe System.

While speed is the predominant factor that can be altered to improve the safety of our roads, a number of infrastructure measures have been identified which help to prevent crashes that result in fatal and serious injuries. The following diagram (Figure 4.1) provides a guide as to how treatments should be aligned with safe system objectives (Austroads, 2018). For further information, also refer to the Austroads (2016) publication *Safe system assessment framework*.

Figure 4.1: Safe system treatment hierarchy



Source: Austroads, 2018

4.1.2 Corridor protection and flexible barriers

Vehicles may travel off the road for a variety of reasons. This can result in collisions with roadside hazards or rollovers. Head-on collisions may also result from run-off road crashes when there happens to be a vehicle travelling in the opposite direction. New road design options have been introduced which are showing positive results in preventing these types of crashes. The latest research evidence suggests that corridor protection is among the best options (Austroads, 2018). Corridor protection consists of continuous lengths of flexible barrier along roadsides and the median. It can also consist of very low speed limits or lower speed limits, together with the infrastructure improvement. Corridor protection can exhibit near perfect Safe System performance (i.e. almost zero crashes resulting in serious injury or death). Continuous flexible barriers on either the roadside or the median are a supporting treatment compatible with future Safe System improvements. They will still allow vehicles to run-off the side of the road to the left or right but are compatible with further work that would upgrade it to a primary treatment. Where flexible barriers are not yet viable due to cost issues, options such as sealed shoulders and audio tactile line marking, wide centre lines and clear zones at the roadside should be considered, along with lowering the speed limit. Safe system assessment treatment hierarchy for road departure crashes and head-on crashes can be found in Austroads' (2016) *Safe system assessment framework*.

Supporting treatments for run-off road crashes on curves include improved curve delineation and signing, which may be based on run-off-road crash risk at the curve (Austroads, 2015b). Perceptual solutions, such as delineation and signage to create the perception of a tighter curve, vehicle activated signs warning of excessive speed, transverse rumble strips, chevron alignment markers, and "slow" pavement markings ahead of curves have also been shown to be effective at controlling the speed to and through horizontal curves (Austroads, 2014). A summary of Safe System countermeasures to reduce the incidence of run-off road or single vehicle crashes and head-on crashes is provided in Table 4.1 and Table 4.2.

Table 4.1: Safe System countermeasures for single vehicle crashes

Safe System	Countermeasure	Evidence
Safe roads	• Continue implementing road treatments - Continuous roadside barriers, W-beams; ATLM, shoulder sealing; development of clear zones - Continuous centre barriers; wide continuous centre line treatment with ATLM - Risk based curve treatment including edge lines, delineation and improved cross sections	 Medium Medium Medium
Safe speeds	• Reduce speed limits on roads lacking safe infrastructure	High
Safe vehicles	• Increase number of vehicles with Electronic Stability Control, AEB • Increase number of vehicles with lane departure warning and lane keeping assist • Increase number of vehicles with fatigue management/warning technology • Vehicle AEB (capable of detecting Australian fauna)	High Medium Low Low
Safe people	• Increase options for safer travel	Low

Table 4.2: Safe System countermeasures for head-on crashes

Safe System	Countermeasure	Evidence
Safe roads	• Continue implementing road treatments - Continuous centre barriers - Implement 2+1 schemes - Wide continuous centreline treatments, ATLM and divided roads	 Medium Medium Medium
Safe speeds	• Reduce default speed limit outside built-up areas	High
Safe vehicles	• Increase number of vehicles with lane departure warning and lane keeping assist • Increase use of vehicles with high speed Autonomous Emergency Braking	Medium High
Safe people	• Community based campaigns around safe passing practices for particular vehicle types (e.g., truck, caravans)	Low

4.1.3 Intersections

Roundabouts should be the preferred type of regional and remote intersection where feasible with design features allowing for speed dissipation and enhancing the visibility of vulnerable road users (Austroads, 2015b). They are currently the intersection type closest to the Safe System model. Priority intersections are the next choice after roundabouts, as traffic signals are generally not suitable for regional and remote intersections due to the lower traffic flow. A number of design features may be applied to priority-controlled intersections to improve their safety, for example staggered T-intersections (Austroads, 2010). Skew angle intersections and misalignment of lanes have been associated with increased crash risk. Preservation of sight distance is important, taking into account the presence of crests, curves, vegetation, and infrastructure such as poles (Austroads, 2015b).

Roundabouts may not be suitable in many regional and remote environments because of the high speed, low volume environment. High cost of land acquisition, service relocation and construction have been noted as barriers to their use in regional and remote areas (Austroads, 2017). Recent research investigated low cost intersection design concepts that could potentially be retrofitted cost-effectively to regional and remote intersections, particularly those considered to constitute a high risk of serious and fatal crashes (Austroads, 2017). One of these include a ‘regional and remote compact roundabout with safety platforms’, which involve a small single-lane roundabout with a partially or fully mountable central island, to allow for heavy vehicles and raised platforms on approach roads to modify approach speeds from 80-100 km/h towards 60 km/h. Further work on heavy vehicle dynamics, visibility and safety of raised platforms needs to be considered in relation to this design. It is estimated that such a roundabout could provide up to 82% casualty crash reduction if it can achieve low entry speeds through encouraging gradual deceleration (Austroads, 2017).

The second is a ‘regional and remote priority-controlled intersection with safety platforms and reduced speed limits’. This is a regional and remote T-intersection with reduced speed limits on all legs, plus rumble strips and a raised platform on the minor approach road. Potential issues are again visibility and safety of the raised platforms. This intersection concept has not yet been trialled and so a crash reduction factor has not been estimated. Raised platforms are used at intersections in Europe and some trials have begun in Victoria (Austroads, 2017).

The third option is the ‘regional and remote priority-controlled intersection with vehicle activated speed limit’ (Austroads, 2017). This concept uses vehicle-activated reduced speed limit signs on the major road approaching a priority controlled intersection. A lower speed is triggered on the major road when a vehicle approaches on the minor road, or by a turning vehicle on the major road. This concept has been trialled in New Zealand and Sweden (Mackie et al., 2017; Mackie, Hoist, Brodie, Tate, & Scott, 2016; Sevefelt & Wessel, 2012).

4.1.4 Separating animals from traffic

Fencing is one of the most effective means of keeping animals away from traffic but requires regular maintenance to repair damage which otherwise would allow animals to pass through it. It is generally not effective to deter kangaroos, which are able to leap over it. Fencing is usually required in combination with animal overpasses or underpasses as animals are likely to break through it if no alternative route is provided (Ascensao, Clevenger, Santos-Reis, Urbano, & Jackson, 2013; Huijser et al., 2008). While fencing and underpasses/overpasses have been shown to be effective, they are also relatively expensive, particularly in the context of regional and remote Australia.

Other innovations include virtual fencing whereby an animal wears a collar that gives them an electric shock to prevent them crossing the virtual fence (Umstatter, 2011), and roadside devices that emit audio or visual signals when triggered by an approaching vehicle, with the purpose of deterring the animal from entering the road (Huijser & McGowen, 2003). Alternatively, roadside detection systems may detect large animals at the side of the road and trigger a warning such as flashing lights and picture-based sign messages to alert drivers that animals are on the road (Grace, Smith, & Noss, 2017).

Improving visibility for the driver, by lighting dangerous roadway sections at night and reducing speed limits are effective measures for reducing animal-vehicle collisions (Al-Ghamdi & Al-Gadhi, 2004; Huijser et al., 2008). Wider clear zones can also improve driver detection of animals on the roadside, especially at night. Vehicle armoury such as roo/bull bars are used in Australia but may prevent the optimal deployment of safety features such as airbags and crumple zones, and in any case are dangerous for pedestrians (Klocker, Croft, & Ramp, 2006).

Car manufacturers are currently working on onboard advanced detection systems to identify pedestrians and animals, including kangaroos, on the roadway (BBC, 2017; Huijser et al., 2008; Saleh, Hossny, & Nahavandi, 2018; Ydenius et al., 2017). Countermeasures may be accompanied by education campaigns to inform drivers about the presence of animals on the roads and the consequences of animal-vehicle collisions (Huijser et al., 2008). These can also be used to encourage drivers to report straying stock if a reporting system is available. Vehicle-based solutions are particularly beneficial given that alterations to the road environment such as fencing and lighting are in many cases unworkable due to the length of the road network.

4.1.5 Funding for countermeasures

The Blackspot program and Roads to Recovery program as described below are currently available to fund countermeasures. However, corridor safety plans should be developed that identify treatments for sections of road rather than specific locations. These are particularly needed in regional and remote areas where there are few black spots due to an extensive road network and low traffic volumes.

Blackspot Programs

Blackspot programs are funded by federal, state and local government with 50% of funding aimed at regional and remote areas (BITRE, 2012). An evaluation of black spots treated between 1996-1997 and 2002-2003 found that the national program reduced fatal and casualty crashes at treated sites by 30% (BITRE, 2012). Roundabouts were found to be the most effective treatment, reducing casualty crashes by over 70%. This was followed by new traffic signals and altering of traffic flow direction, which were shown to reduce crashes by more than 50%. The analysis showed that regional and remote projects were significantly more effective than urban projects. State blackspot programs have also been shown to be effective at reducing crashes in regional and remote areas (Scully, Newstead, Corben, & Candappa, 2006, Chow, Meuleners, & Hendrie, 2015).

The black spot program has been successful at fixing specific high-risk crash locations. However, funding constraints result in a very small proportion of the network receiving treatment. In the future, it is hoped the program can focus on high-risk sections of road to address a greater range of crash sites and to progressively improve the road network. As up to 50% of the road network is controlled by local government, it will be important that they are supported in applying cost-effective Safe System solutions in their areas (Australian Transport Council, 2011).

Roads to Recovery

The Roads to Recovery Program provides $4.8 billion from 2013-2014 to 2021-2022 to local councils and state and territory governments responsible for local roads where there are no councils. Councils were specifically urged to give priority to road safety projects under this funding and to report post-completion evaluations (Department of Infrastructure, Regional Development and Cities, 2017).

4.2 Safe Vehicles

4.2.1 Vehicle technologies to mitigate crash involvement

Vehicles are being increasingly fitted with an array of technologies that assist the driver to maintain and regain control over the vehicle in a potentially hazardous situation, or even take control over the vehicle if the driver fails to do so. Examples of the technologies that would help mitigate forward and lateral collisions and injuries on regional and remote roads are briefly described below.

Electronic stability control

Electronic stability control (ESC) has the potential to reduce the incidence of vehicle loss of control and run-off road crashes (Tracy, 2013). It recognises when driving conditions have become unstable and the driver is at risk of losing control and the direction of the vehicle. It applies corrective action, independent of the driver, to assist the driver to return to the correct and intended direction of travel (Phan, 2017). ESC is an effective technology; it has been shown to have resulted in a 28% reduction in single vehicle crashes of all injury severities and a 32% reduction in driver injury crashes of all severities, with the biggest reduction observed for rollover crashes involving four-wheel drive vehicles (Scully & Newstead, 2010). One limitation of the technology however, is that it is likely to be less effective in circumstances where the driver is not sufficiently able to take back control over the vehicle, for example, when adversely affected by an impairing substance or fatigue/sleepiness (Scully & Newstead, 2010).

Autonomous emergency braking

Autonomous emergency braking (AEB) has the potential to mitigate forward collisions through the detection of, and emergency braking in response to, a detected object such as a vehicle ahead, cyclist, or even a pedestrian. ANCAP has indicated that, from 2018, a 5-star safe vehicle rating will only be awarded to those passenger cars fitted with AEB (McCowen, 2017). Early iterations of AEB were essentially ‘low-speed’ variants and particularly useful in the city or urban environment. In the regional and remote area context, high speed AEB systems utilise long range radar to detect vehicles and other objects up to 200 metres ahead. Taking into account the driver’s speed, it will determine the risk of an imminent collision before autonomously reducing vehicle speed and applying brakes as required.

Lane departure warning and lane keeping assist

Lane departure warning (LDW) and Lane keeping assist (LKA) technologies are often packaged together to alert and/or assist drivers to maintain lane position to primarily avoid a potential lateral collision. LDW alerts drivers that they are drifting or departing from their lane without having signalled their intention to do so (Jansch, 2017). LKA will automatically take corrective action to move the car back into the lane if the driver has not already done so (Mehler et al., 2014). These technologies have the capacity to reduce the incidence of lateral collisions, such as single vehicle, run off road crashes; hit object crashes; rollover crashes; and even head-on collisions (Vehicle Safety Research Group, n.d.) commonly occurring on regional and remote roads.

Adaptive cruise control

Adaptive cruise control (ACC) automatically adapts the vehicle's speed to maintain a constant, safe headway behind the lead vehicle (Dickie, Ng & Boyle, 2009). ACC differs from autonomous emergency braking in that it will not perform emergency braking, though may undertake moderate braking to maintain a safe headway time (Mehler et al., 2014). ACC maintains speed and distance and thus has the potential to reduce the risk and incidence of rear-end crashes (Xiao & Gao, 2010) and the incidence of speed-related crashes in rural areas (OECD, 2016). Field testing has shown that drivers who use ACC, compared with those who do not maintain longer headway distances to the vehicle ahead (Kessler et al., 2012). Longer headways are likely to be protective against involvement in a forward collision with wandering animals in the regional and remote context (AAMI, 2018).

Fatigue warning and monitoring systems

The use of vehicles fitted with systems to monitor the driver for alertness or drowsiness has the potential to reduce the incidence of fatigue related crash types (Vehicle Safety Group, n.d.) that frequently occur on regional and remote roads. These systems are less likely to be effective, however, when the driver is affected by alcohol or other impairing substances (i.e., unable to respond appropriately) (Vehicle Safety Research Group, n.d.). At this stage, fatigue warning and monitoring systems are most often fitted to commercial transport and haulage vehicles, often with back-to-base notifications (Lupova, n.d.). Dawson et al., (2014) conclude that there is currently limited scientific evidence regarding the effectiveness of fatigue warning and management systems. They suggest that technologies currently in use by the road transport industry fail to meet regulatory requirements for a legally and scientifically defensible device and are not capable of providing a comprehensive fatigue management solution. More recently, vehicle manufacturers such as Mercedes Benz have introduced drowsy driver management systems in the light passenger private vehicle fleet to counter fatigue driving (Auto123.com, n.d.). The Mercedes Benz system is particularly oriented to continuous driving on high speed roads (i.e., over 80km/hour), which are known roads for fatigue-related crashes (Palamara, 2016).

Intelligent speed adaptation

Failure to comply with the posted speed limit has been identified as a risk factor for severe injury crashes in regional and remote areas (see section 3.3). Intelligent speed adaptation (ISA) has the potential to influence a driver's compliance with the posted speed limit in these regions, particularly where road infrastructure treatments and police enforcement is less than feasible to manage drivers' speeds. ISA systems, which typically consist of a GPS connected to a speed zone database, determine the position of the vehicle in a road network in relation to the posted speed limit at that point. If the vehicle is found to be exceeding the speed limit, the system may either provide an advisory warning/alert or alternatively autonomously adjust/limit the vehicle's speed (European Commission, 2019). Most recently, a pilot study examining the potential of a limiting ISA system, using US crash data, suggested that the system could reduce the incidence of serious injury crashes by some 62% (Doecke & Ponte, 2017).

Another form of ISA is traffic sign recognition (TSR), an in-vehicle technology which uses camera vision systems to detect, read and interpret roadside traffic signs, including speed signs. TSR is available in some new cars and can be added as an aftermarket system (e.g. Mobileye). There are a number of issues with the accurate reading of signs and it is likely that vehicle manufacturers will continue to rely on spatial databases of speed zones to supplement TSR systems (Austroads, 2018c). More broadly, the use of ISA may be problematic in regional and remote areas where the appropriate speed may be heavily influenced by road and weather conditions rather than reflecting the posted speed.

4.2.2 Promoting the use of safe vehicles

Safe vehicle ratings programs

ANCAP crash results and the UCSR are widely publicised by government road safety and transport agencies and state-based motoring organisations. The program ratings also feature in the Victorian government sponsored websites: www.howsafeisyourcar.com.au and www.howsafeisyourfirstcar.com.au. Historic and current ANCAP ratings can also be found for used cars advertised for sale on www.gumtree.com.au and www.carsales.com.au websites, though there are issues with the appropriateness of using historic ratings generated by previous testing criteria. ANCAP ratings similarly provide foundation information for the selection of 5-star vehicles promoted by safe vehicle fleet purchasing policies (see below). In the regional and remote area context, there appears to be minimal use of ANCAP and UCSR to promote the uptake of safe vehicles. One notable exception is the Road Safety Commission of Western Australia which has produced a consumer guide on safe vehicles suitable for remote and regional Western Australia (Road Safety Commission, nd.) The document provides some guidelines regarding the selection of suitable new and second hand vehicles using ANCAP/UCSR material and the suitability of the vehicle for the driving conditions of WA.

Safe vehicle fleet purchasing policies

In recent years there has been increased recognition that vehicles serve as the 'workplace' for many workers. This appreciation is formally acknowledged in Australasian work health and safety legislation (Austroads, 2018b). The implication of this is that employers should provide their employees with vehicles that are safe as well as fit for purpose and, secondly, that employers and employees alike have a responsibility to promote and maintain safe use of the workplace vehicle to reduce the risk of crashing and injury. The latter issue is the focus of the Austroads *Vehicles as a Workplace* (2018b) report. The importance of 5-star fleet purchasing policies and guidelines is exemplified in the National Transport Commission's (nd.) *A Guide to Applying Road Safety Within a Workplace*. In 2017, the Australian Government adopted a 5 star fleet purchasing strategy (Department of Finance, 2017). Australian jurisdictions have similarly mandated or committed to safe vehicle purchasing. For example, the Western Australian Government has mandated that public sector bodies purchase 5-star rated vehicles (Government of Western Australia, 2017), while the Victorian Transport Accident Commission (Transport Accident Commission, nd.) has developed mandatory specifications for their vehicle fleet. Five-star fleet purchasing strategies of this kind are expected to inevitably contribute to a faster uptake of safe vehicles in the private sector through the eventual on-sale of these government and corporate fleet vehicles (Australian Transport Council, 2011; National Transport Commission, n.d.).

Barriers to the promotion of safe vehicles in regional and remote areas

Increasing the use of newer, more costly safer vehicles among regional and remote area residents, particularly younger age and Aboriginal people, may be difficult because of the social disadvantage and diminished financial means that characterises the low socio-economic status of residents of these areas (ABS, 2011). Consequently, innovative initiatives to address the financial barrier of purchasing a safer vehicle must be considered for these 'at risk' populations. This could include reduced vehicle stamp duty and registration fees, and priority access to the purchase of safe vehicles retired from the government and corporate fleet. The latter is currently being investigated by the Western Australian Government.

A summary of Safe System countermeasures to reduce the prevalence of older vehicles is presented in Table 4.3.

Table 4.3: Safe System countermeasures to reduce the prevalence of older vehicles

Safe System	Countermeasure	Evidence
Safe roads		
Safe speeds		
Safe vehicles	• Increase use of safer, newer vehicles by regional area residents • 5-Star crash performance and safe driver assist technology vehicle policies for industry and government fleets • Implement a scheme in which a proportion of government fleet vehicle sales are directed to regional/remotes areas • Regulate new technologies (ADRs) on all vehicle types (e.g. ABS for motorcycles, ESC and AEB for heavy vehicles, side airbags for light commercial vehicles)	High Medium Low Medium-High
Safe people	• Community based education/promotion campaigns • Financial assistance via vehicle purchasing, registration and insurance incentives to facilitate purchase of newer, safer vehicles	Low-Medium Low

4.3 Safe Speeds

4.3.1 Lower speed limits

The most obvious method of managing speed is by setting appropriate speed limits. However, when speed limits were initially introduced there was little knowledge of the relationship between speed, crash risk, vehicle safety and vulnerable road users (Austroads, 2018a). Over time the population has become accustomed to driving at high speeds and undoing this practice requires long term, ongoing strategies.

In many cases, the current road infrastructure does not support the speed limit on regional and remote roads in Australia. A speed of 70 km/h or less is currently recommended on the basis of Safe System principles to improve the chance of survival in the case of a head-on crash. Given that many such roads currently have a 100 km/h speed limit, a reduction to 70 km/h is unlikely to gain solid community support and thus smaller reductions in speed may need to be used to bring about incremental improvements. This may be done in conjunction with infrastructure upgrades as discussed in the Safe Roads section.

The choice between lowering the speed limit or improving infrastructure is strongly influence by budget. Victorian data suggest that infrastructure solutions are cost-effective on roads with high traffic volumes (>4000 vehicles per day) whereas speed limit solutions may be more cost-effective on low traffic volume roads (<2000 vehicles per day) (Australian Transport Council, 2011).

Trials of lower speed limits in regional and remote areas have generally demonstrated reductions in casualty crashes. For example, speed reductions on roads in South Australia and New South Wales from 110 km/h to 100 km/h were associated with reductions in casualty crashes of just over 25% (Mackenzie, Kloeden & Hutchinson, 2015; Bhatnagar, Saffron, de Roos, & Graham, 2010). Similar results have been found internationally where increasing speed limits has been shown to increase the number of crashes (De Pauw et al., 2014; Jaarsma et al., 2011; Farmer, Retting, & Lund, 1999; Souleyrette & Cook, 2010). In 2014, Tasmania implemented a reduction in the default limit on unsealed roads from 100 to 80 km/h. The effects of this change have not yet been evaluated.

4.3.2 Engineering treatments

In addition to speed limits, alternative speed countermeasures include engineering treatments and enforcement related options. Engineering based countermeasures aim to alert the driver to potential hazards so that they reduce their speed sufficiently before encountering the hazard. Potential hazards include curves, intersections, approaches to towns, railway level crossings and work sites (Austroads, 2014).

Countermeasures that may alert drivers to these hazards include:

- advance warning signs
- chevron alignment markers
- speed advisory signs/speed limits/variable speed limits
- vehicle activated signs,
- transverse rumble strips
- perceptual countermeasures
- slow markings
- lane narrowing
- adequate sight and stopping distance (for railway level crossings).

Specifically for worksites:

- workers holding slow-down and stop signs
- use of cones or barrier devices to reduce lane width.

Countermeasures for risky curves have been associated with a reduction in crashes of up to 40% and for hazardous intersections a reduction in crashes of up to 70% (Austroads, 2014).

When entering a town, advance warning signs advising that the speed limit is about to change, buffer zones where there is a staged reduction in the speed limit and count-down signs to the new speed limit have been shown to be minimally effective in reducing speeds and crashes (Austroads, 2014; Turner, 2009). Rural thresholds are designed to provide a gateway between high and low speed environments using a combination of signs and road markings and have been trialled in New Zealand. They are most effective when they include road narrowing and have been shown to reduce fatal and serious injury crashes by up to 40% (Charlton & Baas, 2006).

4.3.3 Enforcing safe speeds

Enforcing vehicle speeds to the posted limit contributes to uniform travel speeds and reduces the risk of a serious injury collision across the network. Excess speeding by drivers in regional and remote areas entails considerable risks, largely because of the typically higher speed limits in these areas to begin with, and the significant risk of injury associated with higher speed collisions in these locations. Unsurprisingly, speeding has been identified as a significant contributor to fatal crashes in rural Australia (Siskind et al., 2011). However, enforcing safe speeds in non-urban areas can be problematic. Certain policing and enforcement strategies that are successful in major cities are often unsuccessful or considered unsuitable for use in regional and remote areas. For instance, the effectiveness of speed cameras and random breath testing (e.g., through booze buses) is reportedly diminished outside major cities, which can be due to their high visibility and/or the influence of drivers alerting others of operation locations via word-of-mouth (Rural and Regional Affairs and Transport References Committee, 2016). Therefore, there is a need for unique deterrent measures in regional and remote areas, given the enforcement and speed monitoring challenges.

A recommended countermeasure to target speeding is that of average speed enforcement through point-to-point speed cameras in regional and remote areas. Average speed enforcement has a positive influence on vehicle speeds and has been shown to reduce the mean and 85th percentile speeds by up to a third (Soole et al., 2013). Mobile speed cameras are another example of automated speed enforcement that can be adapted to the regional and remote environment. The benefits of mobile speed camera operations have most recently been demonstrated by Newstead et al., (2014) in a review of Western Australia's program. In regional WA, there was an estimated reduction of 18% and 13% in fatal crashes within 500 and 1000 metres of the camera site for every 100 speed camera sessions undertaken per month. Fixed speed cameras and combined speed and red light cameras have also been shown to be effective in reducing casualty and property damage crashes, though they are most frequently used in urban and urbanised regional settings. Speed enforcement programs should ideally be conducted in tandem with education and publicity campaigns in rural areas where speeding is common and seen as socially acceptable (Austroads, 2014).

4.3.4 Vehicle countermeasures - ISA

Advanced driver assist systems (ADAS) are vehicle technologies that assist drivers with the driving task. Of these discussed in section 4.2.1, ISA is most likely to have the greatest effect on vehicle speed. This technology and speed related telematics are also likely to be employed in workplace vehicles to manage drivers' speeds (see below).

4.3.5 Workplace speed management: In-vehicle technologies

There is now a greater appreciation that workplace practices can place undue pressure on workers who drive as part of their job to engage in speeding (Austroads, 2018b). In response to this, and consistent with workplace health and safety management requirements, the corporate and government sectors alike are progressively introducing policies and practices to manage the travel speeds of vehicles used by their employees. Part of this response includes the use of in-vehicle telematics to monitor the speeds of heavy vehicles (NTC, 2014). This technology has the capacity to not only reduce risky driving through increased driver compliance with posted speeds but may lead to increased fuel efficiency, reduced maintenance costs, and reduced downtime (NRSPP, 2017). The Toll Group has been particularly active in the use of in-vehicle monitoring. In 2016, they reported monitoring over 2,200 heavy vehicles for speed events. This is coupled with other initiatives such as 'toolboxing', formal training, and a Driver Excellence Program to raise awareness among drivers of the consequences of speeding and to reinforce speed compliance (Toll, 2016). Toll (2016) reported that their speed management initiatives have reduced the incidence of speeding over a three-year period and concluded that it was "…possible to meaningfully tackle speeding through deployment of technology, training, awareness, consequence management and reporting and visibility at the highest levels" (p. 4) in the heavy vehicle sector.

Table 4.4 summarises Safe System countermeasures for speed management.

Table 4.4: Safe System countermeasures for speed management

Safe System	Countermeasure	Evidence
Safe roads	• Implement road treatments in locations that evidence a high frequency of speed related fatal and serious injury crashes (e.g., perceptual countermeasures to reduce vehicle speeds; countermeasures to calm vehicle speeds; use of Rural Intersection Speed Warning systems; redirection of traffic from high speed low safe infrastructure roads to roads with infrastructure commensurate with higher travel speeds)	Low-Medium
Safe speeds	• Introduce a reduced default speed limit outside built-up areas limit in jurisdictions where limits exceed 100km/h • Introduce reduced speed limits on unsealed roads to 80km/h • Revise speed limits on roads lacking safe infrastructure to determine more appropriate limits	Medium Low Medium
Safe vehicles	• Promote the purchase and use of vehicles with intelligent speed adaptation and adaptive cruise control to improve speed compliance	Medium

Safe System	Countermeasure	Evidence
Safe people	• Implement point-to-point average speed cameras to improve speed compliance	Medium
	• Implement a mix of covert and overt automated mobile speed camera operations in areas with a high incidence of speed related crashes	High
	• Increase marked and unmarked highway patrol speed enforcement operations	Medium
	• Introduce repeat speeding offender and high speed offender programs that require the installation of intelligent speed adaptation systems (that cannot be over-ridden)	Low
	• Introduce vehicle impoundment or licence plate stripping for repeat high range speeding offenders	Low
	• Encourage work, health and safety and private sector policies to restrict speeds of vehicle fleets with monitoring	Low-Medium

4.4 Safe People

4.4.1 Drink driving

Random breath testing

Per se legislation (detection for the presence of proscribed drugs) for driver blood alcohol concentration supported by the use of high visibility bus based random breath testing (RBT) of drivers has proven to be the most effective package to deter drink driving and to reduce the incidence of alcohol related crashes in Australia (Erke, Goldenbeld & Va, 2008). Other research demonstrates that the rate of random breath testing is strongly and significantly inversely associated with the rate of alcohol related crashes (Ferris, Devaney, Sparkes-Carroll & Davis, 2015).

While RBT operations have been judged to be a highly cost-effective measure of reducing the incidence of alcohol related road trauma (Cameron, 2013), it may be less effective in regional and remote areas for a number of reasons. These include, local knowledge of where enforcement operations are occurring; limited police resources to undertake intensive, high profile operations on low volume roads; and the consequent low belief among drivers that they are likely to be caught for drink driving (Terer & Brown, 2014; Armstrong, et al., 2017). Alternative enforcement models that are highly mobile and targeted on detection rather than general deterrence may be more effective in regional areas (Wundersitz & Woolley, 2008; Terer & Brown, 2014). Cameron (2013) has further suggested that best practice for alcohol breath testing in regional areas includes the use of highly mobile car based RBT, which would allow police to undertake testing across minor as well as major roads. This does not, however, exclude the use of high visibility static bus based testing, but it should be supported by the use of car based testing on alternative roads around the bus activity.

Mass media campaigns

Other research evidence points to the important synergy between RBT operations and supportive mass media campaigns targeting drink driving. An early, seminal systematic review of the effectiveness of mass media campaigns for drink driving noted that well-executed campaigns that were integrated with highly visible enforcement, such as bus based RBT, were effective in reducing drink driving and alcohol related crashes (Elder et al., 2004). A review of Australian RBT programs has similarly noted that mass media campaigns are an important in supporting the effectiveness of highly visible RBT operations (Cameron, 2013). In New Zealand, early research found no compelling evidence of a positive impact of mass media campaigns on positive breath test outcomes (Macpherson & Lewis, 1998). This was speculated to be due to the lack of coordination between enforcement operations and the campaigning that typifies much of the Australian RBT operations.

Overall, mass media campaigns targeting drink driving can help raise drivers' perceptions of the likelihood of being caught and positively influence their attitudes towards the legitimacy of RBT (McIntyre, Cockfield & Nieuwesteeg, 2011). Campaigns should however, promote pre-drinking decision making and alternative transport options to separate drinking and driving (Terer & Brown, 2014). It has been suggested that campaigns in regional and remote areas may be less influential on the attitudes and behaviours of drivers unless drivers experience or observe an associated high level of enforcement of drink driving (Armstrong, et al., 2017). They are also likely to be less effective if drivers do not have viable transport alternative to drinking and driving in these areas.

Alcohol interlock programs

Alcohol interlock programs have become an integral countermeasure for drink driving in Australasia and internationally. A comprehensive systematic review of 15 international evaluations concluded that the programs were associated with significant reductions in re-arrests for drink driving amongst program participants to a low of around 25% to 30% (Elder et al., 2011). In Australasia, there is little published information on the effectiveness of alcohol interlock programs and certainly no information to describe the implementation and impact of alcohol interlocks programs in regional and remote areas. The most recent evaluation of Victoria's alcohol interlock program (Watson et al., 2015) sought to determine the impact of the introduction of the program (and other licensing sanctions) and the subsequent 2006 regulatory changes on casualty crash and offence rates. The evaluation was however limited to a sample of around 12% of alcohol interlock participants up to September 2014. Overall, alcohol interlock participants evidenced a significantly lower rate of drink driving offending during the interlock period compared with the 'no-interlock' control drivers.

While there is reasonable evidence of the effectiveness of alcohol interlock programs to reduce recidivism and alcohol related crashes, it is acknowledged that alcohol interlocks do not necessarily address the underlying problem of the abuse of alcohol for a proportion of program participants who are high range offenders (Austroads, 2015a). For these offenders alcohol treatment and rehabilitation programs should be conjointly considered (Elder et al., 2011). The other significant challenge for alcohol interlock programs is how best to implement the program to offenders in regional and remote areas who may have limited financial means to participate and who may not have ready access to alcohol interlock services in their region.

Behavioural programs for offenders

Two examples of behavioural programs for drivers convicted of drink driving are those offered by the Australian Capital Territory and Victoria. The ACT's Alcohol and Drug Awareness Course (ACT Government, 2019) was introduced in November 2011 as a requirement to retain or be reissued with a restricted or probationary licence following a drink driving offence. Eligible drivers must undertake either the Standard course which focuses on educational awareness or the Extended course, which combines educational awareness with a therapeutic focus depending the range of offence and whether the driver is a recidivist offender. First time offenders who exceed their legal limit up to 0.079gm% are required to complete the Standard course while repeat offenders at this BAC level are required to complete the Extended course. High-range (≥0.08gm%) first and repeat offenders are required to complete the Extended course. Both courses incur a charge (ranging from $100 to $300) which must be paid by the driver. The ACT's Alcohol and Drug Awareness Courses were recently evaluated by Thompson, Wundersitz and Raftery (2018). It was found that the introduction of the courses in November 2011 coincided with consistent reductions in drink driving detections between 2012 and 2016 (final year of data examined). It was concluded that the courses may have contributed, along with other drink driving countermeasures (e.g. the Alcohol Interlock Program), to these reductions.

Victoria's Drink and Drug Driving behavioural program for offending drink drivers was introduced in April 2018 (Wishart & Freethy, 2018). This is a mandatory program for drivers convicted of drink, drug or drink and drug offences. Drivers will not regain their licence until they have completed the relevant program. First offender drink drivers <0.15gm% are required to complete a 6-hour drink driver program. Repeat offenders, those convicted of a BAC offence ≥0.15gm%, and those convicted of the more serious combined offence of drink and drug driving are required to complete the intensive 10-hour program aimed at multiple dependencies (i.e., alcohol and drugs). Serious and repeat offenders are also required to complete a 2-hour pre-interlock program and a removal program after having completed the required interlock fitment period. Like the ACT program, eligible drivers will be required to meet the full cost of participating in the program. This program is yet to be evaluated.

It is important that offenders in regional and remote areas have access to such behavioural programs and that these programs are affordable and tailored to be culturally relevant for Aboriginal offenders. However, the difficulties in delivering such programs in regional and remote areas are acknowledged.

4.4.2 Illicit drug driving

Roadside oral fluid testing

All Australian jurisdictions now enforce a zero tolerance and roadside oral fluid testing program using immuno-assay and follow up laboratory testing for three proscribed illicit drugs -cannabis, methamphetamine, MDMA – with NSW also testing for cocaine (Davey, Armstrong, Freeman & Sheldrake, 2017). In New Zealand, police have the authority to take a blood sample to test for a range of illicit and legal substances should the driver fail a compulsory roadside assessment (Office of the Minister of Transport, n.d.). At this stage, there are no published national data on the level of oral fluid testing undertaken in regional versus urban areas, nor of the level of drug driving detected at roadside in regional areas. Similarly, no evaluations have been reported to describe the impact of roadside oral fluid testing on illicit drug-related crashes by region.

Behavioural programs for offenders

Behavioural programs for drug driving offenders are employed by two Australian jurisdictions: The Australian Capital Territory and Victoria. The ACT's Alcohol and Drug Awareness Courses (ACT Government, 2019) were introduced in November 2011 as a mandatory requirement of the offending driver to retain or be reissued with a restricted or probationary licence. Eligible drivers must undertake either the Standard course focusing on educational awareness, or the Extended course combining educational awareness with a therapeutic focus. First time drug driving offenders can complete the Standard course while repeat offenders are required to complete the Extended course. Drivers who chose not to participate in the program, or take too long to complete the program, will continue to have their drivers' licence suspended. Both courses incur a charge (ranging from $100 to $300), which must be paid by the driver. This program has recently been evaluated by Thompson, Wundersitz and Raftery (2018). However, sufficient data, with which the impact of the courses on drug driving offence or re-offence rates could be examined, were not available for the evaluation.

Victoria's Drink and Drug Driving behavioural program for offending drug drivers was introduced in April 2018 (Wishart & Freethy, 2018). This is a mandatory program for drivers convicted of drink, drug or drink and drug offences. Drivers will not regain their licence until they have completed the relevant program. First offender drug-drivers are required to complete a 6-hour drug driving program, while repeat offenders and those convicted of the more serious combined offence of drink and drug driving are required to complete the intensive 10-hour program aimed at multiple dependencies (i.e., alcohol and drugs). Like the ACT program, eligible drivers will be required to meet the full cost of participating in the program. This program is yet to be evaluated for its impact on drug-driving offences.

As previously noted, it is important that regional and remote area offenders have access to such behavioural programs and that these programs are affordable and tailored to be culturally relevant for Aboriginal offenders. A summary of Safe System countermeasures to reduce drink driving and illicit drug driving is presented in Table 4.5.

Table 4.5: Safe System countermeasures to reduce the high incidence of alcohol and illicit drug related crashes

Safe System	Countermeasure	Evidence
Safe roads	• Implement targeted road treatments to reduce the incidence of single vehicle run off road crashes associated with drink and illicit drug driving (e.g. ATLM, barriers) • Provide adequate infrastructure on regional roads to conduct roadside testing (e.g. parking bays)	Medium Medium
Safe speeds		
Safe vehicles	• Ready access to services for the fitment and monitoring of alcohol interlock devices for high alcohol or repeat offenders.	Medium-High
Safe people	• Evidence-based deployment of targeted and random roadside breath and oral fluid testing programs using a combination of mobile and static testing operations. • Provide alternate transport options to separate alcohol and illicit drug use from driving and walking • Community based and culturally relevant education and campaigns to reduce the consumption of alcohol and illicit drugs • Implement mandatory behavioural programs for drink and drug driving offenders that are affordable and culturally relevant • Provide appropriate levels of services for the treatment of alcohol and illicit drugs substance abuse	Medium-High Medium Low-Medium Low-Medium Low-Medium

4.4.3 Fatigue management

Road infrastructure treatment

Select road infrastructure treatments have the potential to reduce the incidence of crash types that are frequently associated with fatigue, particularly in regional and remote areas. A previous Austroads (2011a) review of innovative road safety measures to reduce fatigue highlighted the potential of a number of countermeasures with benefit cost ratios of two or more. Some of these road countermeasures include transverse audio-tactile treatments (i.e., audible edgelines) as an alerting device to regain control over the vehicle and maintain lane position; the use of barriers and clear zones to reduce injury severity in the event of a collision due to fatigue, and perceptual measures to create for the driver an ‘illusion’ that the road geometry is more demanding than it appears, to assist drivers in staying vigilant. The review also noted that warning signs and road markings could be used/improved to assist the driver in understanding the road environment (e.g., upcoming curve, etc.), as well as additional, multiple signage to advise drivers of upcoming rest locations. The review additionally recommended and subsequently trialled an innovative cognitive engagement task to reduce driver monotony on long trips; this was not found to be especially effective, however, in increasing driver alertness (Waldron, n.d.)

Vehicle technologies

A number of advanced driver assist technologies have the potential to reduce fatigue related crashes, particularly on regional and remote roads. These include lateral collision avoidance technologies such as lane departure warning, lane keeping assist, and fatigue warning and monitoring systems, which were discussed in section 4.2.1. In-vehicle technologies are also being increasingly used in the heavy vehicle transport sector - in which fatigue is major problem - to detect fatigue in drivers, to alert the driver and, where relevant their employer, to the fact that they are becoming fatigued. One such technology is the “Guardian” developed by Seeing Machine (Seeing Machines, 2019). In 2015, Toll Group (Australia) partnered with Seeing Machines for the installation of its in-vehicle fatigue and distraction monitoring technology (Australian Transport News, 2015). Since the roll-out of the driver state sensor technology Toll claims that fatigue incidents have been reduced by as much as 80% (Toll Group, n.d.). Another similar technology is Optalert’s drowsiness detection glasses, which use an invisible LED built into the glasses’ frame to measure the operator’s eyelid velocity at 500 times a second (Optalert, n.d.).

Legislation and workplace policies

Fatigue management is one component of Australia’s Heavy Vehicle National Law (HVNL), which is particular to vehicles exceeding 4.5 tonnes (National Heavy Vehicle Regulator, 2019) The HVNL defines a variety of workplace conditions (e.g., maximum work requirements and minimum rest requirements) and compliance standards (e.g., work diary requirements) to reduce the incidence of fatigue in the heavy vehicle transport sector. The HVNL covering fatigue is supported and enforced via the use of the Safe-T-Cam/ANPR program throughout a number of jurisdictions, including New South Wales, Victoria, Queensland and South Australia. This digital camera program has the capacity to detect heavy vehicle movements (i.e., time between cameras) that are in potential breach of the HVNL policies covering working hours and rest breaks.

Transport companies and other corporations that require employees to drive for extended periods that are not covered by the HVNL are encouraged to develop workplace policies and practices to manage fatigue in drivers (National Transport Council, n.d.). This can include the installation of technology to monitor and alert drivers of fatigue and sleepiness as well as fleet driver training about fatigue as a road safety problem and how to identify and manage it.

One example of a comprehensive strategy to manage fatigue in the workplace, transport related and otherwise, is provided by Safe Work Australia (2013). Other fatigue-related management principles are reported in the Austroads (2018b) *Vehicles as Workplace* report. Western Australia, which is not a signatory to the HVNL, also provides an on-line program of fatigue management training for commercial driver accreditation (Department of Mines, Industry Regulation and Safety, 2018; Worksafe, 2019).

Mass media and community based behavioural programs

Mass media education and promotion campaigns are instrumental to managing the risk of fatigue among drivers of private vehicles due to the inability to ‘enforce’ drivers to avoid driving fatigued or while sleepy. Examples of such include Queensland’s 2009-2010 *Driver Fatigue Public Education Campaign* (Department of Transport and Main Roads, n.d.) and New South Wales’ 2013 *Don’t Trust Your Tired Self* (NSW Centre for Road Safety, 2019).

The Driver-Reviver roadside coffee break stop program is perhaps the most well-known Australian community based behavioural program to address fatigue driving. The aim of the program is to reduce the incidence of fatigue driving by encouraging drivers to stop, take a break, and partake of refreshment at a designated Driver-Reviver station (see Figure 4.2). While the program is intensively operated during holiday periods, some jurisdictions regularly operate sites at other times of the year.

Figure 4.2: Driver-Reviver advisory signs

Source: NSW Centre for Road Safety, n.d.

A summary of Safe System countermeasures to reduce the high incidence of fatigue related crashes is shown in Table 4.6.

Table 4.6: Safe System countermeasures to reduce the high incidence of fatigue related crashes

Safe System	Countermeasure	Evidence
Safe roads	• Targeted treatment of road sections known to have a higher incidence of fatigue related crashes using proven single vehicle run-off road countermeasures, e.g., audible edge and centre-line treatments; widened and sealed shoulders; installation of site-appropriate barriers • Install well-appointed roadside rest stops to encourage drivers to take frequent breaks from driving	Medium Low
Safe speeds	• Reduce speed limits on roads that have a lower level of safe infrastructure and are known to have a higher incidence of fatigue related crashes	Medium
Safe vehicles	• Increase the use of safe vehicle technologies in private and fleet vehicles to mitigate lateral and forward collision crashes associated with fatigue, e.g., lane departure warning and lane keeping assist; high speed autonomous emergency braking; and electronic stability control • Increase the use of fatigue management and surveillance technologies in private and fleet vehicles. This could be supported by safe vehicle fleet purchasing policies promoting 5-star vehicles	Medium Medium
Safe people	• Develop and implement community based education and promotion campaigns to inform regional drivers of the risks of fatigue driving; how to identify warning signs of fatigue and poor sleep hygiene; and how to manage fatigue • Engage with local corporations and fleet managers to review the existence and appropriateness of fatigue management policies and work practices to minimise the occurrence of fatigue driving	Low Medium
Other	• Investigate the provision of viable, economic transport options other than personal vehicle use for long distance travellers	Low

4.4.4 Unlicensed driving

Detection and enforcement

The surveillance and detection of unlicensed drivers is undertaken as part of road policing that encompasses alcohol and drug testing operations. Automatic number plate recognition (ANPR) technology is used in addition to physical licence checks to detect unlicensed driving. One shortcoming of the use of ANPR technology is that it may not detect unlicensed drivers who are driving a vehicle registered to another licensed driver (Austroads, 2013). Once detected for unlicensed driving, some jurisdictions (New Zealand, Western Australia, Queensland, South Australia, Tasmania, and Victoria) may impound or immobilise the offender's vehicle (Austroads, 2013).

More broadly, the management of recidivist offenders in regional and remote areas may prove problematic. This is because offenders in these areas are more likely to be socially disadvantaged, have limited financial resources to pay monetary penalties that have been applied, and even less able to satisfy identification requirements to become licensed (see section 3.4.5 in regard to Aboriginal drivers). Alternate approaches need to be identified that do not contribute to the cycle of poverty and disadvantage, including more effective legal measures, the use of technologies, and behavioural interventions.

Administrative and community initiatives to facilitate licensing

Driver licensing programs that aim to help Aboriginal people obtain a licence are highlighted in section 4.4.6. In New Zealand, the *Behind the Wheel* program, administered by New Zealand Transport in conjunction with the Auckland City Council and Auckland Transport, aims to promote and facilitate learning to drive among young people to reduce the incidence of unlicensed driving and crash involvement (1Newsnow, 2016). Participants can complete a range of workshops toward obtaining their learner, restricted or full licence. No information could be located reporting on the implementation or impact of the program.

Safe System countermeasures to reduce the high incidence of unlicensed driving are shown in Table 4.7.

Table 4.7: Safe System countermeasures to reduce the high incidence of unlicensed driving

Safe System	Countermeasure	Evidence
Safe roads		
Safe speeds		
Safe vehicles	• Investigate the feasibility of the fitment of a smart licence-interlock device in vehicles of repeat unlicensed driver offenders	Medium
Safe people	• Use automatic number plate recognition technologies in areas with a known high incidence of unlicensed driving • Continue support of government programs to assist local area residents to obtain a licence and maintain licensure (e.g., payment plan options; restricted area licence options) • Impound vehicles or remove licence plates of the vehicles owned by unlicensed drivers • Develop and implement education campaigns about the sharing of vehicles with unlicensed drivers	Medium Low Low-Medium Low
Other	• Provide/subsidise transport options within local communities as alternatives to unlicensed driving	Low

4.4.5 Seat belt and child restraint use

Legislation and enforcement of seat belt/child restraint laws

Seat belt and child restraint usage rates are particularly high among Australian vehicle occupants, due in part to well-developed legislation and associated police enforcement. This has correspondingly contributed to a reduction over time in the non-use of restraints among crash involved occupants (Austroads, 2009; Marshall, 2018). Policing agencies in some jurisdictions are now utilising new technologies to detect drivers who are unrestrained. For example, Western Australia Police commenced the use of long range cameras (up to 700 metres) to identify drivers who are not restrained, as well as other offences such as using hand-held mobile phones. In 2017, Spanish authorities installed 225 safety cameras at high-risk, highly trafficked road locations to identify drivers not wearing a seat belt (European Transport Safety Council, 2017).

Promoting the correct installation and use of child restraint systems

Initiatives to promote the correct fitment and use of child restraint devices are vital to the optimisation of the protection of children in cars (Brown et al., 2010). Keay et al., (2012) has reported that comprehensive education, distribution and restraint fitting programs can increase the correct installation and use of age-appropriate restraint use among children aged 3 to 5 years from low socioeconomic, non-English speaking backgrounds in New South Wales. Other interventions aimed at the promotion of restraints among Aboriginal children are reported in section 4.4.6.

Mass media campaigns for adult seat belt use

Mass media campaigns to promote seat belt use are frequently used in conjunction with police enforcement campaigns. Several public education campaigns have been undertaken to specifically promote the use of seat belts among adults, particularly males, in regional and remote Australia. Examples of these follow.

Clip Every Trip

Commencing in 2011, the *Clip Every Trip* campaign is aimed at seatbelt use in regional and remote NSW and reinforces the need for seatbelt use at all times. The campaign primarily targets regional and remote male drivers who are 30 to 55 years of age, followed by all regional and remote drivers and passengers. More specifically, the campaign targets residents in regional and remote communities including farmers and tradespeople as well as Aboriginal people. This campaign is ongoing and is mainly delivered through regional TV, with additional support provided through roadside billboards, radio, online and print advertising (Grajewski, 2013)

Keep the Bromance Alive

Seatbelt use, in addition to drink driving and speeding, is one of the key regional and remote road safety issues targeted in the *Keep the Bromance Alive* campaign that was launched by the Motor Accident Commission (MAC) in South Australia during 2017. The campaign features a commercial that airs on regional and metropolitan television and targets drivers, particularly males who live in regional and remote areas as well as those who travel on regional roads (Department of Planning, Transport and Infrastructure, n.d.). (The MACC in the Northern Territory also ran seatbelt campaigns targeting urban and remote populations individually (Northern Territory Motor Accidents Compensation Commission (n.d.).

Table 4.8 shows Safe System countermeasures to increase the use of adult seat belts and child restraints.

Table 4.8: Safe System countermeasures to increase the use seat belts and child restraints

Safe System	Countermeasure	Evidence
Safe roads		
Safe speeds		
Safe vehicles	• Increase availability of vehicles that are 'fit for purpose' (e.g., no over-crowding) and provide for the restraint of all occupants • Promote vehicles with advanced seat belt reminder systems • Promote vehicles that have appropriate fixing points for securing child restraints	Low-Medium Medium High
Safe people	• Implement community wide programs to increase the distribution of child seats to at risk, low socioeconomic groups • Support and promote community programs and other services that provide assistance for the correct installation of child restraints • Utilise long range cameras and ANPR technology to enforce seat belt use • Use alternative sanctions (e.g., community service) to monetary penalties for low socioeconomic offenders • Develop and implement community wide, culturally relevant programs that educate, promote, and positively reinforce correct seat belt wearing among adults and children	Medium Medium Low Low Low-Medium
Other	• Provide/subsidise alternative transport options within local communities to reduce the 'over-crowding' of vehicles and unrestrained travel	Low

4.4.6 At-risk populations

Aboriginal people

Child restraints and adult seat belt use

Studies from the United States show that a variety of strategies including the distribution of child seats and education about their use have been successful in increasing their use (Amiotte, Balanay, & Humphrey, 2016; Billie, Crump, Letourneau, & West, 2016). Similar campaigns have been successfully completed in Australia (NT Motor Accidents Compensation Commission, 2017; Porykali et al., 2017). The Northern Territory program, which is coordinated by the NT Motor Accidents Compensation Commission, began in July 2017 in response to research showing that up to 65% of children were being transported unrestrained in cars. The program involves distribution and fitting of child restraints in remote communities. The program aims to install a total of 1800 child restraints across 24 communities by the end of June 2019. The New South Wales trial included restraint distribution, car seat fitting and checking days, information sessions and community events and training of Aboriginal community workers to fit restraints. In South Australia, On the Right Track Remote (OTRTR) have delivered over 400 child restraints to Aboriginal people living in the Anangu Pitjantjatjara Yankunyatjara (APY) Lands and Maralinga Tjarutja (MT) Lands, with training provided on how to correctly fit and install the child safe restraint into vehicles. By the end of June 2019 OTRTR are aiming to have delivered an additional 200 child restraints to these 10 communities with practical training included (C. Bartosak, personal communication, 9 January 2019).

Improved enforcement of seat belt laws, development of a traffic court system to enforce seat belt citations and education campaigns on importance of seat belt use to prevent severe injuries were found to be successful with Indigenous people in the United States (Amiotte et al., 2016). There is no recent published literature on programs to increase adult seat belt use in regional or remote Australia.

Alcohol use and drink driving

Fitts and Palk (2014) describe a drink driving program developed together with Aboriginal people for those in regional and remote Aboriginal communities in Queensland. Experienced facilitators were interviewed about their views on the program content and the most feasible and effective process for delivering a culturally sensitive drink driving program. Participants were supportive of behaviour change strategies and identified a need for new initiatives that promoted understanding of their drink driving behaviour. A recent review highlighted the importance of rehabilitation courses focusing on behavioural change, as well as providing information (Slootmans, Martenson, Kluppels, & Meesmann, 2017).

As part of its holistic strategy to tackle alcohol abuse, the Northern Territory government introduced a minimum unit price for alcohol, also known as a 'floor price' in October 2018 (Northern Territory Government, 2018). Minimum unit pricing involves setting a price below which it is illegal to sell alcohol. Canadian research has shown that a 10% increase in the minimum price of alcohol was effective in reducing acute alcohol attributable admissions by 8.95% (Stockwell et al., 2013). The Northern Territory government also have point of sale interventions including the Banned Drinker Register, stationing auxiliary police outside bottle shops and the extension of services to provide safe transport and shelter for those who are intoxicated in public spaces. Austroads are currently developing a national drink driving policy framework providing evidence on the effectiveness of drink driving countermeasures.

Driver licensing programs

Programs to help Aboriginal people with all aspects of gaining a driver's licence have been described in New South Wales and the Northern Territory (Cullen, Chevalier, Hunter, Gadsden, & Ivers, 2016; Cullen, Clapham, et al., 2016). The New South Wales program is aimed at drivers aged 16-24 years whereas the Northern Territory program (DriveSafe NT Remote) aims to address the specific issues of remote communities. Similar programs targeting remote licensing operate in South Australia (Howard & Rigney, 2017), Western Australia and Queensland. Programs in Tasmania and Victoria are more geared towards young people and those experiencing economic disadvantage. An evaluation of the South Australian program reports on the many social benefits of the program, which has now been running for over two years (Nereus Consulting, 2017). These include employment and financial benefits, improvements in access to services and leisure time activities, ability of young people to drive older people around once they have got their licence, and improved relations between community and police. During the course of the program, the proportion of people living on the Anangu Pitjantjatjara Yankunytjatjara (APY) lands holding a driving licence is estimated to have increased from around 17% to 36%. Further information regarding Aboriginal licensing programs, including a suite of nationally applicable principles to promote best practice in policy and program design, can be found in the recent Austroads (2019a) report *Improving driver licensing programs for Indigenous road users and transitioning learnings to other user groups*.

Safe System audit of an Aboriginal community

A Safe System audit was conducted at the Bidyadanga Aboriginal Community in Western Australia, commencing in 2009 and funded by Austroads. The audit identified a number of issues regarding roads, vehicles, speeds, road users and safe policy and management (Senserrick, Yip, Grzebieta, et al., 2011). Funding was sought from various agencies to address these issues. Outcomes included improving and correcting signage to WA Main Roads standards, education campaigns on pedestrian safety and safe speeds, improved pedestrian crossings and lighting, and development of the document *Keeping your mob safe. A guide to making roads safer in your community* by the WA Road Safety Commission (Road Safety Commission, 2015).

Remote bus program

The use and improvement of existing transport services and the development of sustainable community driven transport can provide safe travel links between remote communities and larger service centres. An innovative new remote bus program in the Northern Territory provides a service to many small disadvantaged Aboriginal communities in some of the most remote areas of Australia (MRCagney Pty Ltd, 2017). Many routes operate over long distances on rough unsealed roads and under extreme operating conditions and so they require a specialised vehicle fleet. Census information shows that the communities served by the bus program have a lower level of access to private cars, internet and education, a lower average household income and employment levels and a higher proportion of Aboriginal people than the NT average. The service enables people to access health, employment, education and social opportunities. Program funding provides support for the operational and capital costs for commercially operated services. An evaluation of the program completed in 2016 reported the average seat utilisation between 2010-2015 varied considerably by route from as little as 6% up to 74%. The evaluation also looked at various ticket subsidy options as well as increasing the number of routes and the possible discontinuation of some routes which were not well utilised (MRCagney Pty Ltd, 2017).

A summary of Safe System countermeasures to reduce the over-representation of Aboriginal people in crashes is shown in Table 4.9.

Table 4.9: Safe System countermeasures to reduce the higher burden of road trauma among Aboriginal people

Safe System	Countermeasure	Evidence
Safe roads	• Improve roads in and around Aboriginal communities, aligned with Safe Systems principles • Conduct Safe System audits of road networks in and around Aboriginal communities	Medium Medium
Safe speeds		
Safe vehicles	• Promote safe vehicles that are fit for purpose • Provide/subsidise community transport options (e.g., bus service)	Medium Low-Medium
Safe people	• Continue to expand licensing programs for Aboriginal people, e.g., proof of identity, qualified supervisor drivers; overcoming language barriers • Develop culturally appropriate programs addressing Aboriginal road safety issues such as alcohol and illicit drugs, restraint use	Medium Low-Medium

Motorcyclists

A number of initiatives have been introduced to improve the safety of motorcyclists. These include a graduated licensing system in most Australian jurisdictions, modification of roadside barriers, removal of roadside hazards, motorcycle blackspot programs and audits of motorcycling routes, a motorcyclist clothing assessment program (MotoCAP,) and a consumer rating assessment of safety helmets (CRASH) program (CRASH, n.d.).

Of note, an evaluation of the Victorian Motorcycle Blackspot Program conducted in 2015 assessed 176 treatments and found an estimated 27% reduction in casualty crashes and a 31% reduction in fatal and serious injury crashes. Moreover, when the various treatment types were analysed separately, the barrier protection treatment had the largest benefit, with a 74% reduction in fatal and serious injury motorcycle fatal and serious injury crashes (Cairney et al., 2015).

Other possibilities include increasing the uptake of motorcycle safety technologies, such as anti-lock braking systems (ABS) (Motorcycle Safety Review Group, 2015) and autonomous emergency braking (AEB), (Community Research and Development Information [CORDIS], 2016; Savino et al., 2016). Safe System countermeasures to decrease the incidence of motorcycle crashes are presented in Table 4.10.

Table 4.10: Safe System countermeasures to decrease the incidence of motorcycle crashes

Safe System	Countermeasure	Evidence
Safe roads	• Implement a motorcycle blackspot/black links program (as per Victoria) in all jurisdictions with allocated funding dedicated to regional and remote areas • Install roadside appropriate barrier treatments (e.g., with under-runs) for motorcycle riders along identified major black lengths/blackspots	Low Low
Safe speeds	• Align speed limits with road attributes	Medium
Safe vehicles	• Increase the number of motorcycles with safety technologies, e.g., ESC, ABS	Medium
Safe people	• Enhance GLS for motorcyclists • Promote protective clothing and MotoCAP rating program	Low Low

4.4.7 Post-crash response time and trauma management

Opportunities to reduce post-crash injury outcomes can include interventions targeting such things as access to the emergency medical system, the emergency rescue system, the role of bystanders, pre-hospital medical care, trauma care, rehabilitation, and data and information systems (Safety Net, 2009). More specifically, shorter response times, higher levels of staff, and standardisation of emergency vehicles have been cited as some of the core features for better performance of emergency medical services (EMS) in road crash trauma management (Wall, Woolley, Ponte, & Bailey, 2014).

Automatic collision notification (ACN) systems aim to improve emergency medical response times and times to treatment through technology that automatically notifies EMS that a crash has taken place, thereby reducing delays in discovery and notification. ACN systems use safety sensors that already exist in the vehicle, such as for air bags and seatbelts, which can then be used to detect a collision and activate a notification. This notification contains location and relevant vehicular information that can be communicated to EMS using in-vehicle telematics and/or Global Positioning System (Ponte, Ryan, & Anderson, 2016).

Based on road crash fatality data for South Australia during the period 2008-2009, Ponte et al., (2016) estimated that a fully deployed ACN system would result in a 2.4% to 3.8% reduction in all road crash fatalities involving all vehicle types and vulnerable road users. Moreover, there was a greater estimated benefit for fatal road crashes occurring in regional and remote areas with the effectiveness of ACN likely to be between 3.1% and 4.6% (Ponte et al., 2016). Previous studies conducted in Europe and the USA estimated that fully deployed ACN or “eCall” systems can reduce road crash fatalities by between 1.5% and 8.6% per year (Chauvel & Haviotte, 2011; Jonsson, Lubbe, Strandroth, & Thomson, 2015; Lee, Wu, Kang, & Craig, 2017; Sihvola et al., 2009; Wu et al., 2015). As of 31 March 2018, all newly registered passenger and light commercial vehicles in the European Union are required to have GPS-enabled automated eCall emergency devices, in accordance with eCall deployment legislation (European Parliament, 2018).

However, market penetration (i.e., slow uptake of the technology), establishment of communications, and successful detection of a collision, as well as successful transmission of pertinent crash and vehicular information are factors limiting the impact of ACN systems (Ponte et al., 2016). A further, significant limitation that needs to be considered for regional and remote areas is cellular network coverage, which could lead to an ACN system potentially failing in the event of a crash where there is no cellular coverage (Lee et al., 2017; Ponte et al., 2016).

A summary of Safe System countermeasures for post-crash factors is shown in Table 4.11.

Table 4.11: Safe countermeasures for post-crash factors

Safe System	Countermeasure	Evidence
Safe roads		
Safe speeds		
Safe vehicles	• Implement Automatic Crash Notification services such as eCall	Medium
Safe people		
Other	• Develop a consistent methodology for collecting data specific to post-crash emergency response times within Australia • Develop the telecommunications network necessary for eCall and public calls to work effectively in regional and remote areas • Conduct an audit of emergency service response and recovery capabilities (e.g., ambulance, fire trucks, plane, helicopter) and trauma centres (and capabilities of these) in regional and remote areas • Build helipads in hard to access areas (e.g. NZ)	High High Low Low

4.5 Summary: Safe System Countermeasures for Regional and Remote Areas

Regional and remote areas are a very challenging environment with low population density, a vast network of roads of varying quality, significant socio-economic issues, lack of alternative transport options and inadequate resources all of which impact on road safety. Finding solutions to road safety problems in these areas is also a significant challenge. Measures designed to improve road safety in urban areas may not be feasible, and even less affordable, in regional or remote areas. Socio-economic outcomes also need to be considered in the design of countermeasures with careful planning and the linking of outcomes. Consequently, a combination of evidence-based countermeasures and new innovative solutions, involving experimentation with low cost, cost effective measures are urgently needed.

To be effective, road safety solutions for regional and remote areas need to incorporate all three tiers of government in a working partnership with sustainable commitment and investment to achieve the desired outcomes. Local ownership of road safety issues and solutions needs to be created and fostered through community engagement and involvement in the delivery of initiatives.

Importantly, a systems approach will be required to achieve the necessary step change to eliminate harm on regional and remote roads in Australia and New Zealand. Using the Safe Systems approach, systemic planning at the highest level is required, acknowledging that the greatest outcomes or solutions can be attained if all pillars are considered in combination, rather than in isolation. Due to the extent of the road network and the high cost of countermeasures in regional and remote areas, the development and implementation of network-wide safety plans are critical for applying treatments known to reduce fatalities and serious injuries but also address the risks associated with specific road user groups (e.g. facilitate enforcement, enhance rest stops). Based on the analyses of recent road crash data and a review of the literature, a number of key issues (crash types and behaviours) were identified as problematic in regional and remote areas in Australia and New Zealand. A summary of countermeasures by each Safe System pillar for each of the key issues is presented in Table 4.12.

In addition to these key issues, a number of other at-risk groups or road safety issues were identified from either the literature or crash data analyses that require management in a systematic context: males, heavy vehicles, international drivers and local residents and crashes at regional and remote intersections.

Table 4.12: Summary of Safe System countermeasures for regional and remote areas by issue

Issue	Safe roads	Safe vehicles	Safe speeds	Safe people
Single vehicle crashes	Road treatments: Continuous road side and centre barriers, ATLM, shoulder sealing, clear zones Median/centre line treatments Risk-based curve treatment	Vehicle technology e.g. ESC, AEB, lane keep assist AEB capable of detecting animals	Reduced speed limits if unsafe infrastructure	Increase options for safer travel
Head-on crashes	Road treatments: continuous centre barriers 2+1 roads, wide centrelines, divided roads, ATLM Sealed shoulders	Vehicle technology e.g. ESC, lane keep assist High speed AEB	Reduced default speed limit outside built-up areas	Community campaigns for safe overtaking of different vehicle types
Older vehicles		Newer vehicles 5-star fleet purchasing policies Government fleet sold on to regional/ remote areas ADRs - all vehicle types		Financial and insurance incentives Community campaigns
Speed management	Road treatments to reduce speeds e.g. perceptual, traffic calming, warning systems	Vehicle technology e.g. ISA, adaptive cruise control	Reduced default speed limit outside built-up areas Reduced speed limit on unsealed roads Revision of consistent appropriate speed limits	Point-to-point speed cameras Mix of automated enforcement Increased highway patrols Offender program with ISA Alternatives for repeat high range offenders WHS speed restriction policies
Low restraint use		Advanced seat belt reminder systems Vehicles with appropriate child restraint fixing points Fit for purpose vehicles		Community programs to educate and distribute child seats ANPR detection Alternative sanctions Alternative transport options
Alcohol and drugs	Targeted road treatments to reduce run off road crashes Road infrastructure to facilitate roadside testing	Alcohol interlocks for repeat offenders and accessible servicing		Targeted and random enforcement Alternative transport options Treatment services for substance abuse Community based, culturally relevant education Mandatory, locally available behavioural programs for offenders

Issue	Safe roads	Safe vehicles	Safe speeds	Safe people
Unlicensed driving		Smart licence interlocks for repeat offenders		ANPR detection Licensing programs Education programs Impound vehicles/ remove licence plates Alternative transport options
Driver fatigue	Road treatments e.g. ATLM, opposing lane separation, sealed shoulders Road side rest stops	Fatigue management systems Vehicle technology e.g. LDW, LKA, ESC, AEB; Attention Alert	Reduced speed limits if unsafe infrastructure	Workplace and fleet policies Community campaigns Alternative transport options
Aboriginal people	Improve roads around communities SS audit of roads around communities	Affordable and ready access to safe vehicles that are 'fit for purpose' Provision of community transport options		Licensing programs Culturally appropriate road safety programs
Motorcyclists	Blackspot/Black Links program funding Appropriate road side barrier treatments	Motorcycle safety technology e.g. ESC, ABS	Align speed limits with road attributes	GLS for motorcyclists Promotion of protective clothing and MotoCAP rating program
Post-crash care		Automatic Crash Notification service (eCall)		Emergency response times data collection Adequate telecoms network Audit emergency services response and capability Build helipads in inaccessible places

4.6 Effective Planning for a Safe System on Regional and Remote Road Networks

The key element underpinning the Safe System approach is to design and manage travel speeds, road infrastructure, vehicles, road users and the interactions between them to eliminate the harm from road crashes. In the context of regional and remote areas where there is an expansive but lower quality road network and limited resources, strategic planning across all components of the system is necessary to allocate resources and achieve this objective over a realistic long-term time frame. The first step is the development of a network-wide safety plan to determine the safety of infrastructure and identify any gaps in the system or areas where improvements are required.

This should be followed by the implementation of safety plans for corridors within the network to direct investment and reduce fatal and serious injury risk. Corridor safety plans need to apply sustainable treatments known to eliminate or greatly reduce fatalities and serious injuries but also address risks for specific groups. Safety plans would be expected to be applied over a 'medium-term timeframe'. Implementation should involve a co-ordinated approach with all levels of government working together to:

- Identify and prioritise corridors with the highest death and serious injury risk within the network
- Develop corridor safety plans to consistently apply treatments

- Implement mass action treatments to the corridors that can be sustainably applied over a medium time frame. Current evidence-based treatments known to be effective on regional and remote roads include median separation, audio tactile line marking, wide centre lines, lower speed limits, roundabouts, roadside barriers, intersection platforms, ITS solutions (e.g. vehicle activated signs at rural intersections) and gateway treatments. It is important that treatments are implemented consistent with network safety plans and facilitate other requirements such as enforcement, rest stops and alternative transport options.

Austroads is currently developing material to provide further guidance in how to develop network and corridor safety plans and practitioners should check regularly for any releases or updates. Austroads has also developed a Safe Systems Assessment Framework (Austroads, 2016) designed to assist practitioners in methodically considering Safe System objectives in road infrastructure projects. In addition, it provides prompts to enable the consideration of each pillar of the Safe System and provides a treatment hierarchy to identify the most effective treatments for specific crash types.

References

1Newsnow, 2016, Getting behind the wheel to put the brakes on unlicensed drivers. Retrieved from: https://www.tvnz.co.nz/one-news/new-zealand/getting-behind-wheel-put-brakes-unlicensed-drivers

AAMI, 2018, *Canberra crowned Australia's animal collision capital for second year running*. Retrieved from https://www.aami.com.au/aami-answers/press-releases/canberra-animal-collision-capital.html

Aarts, L., Van Nes, N., Wegman, F., Van Schlagen, I., & Louwerse, R., 2009, *Safe speeds and credible speed limits*. Paper presented at the Transportation Research Board 88th Annual Meeting, Washington DC, USA.

ACT Government Justice and Community Safety Directorate, 2019. *Alcohol and Drug Awareness Course*. Retrieved from http://www.justice.act.gov.au/page/view/3078/title/alcohol-and-drug-awareness-course

Al-Ghamdi, A., & Al-Gadhi, S., 2004, Warning signs as countermeasures to camel-vehicle collisions in Saudi Arabia. *Accident Analysis and Prevention, 36(5),* 749-760.

Amiotte, J., Balanay, J. A., & Humphrey, C., 2016, *Seat belt usage interventions for motor vehicle crash prevention on the Pine Ridge Indian Reservation*, South Dakota. Journal of Environmental Health, 78(6), 46-52.

Armstrong, K., Watling, H., Watson, A., & Davey, J., 2017, Profile of urban vs rural drivers detected drink driving via Roadside Breath Testing (RBT) in Queensland, Australia, between 2000 and 2011. *Transportation Research Part F: Traffic Psychology and Behaviour*, *47*, 114-121.

Ascensao, F., Clevenger, A., Santos-Reis, M., Urbano, P., & Jackson, N., 2013, Wildlife–vehicle collision mitigation: Is partial fencing the answer? An agent-based model approach. *Ecological Modelling, 257,* 36-43.

Australian Automobile Association, 2013, *Star rating Australia's national network of highways.* Canberra, ACT: Australian Automobile Association.

Australian Bureau of Statistics, 2011, *Measures of socioeconomic status: Information paper*. 1244.0.55.001. Canberra, ACT: Australian Bureau of Statistics.

Australian Bureau of Statistics, 2017a, *3218.0 Regional population growth*, Australia, 2016-17. Retrieved from http://www.abs.gov.au/ausstats/abs@.nsf/mf/3218.0

Australian Bureau of Statistics, 2017b, *Motor vehicle census, Australia 2017*. (No. 9309DO001). Retrieved from http://www.abs.gov.au/ausstats/abs@.nsf/products/28861A19CCDB9441CA25753D001B59DA

Australian Bureau of Statistics, 2018, *Australian Statistical Geography Standard (ASGS): Volume 5 - Remoteness Structure, July 2016.* 1270.0.55.005. Canberra, ACT: Australian Bureau of Statistics.

Australasian College of Road Safety, 2012, *ACRS Fact sheet: Rural & remote road safety.* Canberra, ACT: Australasian College of Road Safety.

Australian Institute of Health and Welfare, 2017, *National drug strategy household survey 2016*. Canberra, ACT: Australian Institute of Health and Welfare.

Australian New Car Assessment Program [ANCAP], 2017, *New analysis: Fatality rate four times higher in an older vehicle.* Retrieved from http://www.ancap.com.au/media-and-gallery/releases/

Australian Transport Council, 2011, *National Road Safety Strategy 2011-2020*. Canberra, ACT: Australian Transport Council.

Australian Transport News, 2015, Toll to update fleet with fatigue management solutions. Retrieved from https://www.fullyloaded.com.au/product-news/1507/toll-to-update-fleet-with-fatigue-management-solutions

Austroads, 2006, *Guide to road safety part 5: Road safety for rural and remote areas* (AGRS05-06). Sydney, NSW: Austroads.

Austroads, 2009, *Non-wearing of adult seat belts in Australia: Where to next?* (AP-R346-09). Sydney, NSW: Austroads.

Austroads, 2010, *Guide to road design part 6: Road design, safety and barriers* (AGRD06-10). Sydney, NSW: Austroads.

Austroads, 2011a, *Innovative road safety measures to address fatigue: Review of research and results from a treatment trial* (AP-R379-11). Sydney, NSW: Austroads.

Austroads, 2011b, *Improving roadside design stage 2: Interim report* (AP-R387-11). Sydney, NSW: Austroads.

Austroads, 2013, *Developing measures to reduce unlicensed driving* (AP-R424-13). Sydney, NSW: Austroads.

Austroads, 2014, *Methods for reducing speeds on rural roads: Compendium of good practice* (AP-R449-14). Sydney, NSW: Austroads.

Austroads, 2014a, *Improving roadside safety: Summary report* (AP-R437/14). Sydney, NSW: Austroads.

Austroads, 2014b, *Model national guidelines for setting speed limits at high-risk locations* (AP-R455-14). Sydney, NSW: Austroads.

Austroads, 2015a, *Options for rehabilitation in interlock programs* (AP-R484-15). Sydney, NSW: Austroads.

Austroads, 2015b, *Road geometry study for improved rural safety* (AP-T295-15). Sydney, NSW: Austroads.

Austroads, 2016, *Safe system assessment framework* (AP-R509-16). Sydney, NSW: Austroads.

Austroads, 2017, *Understanding and improving safe system intersection performance* (AP-R556-17). Sydney, NSW: Austroads.

Austroads, 2018a, *Towards safe system infrastructure: A compendium of current knowledge* (AP-R560-18). Sydney, NSW: Austroads.

Austroads, 2018b, *Vehicles as workplace* (AP-R561-18). Sydney, NSW: Austroads.

Austroads, 2018c, *Implications of traffic sign recognition (TSR) systems for road operators* (AP-R580-18). Sydney, NSW: Austroads.

Austroads, 2019a, *Improving driver licensing programs for Indigenous road users and transitioning learnings to other user groups*. (AP-R594-19) Sydney, NSW: Austroads..

Austroads, 2019b, *National view on regional and remote road safety*. (AP-R603-19). Sydney, NSW: Austroads.

Auto123.com, (n.d.), Car News - Industry, *Mercedes-Benz's attention assist system*. Retrieved from https://www.auto123.com/en/news/mercedes-benzs-attention-assist-system/41639/

BBC, 2017, *Volvo's driverless cars 'confused' by kangaroos.* Retrieved from https://www.bbc.com/news/technology-40416606

Bhatnagar, Y., Saffron, D., de Roos, M., & Graham, A., 2010, *Changes to speed limits and crash outcome - Great Western Highway case study*. Paper presented at the Australasian Road Safety Research, Policing and Education Conference, Canberra, ACT, Australia.

Billie, H., Crump, C. E., Letourneau, R. J., & West, B. A., 2016, Child safety and booster seat use in five tribal communities, 2010-2014. *Journal of Safety Research, 59,* 113-117.

Brown, J., Hatfield, J., Du, W., Finch, C., & Bilston, L., 2010, Population-level estimates of child restraint practices among children aged 0-12 years in NSW, Australia. *Accident Analysis and Prevention, 42,* 2144-2148.

Bureau of Infrastructure Transport and Regional Economics (BITRE), 2012, *Evaluation of the National Black spot program*. Canberra, ACT: BITRE.

Bureau of Infrastructure Transport and Regional Economics (BITRE), 2016, *Heavy truck safety: crash analysis and trends.* Canberra, ACT: BITRE.

Bureau of Infrastructure Transport and Regional Economics (BITRE), 2017, *Motorcycling safety (Information sheet 89)*. Canberra, ACT: BITRE.

Bureau of Infrastructure Transport and Regional Economics (BITRE), 2018a, *Road trauma Australia 2017 statistical summary*. Canberra, ACT: BITRE.

Bureau of Infrastructure Transport and Regional Economics (BITRE), 2018b, *Location and other risk factors in crashes* (Information sheet 97). Canberra, ACT: BITRE.

Cairney, P., Mitchell, B., Meyer, D., Van Dam, S., & Makwasha, T., 2015, *Evaluation of the Motorcycle Blackspot Program*. Melbourne, VIC: VicRoads.

Cameron, M., 2013, *Best practice in random breath testing and cost-effective intensity levels. Paper presented to the International Conference on Alcohol, Drugs and Traffic Safety* (T2013), Brisbane, Australia.

CARRS-Q., 2016, *Seat belts: Fact sheet of the Centre for Accident Research and Road Safety.* Brisbane, QLD: CARRS-Q.

Charlton, S., & Baas, P., 2006, *Speed change management for New Zealand roads.* Wellington, New Zealand.

Chauvel, C., & Haviotte, C., 2011, *eCall system; French a posteriori efficiency evaluation.* Paper presented at 22nd International Technical Conference on the Enhanced Safety of Vehicles (ESV), Washington DC, USA.

Chow, C., Meuleners, L., & Hendrie, D., 2015, *A preliminary evaluation of the effectiveness and cost-effectiveness of the State Black Spot program in Western Australia, 2011-2012*. Perth, WA: Curtin-Monash Accident Research Centre.

Community Research and Development Information Service (CORDIS), 2016, *Final report summary - ABRAM (Autonomous BRAking for Motorcycles).* Retrieved from https://cordis.europa.eu/result/rcn/189263_en.html

CRASH Consumer Rating and Assessment of Safety Helmets, n.d., *Safer Motorcycle Helmets – Your guide to buying a motorcycle helmet*. Retrieved from https://crash.org.au/

Croser, J. L., 2003, *Trauma care systems in Australia.* Injury, 34(9), 649-651.

Cullen, P., Clapham, K., Hunter, K., Treacy, R., & Ivers, R., 2016, Challenges to driver licensing participation for Aboriginal people in Australia: a systematic review of the literature. *International Journal for Equity in Health,* 15(1), 134.

Cullen, P., Chevalier, A., Hunter, K., Gadsden, T., & Ivers, R., 2016, 'The program was the solution to the problem': Process evaluation of a multi-site driver licensing program in remote communities. *Journal of Transport and Health*, 4, 81-89.

Davey, J., Armstrong, K., Freeman, J., & Sheldrake, M., 2017, *Roadside drug testing scoping study. Final report June 2017.* Brisbane, QLD: CARRS-Q.

Dawson, D., Searle, A. & Paterson, J., 2014, Look before you (s)leep: Evaluating the use of fatigue detection technologies within a fatigue risk management system for the road transport industry. *Sleep Medicine,* 18, 141-152.

Dempsey, K., 2016, *In harm's way: A study of Northern Territory linked crash records.* (Doctor of Public Health). Charles Darwin University, Darwin, NT.

De Pauw, E., Daniels, S., Thierie, M., & Brijs, T., 2014, *Safety effects of reducing the speed limit from 90km/h to 70km/h. Accident Analysis and Prevention*, 62, 426-431.

Department of Finance, 2017, Fleet Vehicle Selection Policy (as at 1 July 2017). Retrieved from https://www.finance.gov.au/vehicle-leasing-and-fleet-management/fleet-guidance-and-related-material.html

Department of Infrastructure, Regional Development & Cities., 2017, *Roads to recovery program.* Retrieved from https://investment.infrastructure.gov.au/infrastructure_investment/roads_to_recovery/

Department of Mines, Industry Regulation and Safety, 2018, Commercial vehicle driver fatigue management training. Retrieved from https://www.commerce.wa.gov.au/worksafe/commercial-vehicle-driver-fatigue-management-training

Department of Planning, Transport and Infrastructure. Government of South Australia., 2017, *Alcohol and drugs in road crashes in South Australia. Fact Sheet. October 2017*. Adelaide, SA: Department of Planning, Transport and Infrastructure.

Department of Planning, Transport and Infrastructure, South Australia (n.d.), *Road safety keeps the Bromance alive.* Retrieved from https://www.dpti.sa.gov.au/m/towardszerotogether/news_-_towards_zero_together?a=156841

Department of Transport and Main Roads. (nd.). *Driver fatigue public education campaign 2009/2010.* Queensland: Department of Transport and Main Roads.

Dickie, D., & Ng Boyle, L., 2009, *Drivers' understanding of adaptive cruise control limitations.* Proceedings of the Human Factors and Ergonomic Society Annual Meeting, 53(23), 1806-1810.

Dobbie, K., 2002, *An analysis of fatigue-related crashes on Australian roads using an operational definition of fatigue* (OR 23). Canberra, ACT: Australian Transport Safety Bureau.

Doecke, S., & Woolley, J., 2011, *Further investigation into the effective use of clear zones and barriers in a safe system's context on rural roads.* Paper presented at the Australasian Road Safety Research, Policing and Education Conference, Perth, WA, Australia.

Doecke, S., & Ponte, G., 2017, *The safety benefits of limiting ISA: A pilot study using real world crash situation* (CASR141). Adelaide, SA: Centre for Automotive Safety Research.

Elder, R.W., Shults, R.A., Sleet, D.A., Nichols, J.L., Thompson, R.S., & Rajab, W., 2004, Effectiveness of mass media campaigns for reducing drinking and driving and alcohol-involved crashes: A systematic review. *American Journal of Preventive Medicine,* 27, 57–65.

Elder, R., Voas, R., Beirness, D., Shults, R., Sleet, D. Nichols, J., Compton, R., 2011, Effectiveness of ignition interlocks for preventing alcohol-impaired driving and alcohol related crashes. *American Journal of Preventive Medicine*, 40 (3), 326-376.

Elvik, R., & Vaa, T. (eds.)., 2004, *The handbook of road safety measures.* Oxford, UK: Elsevier.

Elvik, R., Hoye, A., Vaa, R., & Sorenson, M., 2009, *The handbook of road safety measures (2nd ed.).* Bingley, UK: Emerald Group Publishing.

Erke, A., Goldenbeld, C., & Va, T., 2008, The effects of drink-driving checkpoints on crashes: a meta-analysis. *Accident Analysis and Prevention, 41,* 914-923.

European Commission, 2019, *Intelligent Speed Adaption (ISA).* Retrieved from https://ec.europa.eu/transport/road_safety/specialist/knowledge/speed/new_technologies_new_opportunities/intelligent_speed_adaptation_isa_en

European Parliament, 2018, *Saving lives: eCall mandatory in new car models from this week* [Press release]. Retrieved from http://www.europarl.europa.eu/news/en/press-room/20180326IPR00510/saving-lives-ecall-mandatory-in-new-car-models-from-this-week

European Transport Safety Council, 2017, *New Spanish safety cameras to detect seat belt use*. Retrieved from https://etsc.eu/new-spanish-safety-cameras-to-detect-seat-belt-use/.

Farmer, C. M., Retting, R. A., & Lund, A. K., 1999, Changes in motor vehicle occupant fatalities after repeal of the national maximum speed limit. *Accident Analysis and Prevention, 31(5),* 537-543.

Fatovich, D. M., Phillips, M., Langford, S. A., & Jacobs, I. G., 2011, A comparison of metropolitan vs rural major trauma in Western Australia. *Resuscitation, 82(7),* 886-890.

Ferris, J., Devaney, M., Sparkes-Carroll, M., & Davis, G., 2015, *A national examination of random breath testing and alcohol-related traffic crash rates (2000-2015)*. Canberra, ACT: Foundation for Alcohol Research and Education.

Fildes, B., Langford, J., Andrea, D., & Scully, J., 2005, *Balance between harm reduction and mobility in setting speed limits: A feasibility study* (AP-R272-05). Sydney, NSW: Austroads.

Fitts, M., Palk, G., Lennon, A., & Clough, A., 2013, Prevalence and characteristics of indigenous drink-driving convictions in Queensland, Australia. *Road and Transport Research, 22,* 40-51.

Fitts, M. S., & Palk, G. R., 2014, *Development of a drink driving program for regional and remote Aboriginal and Torres Strait Islander communities. Final Report.* Retrieved from http://www.ndlerf.gov.au/sites/default/files/publication-documents/monographs/monograph-55.pdf

Government of Western Australia Department of Finance., 2017, *WA Government fleet policy and guidelines effective: 8th September 2017.* Perth, WA: Government of Western Australia Department of Finance.

Grace, M., Smith, D., & Noss, R., 2017, Reducing the threat of wildlife-vehicle collisions during peak tourism periods using a roadside animal detection system. *Accident Analysis and Prevention, 109,* 55-61.

Grajewski, R., 2013, New South Wales Road Safety Campaign, *Clip Every Trip,* Retrieved from https://www.youtube.com/watch?v=hRg5CISP3EY

Hall, A., Ho, C., Keay, L., McCaffery, K., Hunter, K., Charlton, J.L., Hayen, A., Bilston, L., & Brown, J., 2018, Barriers to correct child restraint use: A qualitative study of child restraint users and their needs. *Safety Science,* 109, 186-194.

Haworth, N., & Rechnitzer, G., 1993, *Description of fatal crashes involving various causal variables* (Report No. CR119). Melbourne, VIC: Monash University Accident Research Centre.

Helps, Y., & Moller, J., 2007, *Aboriginal people travelling well literature review: driver licensing issues, seat restraint non-compliance, Aboriginal health, Aboriginal disability.* Canberra, ACT: Australian Transport Safety Bureau. Retrieved from https://www.lowitja.org.au/aboriginal-people-travelling-well-literature-review-driver-licensing-issues-seat-restraint-non

Helps, Y., Moller, J., Kowanko, I., Harrison, J., O'Donnell, K., & de Crespigny, C., 2008, *Aboriginal people travelling well: Issues of safety, transport and health.* Retrieved from https://www.lowitja.org.au/aboriginal-people-travelling-well-literature-review-driver-licensing-issues-seat-restraint-non

Henley, G., & Harrison, J., 2013, Injury of Aboriginal and Torres Strait Islander people due to transport, 2005-06 to 2009-10. Retrieved from Canberra: https://www.aihw.gov.au/getmedia/b2dd484e-48ce-4adf-bcd6-c197f42b38bd/15819.pdf.aspx?inline=true

Howard, M., & Rigney, V., 2017, *On the right track remote: Road safety and driver licencing on the Anangu Pitjantjatjara Yankunytjatjara (APY) and Maralinga Tyarutja (MT) lands.* Paper presented at the Australasian Road Safety Conference, Perth, Western Australia, Australia.

Huijser, M., & McGowen, P., 2003, *Overview of animal detection and animal warning systems in North America and Europe*. Paper presented at the International Conference on Ecology and Transportation, Lake Placid, New York, USA.

Huijser, M., McGowen, P., Fuller, J., Hardy, A., Kociolek, A., & Clevenger, A., 2008, *Wildlife-vehicle collision reduction study: Report to Congress* (FHWA-HRT-08-034). McLean, VA: Federal Highway Administration.

Jaarsma, R., Louwerse, R., Dijkstra, A., de Vries, J., & Spaas, J.-P., 2011, Making minor rural roads networks safer: The effects of 60 km/h zones. *Accident Analysis and Prevention, 43(4),* 1508-1515.

Jansch, M., 2017, Lane Keeping Assist systems, European road safety decision support system, developed by the H2020 project SafetyCube. Retrieved from www.roadsafety-dss.eu.

Job, R. & Bin-Sallik, M., 2013, Indigenous road safety in Australia and the "Drivesafe NT Remote" project. *Journal of the Australasian College of Road Safety, 24,* 21-27.

Johnston, P., Brooks, C., & Savage, H., 2008, *Fatal and serious road crashes involving motorcyclists* (Monograph 20). Canberra, ACT: Department of Infrastructure, Transport, Regional Development and Local Government.

Jonsson, J., Lubbe, N., Strandroth, J., & Thomson, R., 2015, *The effect of advanced automatic collision notification (AACN) on road fatality reduction in Sweden.* Paper presented at the FAST-zero 2015 Symposium, Gothenburg, Sweden.

Jurewicz, C., Sobhani, A., Woolley, J., Dutschke, J., & Corben, B., 2015, *Proposed vehicle impact speed-severe injury probability relationships for selected crash types.* Paper presented at the Australasian Road Safety Conference, Gold Coast, Queensland, Australia.

Keay, L., Hunter, K., Brown, J., Bilstron, L., Simpson, J., Stevenson, M., & Ivers, R., 2013, Child restraint use in low socio-economic areas of urban Sydney during transition to new legislation. *Accident Analysis and Prevention, 50,* 984-991.

Keay, L., Hunter, K., Brown, J., Simpson, J., Bilstron, L., Elliott, M., Stevenson, M., & Ivers, R., 2012, Fitting program to promote correct use of age-appropriate child restraints for children aged 3 to 5 years: A cluster randomised trial. *American Journal of Public Health, 102*, e96-e102.

Kent, R., & Forman, J., 2015, *Restraint system biomechanics. In N. Yoganandan et al. (eds). Accidental injury: Biomechanics and prevention.* New York, USA: Springer Science+Business Media.

Kessler, C., Etemad, A., Alessandretti, G., Heinig, K., Brower, R., Cserpinszky, A., Hagleitner, W., & Benmimoun, M., 2012, *European large-scale field operational tests on in-vehicle systems: 7th Framework programme* (Deliverable D11.3). Germany: EuroFOT Consortium.

Khalil, T., 2015, *Introduction. In N. Yoganandan et al. (eds). Accidental injury: Biomechanics and prevention.* New York, USA: Springer Science+Business Media.

Klinich, K., Manary, M., & Weber, K., 2012, Crash protection for child passengers: Rational for best practice. *UMTRI Research Review, January-March, 43,* (1),1.

Klocker, U., Croft, D., & Ramp, D., 2006, Frequency and causes of kangaroo-vehicle collisions on an Australian outback highway. *Wildlife Research, 33(1),* 5-15.

Kloeden, C., Ponte, G., & McLean, A., 2001, *Travelling speed and the risk of crash involvement on rural roads.* Adelaide, SA: Australian Transport Safety Bureau.

Lee, E., Wu, J., Kang, T., & Craig, M., 2017, Estimate of mortality reduction with implementation of advanced automatic collision notification. *Traffic Injury Prevention, 18(Suppl. 1)*, S24-S30.

Lupova, E. (nd.). *Driver fatigue management research paper.* Canberra, ACT: Canberra Innovation Network.

Mackenzie, J., Kloeden, C., & Hutchinson, T., 2015, *Reduction of speed limit from 110 km/h to 100 km/h on certain roads in South Australia: a follow up evaluation.* Paper presented at the Australasian Road Safety Conference, Gold Coast, Queensland, Australia.

Mackie, H., Brodie, C., Scott, R., Hirsch, L., Tate, F., Russel, M., & Hoist, K., 2017, 'The signs they are a a-changing': Development and evaluation of New Zealand's rural intersection active warning system. *Journal of the Australasian College of Road Safety, 28(3),* 11-21.

Mackie, H., Hoist, K., Brodie, C., Tate, F., & Scott, R., 2016, *Long-term speed and safety outcomes from New Zealand's rural intersection active warning system.* Paper presented at the Australasian Road Safety Conference, Canberra, ACT, Australia.

Macpherson, T., & Lewis, T., 1998, New Zealand drink-driving statistics: The effectiveness of road safety television advertising. *Marketing Bulletin, 9,* 40 - 51.

Marshall, W., 2018, Understanding international road safety disparities. Why is Australia so much safer than the United States. *Accident Analysis and Prevention, 11,* 251-265.

McCowen, D., 2017, *The breakdown: Autonomous Emergency Braking.* Retrieved from https://www.drive.com.au/motor-news/the-breakdown-autonomous-emergency-braking

McIntyre, A., Cockfield, S., & Nieuwesteeg, M., 2011, *Drink and drug driving in Victoria: Lessons from 10 years of TAC Research*. Paper presented at Australasian College of Road Safety Conference, Melbourne, Victoria, Australia.

Mehler, B., Reimer, B., Lavalliere, M., Dobres, J., & Coughlin, J.F., 2014, *Evaluating technologies relevant to the enhancement of driver safety.* Washington, DC: AAA Foundation for Traffic Safety.

Ministry of Transport, 2010, *Safer Journeys. New Zealand's road safety strategy 2010-2020*. New Zealand: Ministry of Transport.

Ministry of Transport, 2017a, *Motor vehicle crashes in New Zealand 2016.* Retrieved from https://www.transport.govt.nz/resources/road-safety-resources/roadcrashstatistics/motorvehiclecrashesinnewzealand/motor-vehicle-crashes-in-new-zealand-2016/

Ministry of Transport, 2017b, Alcohol and drugs 2017. New Zealand: Ministry of Transport.

Motorcycle Safety Review Group, 2015, *Western Australian strategic direction for improving the safety of motorcyclists and moped riders 2016 - 2020.* Retrieved from https://www.rsc.wa.gov.au/RSC/media/Documents/Resources/Publications/motorcycle-safety-review.pdf

MRCagney Pty Ltd., 2017, *NT Remote bus program service evaluation. Final report.* NT, Australia.

National Rural Health Alliance. (2014). *Alcohol use in rural Australia [Fact Sheet].* Retrieved from http://ruralhealth.org.au/sites/default/files/publications/nrha-factsheet-alcohol.pdf

National Rural Health Alliance, 2015, *Submission to the Rural and Regional Affairs and Transport References Committee Inquiry into Aspects of Road Safety in Australia.* Retrieved from http://ruralhealth.org.au/sites/default/files/documents/nrha-policy-document/submissions/nrha-sub-road-safety.pdf

National Transport Commission. (nd.). *A guide to applying road safety within a workplace.* Melbourne, VIC: National Transport Commission.

National Transport Commission, 2014, *Delivering a compliance framework for heavy vehicle telematics. Final policy paper.* Melbourne, VIC: National Transport Commission.

National Heavy Vehicle Regulator, 2019, *Heavy vehicle national law and regulations.* Retrieved from https://www.nhvr.gov.au/law-policies/heavy-vehicle-national-law-and-regulations

Nereus Consulting and The Story Catchers, 2017, *On the right track remote evaluation report.* Retrieved from https://www.dpti.sa.gov.au/__data/assets/pdf_file/0005/426902/OTRTR_evaluation_report_Feb_2017_Fnl_3.pdf

Newstead, S., Diamantopoulou, K., Lawrence, B., Clark, B., & Palamara, P. (2014). *An evaluation of automated traffic enforcement operations in Western Australia, 1995-2013* (Report 12-025RSC). Perth, WA: Curtin-Monash Accident Research Centre.

NSW Centre for Road Safety, 2017, *Drug driving trauma trends*. Sydney, NSW: Transport for NSW.

NSW Centre for Road Safety 2019, *Don't trust your tired self*. Retrieved from https://roadsafety.transport.nsw.gov.au/campaigns/donttrustyourtiredself.html

Newstead, S., Watson, L., & Cameron, M., 2016, *Vehicle safety ratings estimated from police reported crash data: 2016 update* (Report No. 328). Melbourne, VIC: Monash University Accident Research Centre.

New Zealand Transport Agency, 2011, *High-risk rural roads guide.* Wellington, New Zealand: New Zealand Transport Agency.

Nilsson, G., 2004, T*raffic safety dimensions and the Power Model to describe the effect of speed on safety.* (Doctoral thesis), Lund Institute of Technology.

Northern Territory Government, 2018, *Alcohol harm minimisation action plan, 2018-2019.* Darwin, NT: Northern Territory Government.

Northern Territory Motor Accidents Compensation Commission, 2017, *Buckle up Borroloola.* Darwin, NT: NT Motor Accidents Compensation Commission.

Northern Territory Motor Accidents Compensation Commission, (n.d.), *Always wear your seatbelt*. Retrieved from http://www.ntmacc.com.au/seatbelts.

NRMA Insurance, 2018, *Road roos a risk this long weekend.* Retrieved from https://www.nrma.com.au/road-roos-risk-winter

NRSPP, 2017, *In-vehicle monitoring systems (IVMS): Safety through good practice telematics.* Retrieved from https://www.nrspp.org.au/resources/discussion-paper-in-vehicle-monitoring-systems-ivms-safety-through-good-practice-telematics/

NSW Centre for Road Safety, 2018, *Saving lives on country roads.* Retrieved from https://roadsafety.transport.nsw.gov.au/campaigns/saving-lives-on-country-roads/index.html

NSW Centre for Road Safety. (nd.). *Driver Reviver*. Retrieved from https://roadsafety.transport.nsw.gov.au/stayingsafe/fatigue/driverreviver/docs/driver_reviver_guidelines.pdf

OECD, 2010, *Drugs and driving: Detection and deterrence.* Paris, France: OECD Publishing.

OECD, 2016, *Zero road deaths and serious injuries: Leading a paradigm shift to a safe system.* Paris, France: OECD Publishing

Office of the Minister of Transport, (n.d.), *Report back on the drug-driving regime*. Ministry of Transport, New Zealand. Retrieved from https://www.transport.govt.nz/assets/Uploads/Our-Work/Documents/59a420b00d/Cabinet-Paper-Report-Back-on-Drug-Driving-Regime.pdf.

Optalert (n.d.), *Scientifically designed Glasses*. Retrieved from https://www.optalert.com/explore-products/scientifically-validated-glasses-mining/

Palamara, P., 2016, *The application of a proxy measure to estimate the incidence of driver fatigue in Western Australian motor vehicle crashes* (RR 16-003). Perth, WA: Curtin-Monash Accident Research Centre.

Palamara, P., 2018, *Promoting Safe Vehicles to Vulnerable Drivers* (RR18-06). Perth, WA: Curtin-Monash Accident Research Centre.

Palamara, P., Broughton, M., & Chambers, F., 2014, *Illicit drugs and driving: An investigation of fatalities and traffic offences in Western Australia* (RR13-001). Perth, WA: Curtin-Monash Accident Research Centre.

Palamara, P., Kaura, K., & Fraser, M., 2013, *An investigation of serious injury motor vehicle crashes across metropolitan, regional and rural Western Australia* (RR 09-001). Perth, WA: Curtin-Monash Accident Research Centre.

Parliament of Victoria, 2012, *Inquiry into motorcycle safety*. (ISBN: 978-0-9807166-2-7). Victoria, Australia: Road Safety Committee.

Phan, V., 2017, *Electronic Stability Control (ESC): European road safety decision support system developed by the H2020 project Safety Cube.* Retrieved from www.roadsafety-dss.eu.

Phillips, R., 2015, A review of definitions of fatigue – And a step toward a whole definition. *Transportation Research Part F*, 29, 48-56.

Ponte, G., Ryan, G. A., & Anderson, R. W. G., 2016, An estimate of the effectiveness of an in-vehicle automatic collision notification system in reducing road crash fatalities in South Australia. *Traffic Injury Prevention, 17(3)*, 258-263.

Porykali, B., Hunter, K., Ralph, M., Keay, L., Clapham, K., Brown, J., . . . Ivers, R., 2017, *Delivery of a child car seat program in 12 Aboriginal Communities in NSW: Elements for a detailed process evaluation.* Paper presented at the Australasian Road Safety Conference, Perth, Western Australia.

RACV, 2016, *Risk of animal collisions increases warns RACV*. Retrieved from https://www.racv.com.au/about-racv/our-business/media-releases/risk-of-animal-collisions-increases-warns-racv.html

Raftery, S., & Anderson, R., 2012, *Factors associated with older car crashes (CASR096)*. Adelaide, SA: Centre for Automotive Safety Research.

Road Safety Commission Western Australia, 2015, *Keeping your mob safe, a guide to making roads safer in your community*. Retrieved from http://biblio.healthinfonet.org.au/key-resources/promotion-resources?lid=30724

Road Safety Commission (nd.), *A consumer guide to safer vehicles suitable for remote and regional Western Australia*. Perth, WA: Road Safety Commission Retrived from https://www.rsc.wa.gov.au/RSC/media/Documents/Resources/Publications/consumer-guide-safer-vehicles.pdf

Rowden, P., Steinhardt, D., & Sheehan, M., 2008, *Road crashes involving animals in Australia. Accident Analysis and Prevention, 40(6),* 1865-1871.

Rural and Regional Affairs and Transport References Committee, 2016, *Aspects of road safety in Australia. Interim report.* (ISBN 978-1-76010-431-3). Canberra, ACT: Department of the Senate Retrieved from https://www.aph.gov.au/Parliamentary_Business/Committees/Senate/Rural_and_Regional_Affairs_and_Transport/Road_safety/Interim%20Report/c03

Safety Net, 2009, *Post Impact Care.* Retrieved from https://ec.europa.eu/transport/road_safety/sites/roadsafety/files/specialist/knowledge/pdf/postimpactcare.pdf

Safe Work Australia, 2013, *Guide for managing the risk of fatigue at work.* Retrieved from www.swa.gov.au

Saleh, K., Hossny, M., & Nahavandi, S., 2018, *Effective vehicle-based kangaroo detection for collision warning systems using region-based convolutional networks*. Sensors, 18.

Savino, G., Mackenzie, J., Allen, T., Baldock, M., Brown, J., & Fitzharris, M., 2016, A robust estimation of the effects of motorcycle autonomous emergency braking (MAEB) based on in-depth crashes in Australia. *Traffic Injury Prevention, 17(Suppl. 1),* S66-S72.

Scully, J., & Newstead, J., 2010, *Follow-up evaluation of Electronic Stability Control effectiveness in Australasia* (Report No. 306). Melbourne, VIC: Monash University Accident Research Centre.

Scully, J., Newstead, S., Corben, B., & Candappa, N., 2006, *Evaluation of the effectiveness of the $240M Statewide Blackspot Program - Accident Blackspot component*. Melbourne, VIC: Monash University Accident Research Centre.

Seeing Machines, 2019, *Guardian*. Retrieved from https://www.seeingmachines.com/guardian/guardian/

Senserrick, T., Yip, P., Grzebieta, R., Ivers, R., Clapham, K., & Lyford, M., 2011, *Safe system demonstration project involving an Indigenous community: Audit and implementation plan* (AP-R377B/11). Sydney, NSW: Austroads.

Sevefelt, B., & Wessel, P., 2012, *Variable speed limits in unprotected intersections: Implementation and evaluation of 12 sites in Sweden.* Paper presented at the 19th ITS World Congress, Washington DC, USA.

Sihvola, N., Luoma, J., Schirokoff, A., Salo, J., & Karkola, K., 2009, In-depth evaluation of the effects of an automatic emergency call system on road fatalities. *European Transport Research Review, 1(3),* 99-105.

Siskind, V., Steinhardt, D., Sheehan, M., O'Connor, T., & Hanks, H., 2011, Risk factors for fatal crashes in rural Australia. *Accident Analysis and Prevention, 43,* 1082-1088.

Slootmans, F., Martenson, H., Kluppels, L., & Meesmann, U., 2017, *Rehabilitation courses as alternative measure for drink-driving offenders.* Retrieved from https://www.roadsafety-dss.eu/assets/data/pdf/synopses/Rehabilitation_courses_as_alternative_measure_for_drunk_driving_offenders_13062017_pending_approval.pdf

Soole, D., Watson, B., & Fleiter, J., 2013, Effects of average speed enforcement on speed compliance and crashes: A review of the literature. *Accident Analysis and Prevention, 54,* 46-56.

Souleyrette, R., & Cook, D., 2010, *Evaluation of Iowa's 70 mph speed limit - 4 years later.* Ames, IA: Iowa State University.

Statistics New Zealand, 2016, *Subnational population estimates: At 30 June 2016 (provisional).* Retrieved from http://archive.stats.govt.nz/browse_for_stats/population/estimates_and_projections/SubnationalPopulationEstimates_HOTPAtJun16.aspx

Statistics New Zealand, 2017, *Statistical standard for geographic areas 2018.* Retrieved from www.stats.govt.nz.

Sticher, G., & Sheehan, M., 2006, *Assessment for personal crash risk among rural drivers: Perception versus reality.* Paper presented at the Australasian Road Safety Research, Policing and Education Conference, Gold Coast, Queensland, Australia.

Stockwell, T., Zhao, J., Martin, G., Macdonald, S., Vallance, K., Treno, A., . . . Buxton, J., 2013, Minimum alcohol prices and outlet densities in British Columbia, Canada: Estimated impacts on alcohol-attributable hospital admissions. *American Journal of Public Health, 103(11),* 2014-2020.

Terer, K., & Brown, R., 2014, Effective drink driving prevention and enforcement strategies: Approaches to improving practice. *Trends and Issues in Crime and Justice,* (472), 1.

Thompson, J., Wundersitz, L., & Raftery, S., 2018, *Evaluation of the performance of Alcohol and Drug Awareness Courses currently provided in the ACT.* Paper presented at the 2018 Australasian Road Safety Conference, Sydney, New South Wales, Australia.

Thomson, N., Krom, I., & Ride, K., 2009, *Summary of road safety among Indigenous peoples*. Retrieved from: https://www.healthinfonet.ecu.edu.au/uploads/docs/road-review.pdf

Toll Group, 2016, *Submission to the National Transport Commission on: Enforcement approaches for speeding heavy vehicles, Discussion Paper.* Retrieved from https://www.ntc.gov.au/media/1411/enforcement-approaches-for-speeding-heavy-vehicles-discussion-paper-may-2016-sarah-jones-toll-group-jun-2016.pdf

Toll Group, (n.d.), Innovative vehicle design revolutionises dangerous goods transport. Retrieved from https://www.tollgroup.com/news-and-media/case-studies/innovative-vehicle-design-revolutionises-dangerous-goods-transport

Tracy, D., 2013, *This is how ABS, ESC and Traction Control work.* Retrieved from https://jalopnik.com/this-is-how-abs-esc-and-traction-control-work-513807036

Transport Accident Commission (nd.). *Vehicle purchase policy.* Melbourne, VIC.

Transport and Infrastructure Council, 2015, *National remote and regional transport strategy.* Canberra, ACT: Department of Infrastructure, Regional Development and Cities.

Transport and Infrastructure Council, 2017, *National Road Safety Strategy 2011-2020 Implementation status report*. Canberra, ACT: Department of Infrastructure, Regional Development and Cities.

Transport and Infrastructure Council, 2018, *National Road Safety Action Plan 2018-2020.* Canberra, ACT: Department of Infrastructure, Regional Development and Cities.

Turner, B., 2009, *Engineering based approaches to reducing rural speed.* Paper presented at the Australasian Road Safety Research, Policing and Education Conference, Sydney, New South Wales, Australia.

Umstatter, C., 2011, The evolution of virtual fences: A review. *Computers and Electronics in Agriculture, 75(1),* 10-22.

Vehicle Safety Research Group. (nd.). *The contribution of vehicle safety improvement to road trauma trends and the potential benefits of new safety technologies for light and heavy vehicles.* Melbourne, VIC: Monash University Accident Research Centre.

Waldron, G. (nd.). *Innovative countermeasures for driver fatigue.* Melbourne, VIC: ARRB Group.

Wall, J., Woolley, J., Ponte, G., & Bailey, T., 2014, *Post crash response arrangements in Australia compared to other high performing road safety nations.* Paper presented at the Australasian Road Safety Research Policing Education Conference, Melbourne, Victoria, Australia.

Watson, A., Imberger, K., Cavallo, A., Healy, D., Freeman, J., Filtness, A., Wilson, H., & Catchpole, J., 2015, *The impact of safety measures on the re-offence and crash rates of drink-driving offenders in*

Victoria. Paper presented to the 2015 Australasian Road Safety Conference, Gold Coast, Queensland, Australia.

Watson, B., Tunnicliff, D., Manderson, J., O'Connor, E., Stefaniw, M., Fraine, G., & Samuels, S., 2004, *The safety of international visitors on Australian Roads.* Brisbane, QLD: CARRS-Q.

Watson, B., Watson, A., Siskind, V., Fleiter, J., & Soole, D., 2015, Profiling high-range speeding offenders: Investigating criminal history, personal characteristics, traffic offences, and crash history. *Accident Analysis and Prevention, 74,* 87-96.

Watson, M., Elliott, P., Kinsella, C., & Wilson, S., 1997, *Aboriginal road safety issues report.* Adelaide, SA: Aboriginal Drug and Alcohol Council (SA) Inc.

Wishart, S., & Freethy, C., 2018, *Victorian government drink and drug-driving countermeasures.* Paper presented at the 2018 Australasian Road Safety Conference, Sydney, New South Wales, Australia.

Woolley, J., & Crozier, J., 2018, *Inquiry into the National Road Safety Strategy 2011-2020.* Canberra, ACT: Department of Infrastructure, Regional Development and Cities.

Worksafe, 2019, *Fatigue Management Training*. Retrieved from https://fatigue.safetyline.wa.gov.au/

Wu, J., Craig, M., & Longthorne, A., 2015, *Updated estimates of potential traffic fatality reductions with automatic collision notification.* Paper presented at the Proceedings from the 24th International Technical Conference on the Enhanced Safety of Vehicles, Gothenburg, Sweden.

Wundersitz, L., & Raftery, S., 2017, Understanding the context of alcohol impaired driving for fatal crash–involved drivers: a descriptive case analysis. *Traffic Injury Prevention, 18(8),* 781-787.

Wundersitz, L., & Woolley, J., 2008, *Best practice review of drink driving enforcement in South Australia* (Report no. CASR036). Adelaide, SA: Centre for Automotive Safety Research.

Xiao, L., & Gao, F., 2010, A comprehensive review of the development of adaptive cruise control systems. *Vehicle Systems Dynamics, 48,* 1167-1192.

Ydenius, A., Kullgren, A., Rizzi, M., Engstrom, E., Stigson, H., & Strandroth, J., 2017, *Fatal car to moose collisions: Real-world in-depth data, crash tests and potential of different countermeasures.* Paper presented at the 25th Enhanced Safety of Vehicles (ESV) Conference Proceedings, Detroit, Michigan, USA.

Zhang, M., Meuleners, L., Chow, C., & Govorko, M., 2014, *The epidemiology of heavy vehicle crashes in Western Australia: 2001-2013.* Perth, WA: Curtin-Monash Accident Research Centre.

Appendix A Fatal and Injury Crash Data Tables

Table A 1: Average annual casualty crashes (2012-2016) in regional and remote areas by crash type

Crash type	Australia	New Zealand
Pedestrian	788	280
Adjacent direction	2359	532
Same direction	2641	562
Opposite direction	1836	560
Manoeuvring	964	182
Overtaking	314	104
On path	955	255
Off path	9083	664
Miscellaneous	220	43
Unknown	115	0

Table A 2: Average annual casualty crashes (2012-2016) in regional and remote areas by hour of day

Hour of day	Australia	New Zealand
0	299	85
1	271	78
2	222	67
3	200	62
4	216	58
5	368	79
6	552	108
7	747	181
8	1114	274
9	1024	202
10	1150	234
11	1277	260
12	1281	251
13	1248	274
14	1380	312
15	1627	407
16	1499	348
17	1317	327
18	963	250
19	693	175
20	537	148
21	488	133
22	427	114
23	378	106

Table A 3: Average annual casualty crashes (2012-2016) in regional and remote areas by day of week

Day of week	Australia	New Zealand
Sunday	2808	657
Monday	2597	594
Tuesday	2553	598
Wednesday	2595	632
Thursday	2703	641
Friday	3022	736
Saturday	3021	718

Table A 4: Average annual casualty crashes (2012-2016) in regional and remote areas by month of year

Month	Australia	New Zealand
January	1615	411
February	1553	394
March	1736	431
April	1636	369
May	1648	386
June	1533	356
July	1551	360
August	1597	337
September	1548	327
October	1633	364
November	1606	391
December	1644	448

Table A 5: Average annual casualty crashes (2012-2016) in regional and remote areas by speed zone

Speed zone	Australia	New Zealand
≤50	3930	1606
60	3924	28
70	550	162
80	2558	195
90	332	10
100	5841	2574
110	1578	0

Table A 6: Average annual casualty crashes (2012-2016) in regional and remote areas by vehicle type

Vehicle type	Australia	New Zealand
Truck	938	356
Bus	149	32
Motorcycle	3220	549
Other vehicle	213	40
Passenger vehicle	22877	4087
Pedal cycle	818	284
Unknown vehicle	284	0

Table A 7: Average annual male casualties (2012-2016) in regional and remote areas by age group

Male age group	Australia	New Zealand
0-16	1043	283
17-25	3701	863
26-39	3431	650
40-59	4108	855
60-69	1246	276
70+	1056	247

Table A 8: Average annual female casualties (2012-2016) in regional and remote areas by age group

Female age group	Australia	New Zealand
0-16	911	218
17-25	2878	626
26-39	2321	463
40-59	2733	600
60-69	956	210
70+	955	225

Table A 9: Average annual casualties (2012-2016) in regional and remote areas by casualty type

Casualty type	Australia	New Zealand
Driver	14977	3655
Passenger	5917	1053
Motorcycle rider	3119	475
Motorcycle pillion	160	38
Cyclist	798	283
Pedestrian	925	315
Other	30	1

Table A 10: Average annual casualties (2012-2016) in regional and remote areas by restraint use

Restraint use	Australia	New Zealand
Yes, restrained	16878	2425
No, unrestrained	837	249
Unknown	3233	2199
None available	-	236

Austroads' **Guide to Road Safety Part 5: Road Safety for Regional and Remote Areas** examines the nature and causes of crashes in regional and remote areas, and identifies measures that will result in reduced road trauma.

Guide to Road Safety Part 5

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