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FINAL REPORT

Project Title: R85 Review of Engineering Treatments for Urban Fringe Environments (2018/19)

ARRB Project No: PRS18075

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SUMMARY

The purpose of this strategic-level project was to determine how the rising trend in crashes happening in the urban fringe, predominantly due to the increasing volumes of vehicles on roads designed for lower volumes or original alignments, can be addressed. The outputs from this process will allow earlier (proactive) identification of locations of potential crashes and targeting of future funding to address these issues, along with outcomes that can be used to amend TMR's existing guidance.

Despite being an issue for most road agencies and local governments, limited literature was available which identified current practices of engineering treatments in urban fringe environments. This confirmed the gap in guidance available to practitioners when challenged with population growth, which places a greater demand on the road network and changes the mix of transport users and transport needs within the urban fringe environment.

Ten years of crash data was analysed for case study roads to determine the high-risk crash types. Head-on crashes, off-carriageway on curve (hit object) crashes, adjacent approaches intersection crashes, overtaking (although the proportions were low) and vehicle leaving driveway crashes were found to be over-represented when compared to all state-controlled roads.

From undertaking a literature review, stakeholder consultation, and the crash analysis, safety risk factors were identified for urban fringe roads. These include increasing traffic volumes, changes in road function, increased crash risk, changes in land use and the mix of road users, access management, and inappropriate road features for increased traffic volumes.

Based on the research conducted, a treatment framework has been developed to enable TMR to proactively manage the identified risk factors and to target future funding to address the infrastructure requirements as roads transition from rural to urban environments. Although this study focused on state-controlled roads, the issues are equally relevant to local government who will experience are experiencing the same issues as development occurs.

To effectively manage the transition of rural roads to urban roads, it is important to determine the extent of traffic growth resulting from development and the likely impacts this growth has on the road network. It is recommended that TMR identify existing and future roads which are or are likely to be classified as urban fringe roads, to gain a better understanding of the future infrastructure upgrades required and to prioritise the works required.

Although a framework of solutions has been provided, the issue remains on identifying where current and emerging risk will arise on the road network. Further research is recommended to develop a process to enable urban fringe roads to be identified and assessed so that the treatments can be applied to reduce the risk of crashes on these roads and to identify possible ways to obtain funding from additional sources.

It is recommended that the impacts of development on the urban fringe roads be given greater attention at the planning stage to allow TMR to more effectively manage the impacts on the network and to potentially seek greater contributions from developers.

The framework provides guidance, specifically for urban fringe roads, which is not currently available in TMR's technical documents and guidelines. It is recommended that guidance provided in the framework be included in TMR's technical documents and guidelines where appropriate.

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1.1 Background

The purpose of this strategic-level project was to determine how the rising trend in crashes happening in the urban fringe, predominantly due to the increasing volumes of vehicles on roads designed for lower volumes or original alignments, can be addressed. The outputs from this process will allow earlier (proactive) identification of locations of potential crashes and targeting of future funding to address these issues, along with outcomes that can be used to amend TMR's existing guidance.

The Mt Lindesay Highway south of Brisbane is an example of an urban fringe environment whereby urban development has rapidly expanded in recent years. Locations such as this now incorporate both industrial and housing developments with increases in population and transportation requirements interacting and utilising road corridors designed decades ago to different design standards to maximise long-distance travel. As a result, road safety transportation risks will increase with the increasing exposure, hence the need for this project. Further examples of urban fringe development environments can be evidenced on the rapidly developing Sunshine Coast region.

1.2 Objectives

The overall objective of this project was to identify how to manage urban fringe environments at the planning, development, design and operations stages to improve road safety outcomes.

The anticipated benefits of this project include:

- to assist technical professionals in enhancing road safety outcomes for urban fringe environments
- to assist in identifying high-risk sites in urban fringe environments where safety treatments could help reduce the severity of crashes
- to identify how to better manage, from a safety point of view, the urban fringe environments at the planning, development, design and operation stages.

1.3 Scope

The scope of the project included:

- undertaking a literature review to establish current practices nationally and internationally and identifying applicable gaps in knowledge and practice
- identifying a series of engineering risk factors contributing to road safety outcomes in urban fringe environments for consideration of inclusion in the development of a decision support tool
- development of a decision treatment framework that can be used to inform decision-making processes relating to engineering interventions and strategies for urban fringe environments.

The scope of the project was to identify and understand from a road safety engineering perspective the potential risk factors that contribute to crashes in this type of environment to assist in the development of improved safety outcomes.

1.4 Methodology

An outline of the project methodology is provided below. Further details for each of the tasks undertaken are provided in the relevant sections of the report.

1.4.1 Literature Review

A comprehensive literature review was undertaken to firstly define urban fringe environments and to identify and establish current practices of engineering treatments in urban fringe environments both nationally and internationally. The literature review established current gaps and provided a series of recommendations for improvement.

1.4.2 Identification of Risk Factors

The identification of risk factors was obtained from:

- The literature review
- stakeholder consultation – Focus groups discussions were undertaken with key reference group stakeholders associated with the development of road safety programs and projects in urban fringe environments and the operation of urban fringe routes. This was supplemented with a questionnaire sent to state road agencies.
- historical crash data – TMR provided historical crash data for several typical urban fringe roads to facilitate the identification of risk factors that have contributed to actual crashes.

1.4.3 Development of Decision Treatment Framework

The information obtained from the stakeholder consultation, literature review, and the identification of risk factors from data analysis was used to inform the development of a decision treatment framework.

1.4.4 Reporting and Documentation

A report was prepared documenting the project findings and the decision support framework.

2 LITERATURE REVIEW

2.1 Introduction

The literature review explores the rising trend in crashes happening in the urban fringe environments. The review provides a definition of urban fringe environments, along with outlining previously undertaken engineering treatments implemented both nationally and internationally. Although the literature search targeted treatments for roads within an urban fringe environment, the search was broadened to include treatments used in similar environments that may be applicable to urban fringe roads. Gaps in knowledge and current practice associated with engineering treatments to improve road safety in urban fringe environments were identified. The outputs from this process will allow targeting of future funding to address these issues, along with outcomes that can be used to amend the Department of Transport and Main Roads' (TMR) existing guidance.

2.1.1 Search Method

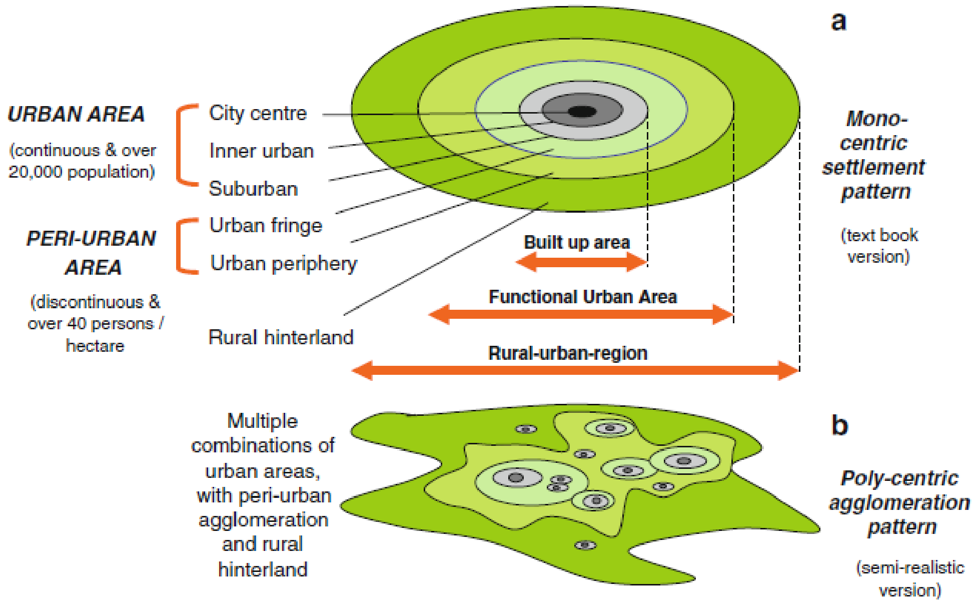
In order to identify relevant research, a literature review was conducted using the resources from the ARRB knowledge base. These resources included the Library's own comprehensive collection of technical land transport literature and information retrieval specialists with extensive experience in the transport field, as well as access to the collections and expertise of other transport-related libraries throughout Australia and internationally.

Used specifically in this literature search were the Australian Transport Index (ATRI) and Transportation Research Information Documentation (TRID) databases. Use of these databases ensured wide coverage for quality research material within the subject area from national and international sources. This was supplemented by an internet search.

2.2 Definition of the Urban Fringe

The term 'urban fringe' is defined as a zone along the edges of a built-up area, also known as the rural to urban transition zone (Ravetz, Fertner & Nielsen 2013). Buxton and Choy (2007) describe the urban fringe to be situated within the peri-urban area; typically, these areas are nearby metropolitan areas on their inner boundary, a rural area on their outer boundary, or as the land in between. Figure 2.1 shows a geographical concept of an urban fringe environment. According to Ravetz, Fertner and Nielsen (2013) the peri-urban area is identified as discontinuous and over 40 persons per hectare.

Figure 2.1: Geographical concept of an urban fringe environment



Source: Ravetz, Fertner and Nielsen (2013).

Ravetz, Fertner and Nielsen (2013) explain that the context for the urban fringe environment is the broader picture of change and population growth in human settlements. The process begins with the expansion of metropolitan areas into the countryside and/or rural land areas. The European Environment Agency (EEA) (2006) characterises the urban fringe by a low density mix of land users, scattered urban development, urban concentrations around transport hubs, together with vast amounts of green space e.g. parks, nature reserves and golf courses.

The Roads and Traffic Authority (RTA) (2011) provides speed zoning guidelines for this area and defines semi-urban/rural fringe areas as having one to two intersections per kilometre and five to six regularly used driveways or private accesses per kilometre.

TMR (2018a) *Manual of Uniform Traffic Control Supplement Part 4* defines a semi-urban road environment as outlined in Table 2.1.

Table 2.1: Environmental context classification

Road in environmental context classification	Description	Typical land uses[1]
Urban environment	A road in which either of the following is present for a distance of at least 500 m or, if the length of road is shorter than 500 m for the whole road: a) average lot sizes of less than 0.5 Ha in size and have an average frontage of less than 40 m, **or** b) street lights not over 100 m apart.	Typical land uses may include: • commercial strip shopping • commercial big box • industrial • urban residential • rural town; and • highway / arterial roads with controlled access.
Semi-urban environment	If a road section does **not** meet the criteria for 'Urban' and typically buildings on adjacent lots, not over 100 m apart, on land next to the road for a distance of at least 500 m or, if the length of road is shorter than 500 m for the whole road.	Typical land uses may include: • urban residential • rural residential • rural town, and • highway / arterial roads with controlled access.
Rural environment	All other roads.	Typical land uses may include: • rural residential • remote rural, and • no-access freeways with at-grade intersections.

1. Land uses have been provided as a guide **only**. The components listed in the *Description* must be used for *Identification* of the appropriate environmental context class.

Source: TMR (2018a).

2.3 Road Safety Issues in Urban Fringe Environments

Researchers and road safety stakeholders are showing increasing concern associated with the frequency of crashes within urban fringe environments. Due to the expansion of population and services, road infrastructure and road networks are facing increased demand. In addition, transport and mobility patterns are in a constant flux of change. For example, urban fringe environments often consist of industrial, residential, business, and associated services mixed with farming communities, rural hinterland and transport corridors. Different transport and mobility patterns associated with the vast array of road network users provides challenges for road agencies to design the network to cope with the growing demand.

Recent case studies for urban fringe environments along areas on the Mount Lindesay Highway and Eatons Crossing Road within Queensland have shown increased casualty crashes in the last five years. A common trend across these urban fringe environments is an increasing frequency of crashes relating to intersections, opposing vehicles turning, vehicles leaving carriageways and high-speed environments. These types of crashes suggest issues associated with vehicle movements and the different mix of road users within the urban fringe environment.

To address these issues and reduce the frequency of crashes, road safety stakeholders have utilised a range of engineering treatments. The following section provides details of the types of engineering treatments that have previously been implemented and outlines the effectiveness of these treatments.

2.4 Engineering Treatments

A challenge found by local governments and road agencies is ensuring that decisions for road safety engineering treatments are appropriate and that the most cost-effective safety outcome is achieved (Austroads 2015). This section provides an overview of the engineering treatments commonly used to address rising crash trends in urban fringe environments in Australia and internationally.

2.4.1 Australia

Main Roads Western Australia published the *Guidelines for the Selection of Intersection Control* in 2015. This document provides technical information to assist practitioners to determine whether roundabouts or traffic signals are appropriate intersection controls for major roads carrying high volumes of traffic.

Table 2.2 outlines the suitability of traffic control treatments on various road types, whereby the Distributor A (which has indicative traffic volumes above 8000 vpd), Distributor B (which has indicative traffic volumes above 6000 vpd) and Local Distributor roads (which has indicative traffic volumes above 3000 vpd) classifications represent the typical urban fringe environment. Main Roads Western Australia (2015) reported that roundabouts and stop or give way signs are the most appropriate treatments to provide safety advantages and lower delays in off-peak periods.

Table 2.2: Suitability of types of traffic control to different road types

	Primary Distributor (excluding Freeways)	Distributor A	Distributor B & Local Distributor	Access Road
Traffic Signals				
Primary Distributor (excluding Freeways)	O	O	O	X
Distributor A	O	O	O	X
Distributor B & Local Distributor	O	O	X	X
Access Road	X	X	X	X
Roundabouts				
Primary Distributor (excluding Freeways)	A	A	X	X
Distributor A	A	A	A	X
Distributor B & Local Distributor	X	A	A	O
Access Road	X	X	O	O
STOP signs or GIVE WAY signs				
Primary Distributor (excluding Freeways)	X / (O)	X / (O)	A	A
Distributor A	X / (O)	X / (O)	A	A
Distributor B & Local Distributor	A	A	A	A
Access Road	A	A	A	A
Legend: A = Most likely to be an appropriate treatment O = May be an appropriate treatment X = Usually an inappropriate treatment				

Source: Main Roads Western Australia (2015).

Main Roads Western Australia (2015) also reported on the typical crash rates from a five-year case study 2009 to 2013 in the Perth inner and outer metropolitan areas. The outer metropolitan areas in this study are consistent with the definition of an urban fringe environment. Table 2.3 shows that intersections controlled by roundabouts have significantly lower crash rates than intersections controlled by traffic signals. In particular, the crash differential between signalised intersections and roundabouts is the highest where state roads intersect with local roads. This intersection of lower order roads with higher order roads is representative of the urban fringe environment. Therefore, the engineering treatment of roundabouts could be considered an appropriate treatment within the urban fringe.

Table 2.3: Perth inner and outer metropolitan area mean crash frequency for all crash types

	Mean Crash Frequency for All Crash Types (Crashes / Intersection / Year)		
State Road / State Road Intersections	**Traffic Signals**	**Roundabouts**	**Ratio TS/R**
Inner Metropolitan Area[1]	17.6	4.4	4.0
Outer Metropolitan Area[2]	11.2	4.6	2.4
State Road / Local Road Intersections			
Inner Metropolitan Area	13.6	0.2	68
Outer Metropolitan Area	13.2	0.8	16.5
Local Road / Local Road Intersections			
Inner Metropolitan Area	8.2	1.2	6.8
Outer Metropolitan Area	8.2	1.6	5.1

Notes:

- Inner Metropolitan Area: Bassendean, Bayswater, Belmont, Canning, Claremont, Cottesloe, Fremantle, Melville, Nedlands, Perth, Stirling, South Perth, Subiaco, Cambridge
- Outer Metropolitan Area: Armadale, Kalamunda, Cockburn, Gosnells, Rockingham, Swan, Wanneroo, Joondalup, Mundaring, Kwinana, Serpentine-Jarradale

Source: Main Roads Western Australia (2015).

Table 2.4 displays a summary of site-specific factors, including physical controls, road environment, road users and traffic management. Main Road Western Australia (2015) have made recommendations for treatment types against site-specific factors and rated them based on likelihood. It can be shown in Table 2.4 that signals may be appropriate, and roundabouts are likely treatments to reduce intersection related crashes within the urban fringe environment. It can also be seen that signals and roundabouts are appropriate treatments to address issues associated with different road users and their mobility activities likely to occur in an urban fringe environment.

Table 2.4: Summary of specific factors and form of intersection treatment selection

Site Specific Factors	Signals	Roundabout
Physical Controls		
• Number of intersection legs	M – Up to maximum of 4	M – Up to maximum of 6
• Number of through lanes	L – Up to 3	L – Up to 2. M/U – Up to 3 – subject to design
• Space available	M – subject to design	M/U – subject to design (may be difficult in Brownfield sites)
• Site topography	M – subject to design	M/U – subject to design (may be difficult in hilly terrains)
• Access to adjacent properties	M – subject to design	M – subject to design
Road Environment		
• Rural area	U	L
• Outer urban or fringe areas	M	L
• Inner urban area	L	M
• High speed approaching traffic	M – May consider with 80 km/h speed limit & warning signs / flashing lights	L - with design features to control approach speed
Road Users		
• Pedestrian needs		
○ Children, the elderly and the disabled	L	U – unless pedestrian signals provided
○ Significant number of other pedestrians	L	M - consider pedestrian facilities, low design speed and spare capacity
• Bicyclists needs		
○ Significant number of children or recreational cyclists	L	U – unless off-road facility and pedestrian signals provided
○ Significant number of other cyclists	L	M – with low speed design
• Needs of large vehicles	L	M/U – may be difficult with high volumes & high % heavies
Traffic Management		
• Route or area strategies		
○ Adjacent to linked signals	L	U
○ Isolated locations	M	L
○ Adjacent sites controlled with roundabouts	M	L
○ Control of traffic through a local area	L	U
• Traffic volumes and capacity		
○ Balanced flows	M	M
○ Unbalanced flows	M	M – with metering signals
○ Significant turning volumes	M – with adequate turn lane capacity	L
○ Minimising off-peak delays	U	L
• Public transport		
○ (Light Rail) Trams	L	U
○ Buses	L	L
○ Adjacent to a railway level crossing	L	U

Legend:
L - Likely to be an appropriate form of control M - May be an appropriate form of control U – Unlikely to be an appropriate form of control

Source: Main Roads Western Australia (2015).

In addition, further evidence of appropriate engineering treatments within an urban fringe environment are provided by Austroads (2016a). This research report clearly outlines identified measures to achieving Safe System speeds on urban arterial roads, which may also be appropriate for the urban fringe environments.

Commonly applied treatments on urban arterials include:

- roundabouts, horizontal deflection on the approach, and reduced speed limits at intersections
- pedestrian refuge islands, medians, reduced speed limits and variable speed limit signs at mid-blocks.

Proposed engineering treatments include:

- local area traffic management such as, wombat crossings and raised platforms at mid-blocks
- raised intersections, signalised roundabouts, turbo roundabouts and dwell-on-red signals at intersections.

Further work conducted by Austroads (2014) *Methods for Reducing Speeds on Rural Roads: Compendium of Good Practice* focused on engineering treatments that can be applied to address speed, either at key locations or route-based scenarios.

Table 2.5 shows a summary of engineering treatments that can be implemented within an urban fringe environment, such as when approaching towns. Austroads (2014) states it is important to indicate to drivers the change in environment, as the risks are likely to increase when entering urban/built-up areas. The treatment types include advance warning, buffer zones, countdown signs, rural thresholds/gateway treatments and vehicle-activated traffic signals.

Table 2.5: Summary of engineering treatments approach to built-up areas

Approaching towns/transition zones					Appendix reference
Treatment type	**Brief description**	**Crash reduction**	**Speed reduction**	**Usage**	
Advance warning	Signage warning of a lower speed environment ahead.	Minimal	Minimal	Well established	Appendix A.4.1
Buffer zones	A short length of speed zone used to provide a stepped change between adjacent sections of road that have different speed limits.	Minimal	Minimal	Well established	Appendix A.4.2
Count-down signs	Count-down signs in advance of towns displaying a decreasing number of diagonal marks until a new speed limit comes into force.	Minimal	Minimal	Untested	Appendix A.4.3
Rural thresholds/ gateway treatments	Use of signs with other techniques to create a rural threshold or gateway between high and low speed environments.	35%	25 km/h	Well established (NZ only)	Appendix A.4.4
Vehicle activated traffic signals	Signs are triggered by approaching vehicles that exceed a threshold speed.	Unknown	Unknown	Untested	Appendix A.4.5

Source: Austroads (2014).

Austroads (2014) also reported on the engineering treatments on routes/rural routes and mid-block locations as there are large safety benefits that can be obtained from a reduction in speed within these road environments. The treatment types include: reduced speed limits, road narrowing, and weather activated speed limit signs. Table 2.6 shows the engineering treatments along with their description and achievements in speed reduction.

Table 2.6: Summary of engineering treatments on routes/rural routes and mid-block locations

On routes/rural routes and mid-block					Appendix reference
Treatment type	**Brief description**	**Crash reduction**	**Speed reduction**	**Usage**	
Speed limits	Setting an appropriate rural speed limit.	Unknown	4 km/h	Emerging treatment	Appendix A.5.1
Road narrowing	Road narrowing to reduce speeds, using physical or perceptual measures, or a combination of both.	Unknown	5 km/h	Shows promise	Appendix A.5.2
Weather activated speed limit signs	Use of dynamic message signs to inform drivers of adverse weather conditions (e.g. fog, wind, snow) and static signs to inform of changes in speeds when these conditions are present.	Unknown	5 km/h	Shows promise	Appendix A.5.3er

Source: Austroads (2014).

Austroads (2014) further stated that non-engineering treatments such as enforcement and penalties, education, training and publicity and intelligent transport systems e.g. in-vehicle monitoring technologies can also assist in reducing speed-related crashes in the rural to urban transition zone.

More recent research by Austroads (2017a) reported on key safety solutions along with issues that need to be considered when effectively addressing safety on urban mixed use arterial routes. Six case studies were analysed across Australia and New Zealand and a large variety of treatments were suggested for implementation at different types of locations. The case studies were selected to represent a range of road environments and the mixture of road users including pedestrians, cyclists and motorised vehicles. The key treatments that were identified in this study (Table 2.7) included those that helped to manage vehicle speeds such as raised platforms, gateway treatments, road narrowing, and textured surfacing. Other treatments that related to improving vulnerable road user safety were pedestrian crossings, cycle lanes and separated pathways. The likely safety benefits were analysed along with estimates of likely crash reductions which demonstrated the effectiveness of each treatment type.

Engineering treatments displayed in Table 2.7 have been summarised from Austroads *Safe System Infrastructure on Mixed Use Arterials* and present the most commonly used mixed use arterial treatments along with the indicative information on treatment effectiveness, cost and treatment life (Austroads 2017a).

Table 2.7: Mixed use arterial treatments

Treatment type	Brief description	Crash modification factor (CMF)	Usage	Cost	Treatment life
Raised intersections	Either the entire intersection is raised, acting as a type of speed platform, or raised sections can be placed in advance of the intersection (sometimes referred to as raised stop bars).	0.60	Emerging	Medium–high	20 years +
Roundabouts	Intersection control measure implemented in order to reduce speeds and reduce road user conflict points.	0.25	Well established	High	20 years +
Reduced speed limit	Involves managing posted speed limits, revising them towards Safe System levels.	0.75	Well established	Low	10 years +

Treatment type	Brief description	Crash modification factor (CMF)	Usage	Cost	Treatment life
Lane narrowing	Narrowing lane through perceptual and physical measures, e.g. kerb extensions, wide medians or shoulders.	0.70	Emerging	Low–medium	5–10 years
Road diet	Road narrowing measure typically involving the conversion of a four-lane road (two each way) into a road with only one lane in each direction, and a central two-way right-turn lane.	0.65	Emerging	Low-medium	10 years +
Humps/platforms	Vertical deflection treatments used to control speed, with various forms of speed humps available for different road types.	0.60	Emerging	Medium–high	10 years +
Wombat crossings	Similar profile and speed reduction effect as flat-top speed humps but differ by giving priority to pedestrians rather than motorists.	0.60	Emerging	Medium–high	10 years+
Gateway treatments	Use of signs with other techniques to create a threshold or gateway between high and low-speed environments.	Unknown (up to 0.60 for rural)	Shows promise (well established for rural)	Low–medium	5–20 years

Source: Austroads (2017a).

2.4.2 International

As a means of providing further insight into the effectiveness of engineering treatments within urban fringe environments, this review investigated international literature. A limited number of resources were obtained relating specifically to the urban fringe environment. Within the USA, Austroads (2017a) indicated that road diet treatments (median turning lanes) have been extensively used to reduce causality crashes in these road environments. Results indicated that this type of treatment can provide a 35% reduction in casualty crashes (CMF 0.65) along with reducing speeds by 5 km/h. A further benefit of road diet treatments is that they can also provide enough space to install a bicycle lane or on-street parking.

Sweden is often considered a world leader in road safety and their treatment programs included implementing flexible barriers to reduce fatalities and serious injuries (Corben et al. 2001). This treatment type targets head-on and run-off-road crashes. In addition, extended lengths of flexible barriers have been applied to their networks in conjunction with adopting a ‘2 + 1’ road configuration (Larsson, Candappa & Corben 2003).

In the United Kingdom, Cambridge County Council (2018) reported implementing horizontal speeding treatments such as road narrowing, priority narrowing and change lane markings as an effective way to treat speed-related crashes. It was also reported that vertical speed treatments such as speed cushions, speed humps and speed tables have significant advantages to improving road safety for motorists and vulnerable road users.

2.5 Summary

Reducing crashes and injury severity within an urban fringe environment poses unique challenges associated with the road network, the variety of road users and the different mobility and transport activities required within the environment. Within the urban fringe environment there exist common types of crashes relating to intersections and increased traffic and activities.

There was limited literature available which identified current practices of engineering treatments in urban fringe environments. This has confirmed the gap in guidance available to practitioners when challenged with population growth, which places a greater demand on the road network and changes the mix of transport users and needs within the urban fringe environment.

This review of the literature has demonstrated some consistencies with treatment types both nationally and internationally. To address issues associated with intersections, treatments typically included implementing signals and roundabouts as a strategy for reducing crashes. A range of engineering treatments to reduce speed-related incidents included signage, speed platforms, road narrowing and road diets. However, many of the treatments identified have been taken from roads similar to urban fringe roads but not specifically targeting the urban fringe environment. This highlights the lack of evidence available for the successful application of treatments in the urban fringe environment.

There appears to be a range of common treatments to reduce crashes within urban fringe environments and these treatments may provide an effective reduction in crashes across the majority of the urban fringe network. However, some urban fringe environments may have particularly specific issues requiring a degree of flexibility.

3 CRASH ANALYSIS OF CASE STUDIES

The characteristics of crashes on typical urban fringe roads are provided to aid in identifying common features, if any. A comparison of the crash characteristics on the state-controlled roads is provided for the ten-year period 2008–17.

A case study approach was taken for the crash analysis as no specific data or classification was available in the TMR database to identify and extract all urban fringe roads. Therefore, TMR provided data for roads which they considered to exhibit characteristics of urban fringe roads. The urban fringe roads analysed included:

- Caboolture – Bribie Island Rd (126)
- Beaudesert – Nerang Road (202)
- Beaudesert – Beenleigh Road (203)
- Tamborine – Oxenford Road (206)
- Waterford – Tamborine Rd (207)
- Ipswich – Boonah Road (211)
- Eatons Crossing Rd (4032)
- Mount Lindesay Hwy (25A).

Note, no information was provided regarding the timing of any treatments or upgrades to these roads and when any development has occurred.

This section compares the total casualty crashes of all the study roads with all state-controlled roads. The results for the individual case study roads are provided in Appendix A.

3.1 Annual Distribution

Figure 3.1, Figure 3.2 and Figure 3.3 show the annual distribution of casualty crashes on the urban fringe roads compared to that of all state-controlled roads. No trend in crashes was apparent in the roads analysed.

Figure 3.1: Annual distribution of casualty crashes – case study roads only

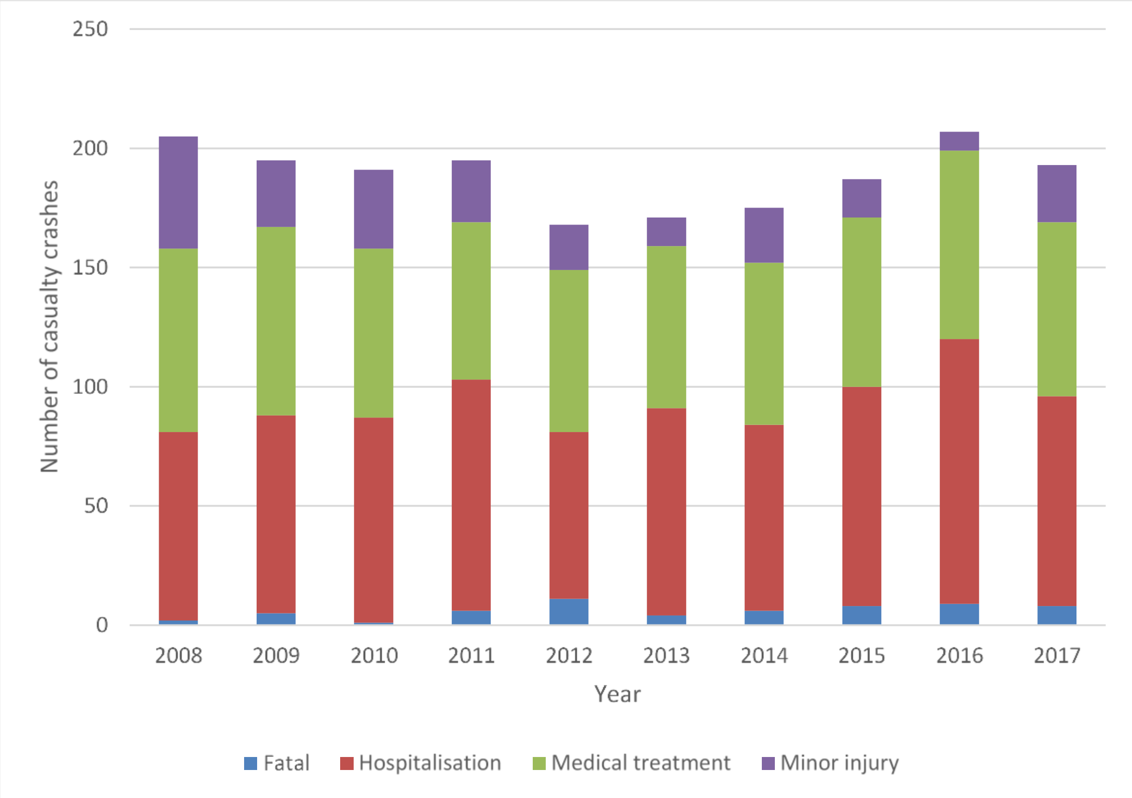


Figure 3.2: Annual proportion of casualty crashes

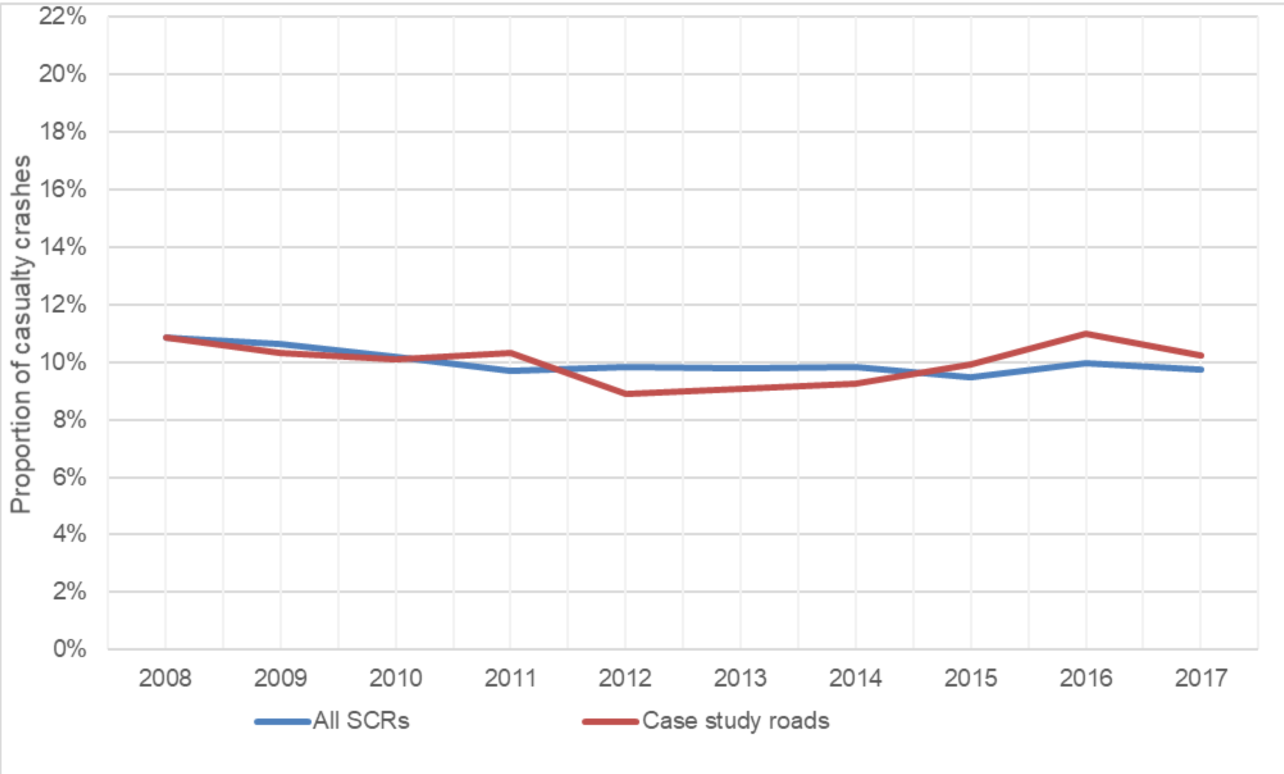
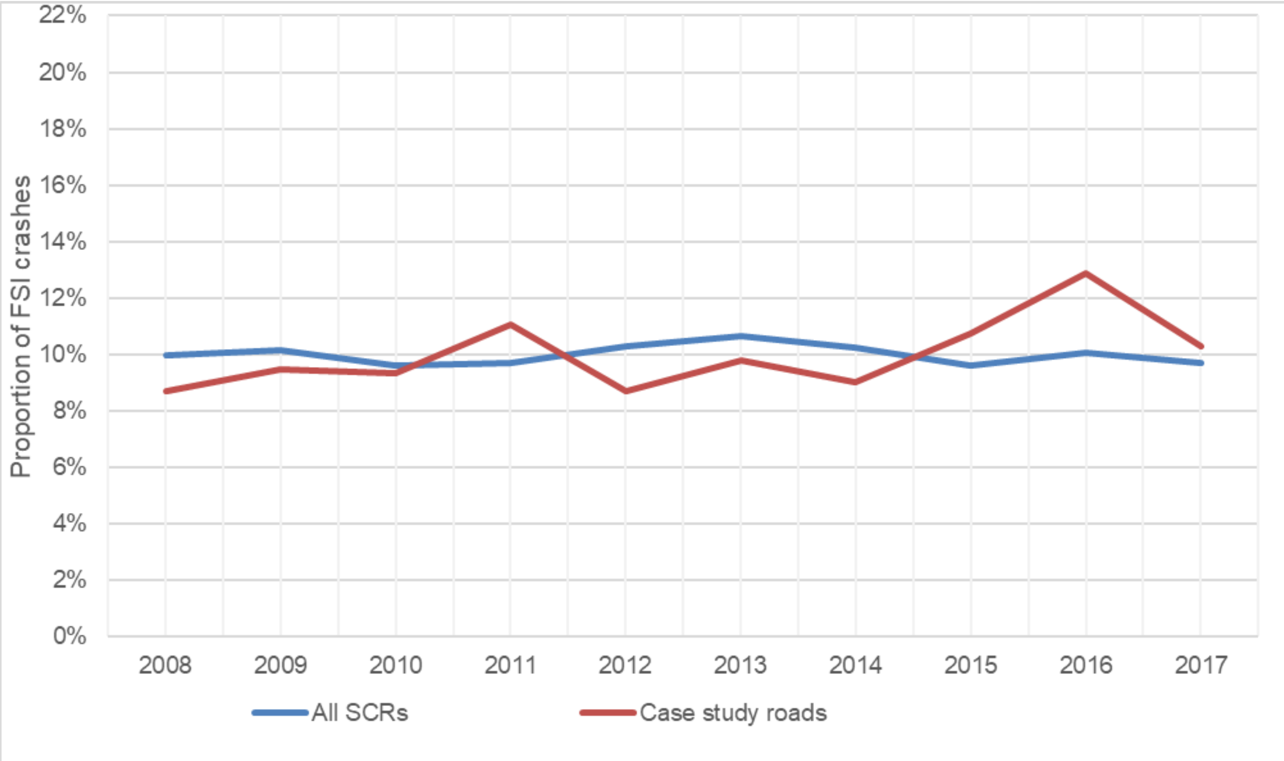


Figure 3.3: Annual distribution of Fatal and Serious Injury (FSI) crashes



3.2 Crash Type by Definitions for Coding Accidents (DCA) Group

The distribution by crash type is shown in Figure 3.4 and Figure 3.5. The crashes which were over-represented compared with all state-controlled roads for all casualty crashes included:

- head-on
- intersection from adjacent approaches
- off-carriageway on curve (hit object)
- opposing vehicles turning (slightly above state-controlled roads)
- out-of-control on curve (slightly above state-controlled roads)
- overtaking same direction
- vehicles leaving driveway.

For FSI crashes, head-on crashes were particularly high when compared to crashes on all state-controlled roads. Crashes which were over-represented compared with all state-controlled roads for FSI crashes included:

- head-on
- intersection from adjacent approaches
- off-carriageway on curve (hit object)
- opposing vehicles turning
- overtaking same direction.

Figure 3.4: Casualty crashes by DCA group

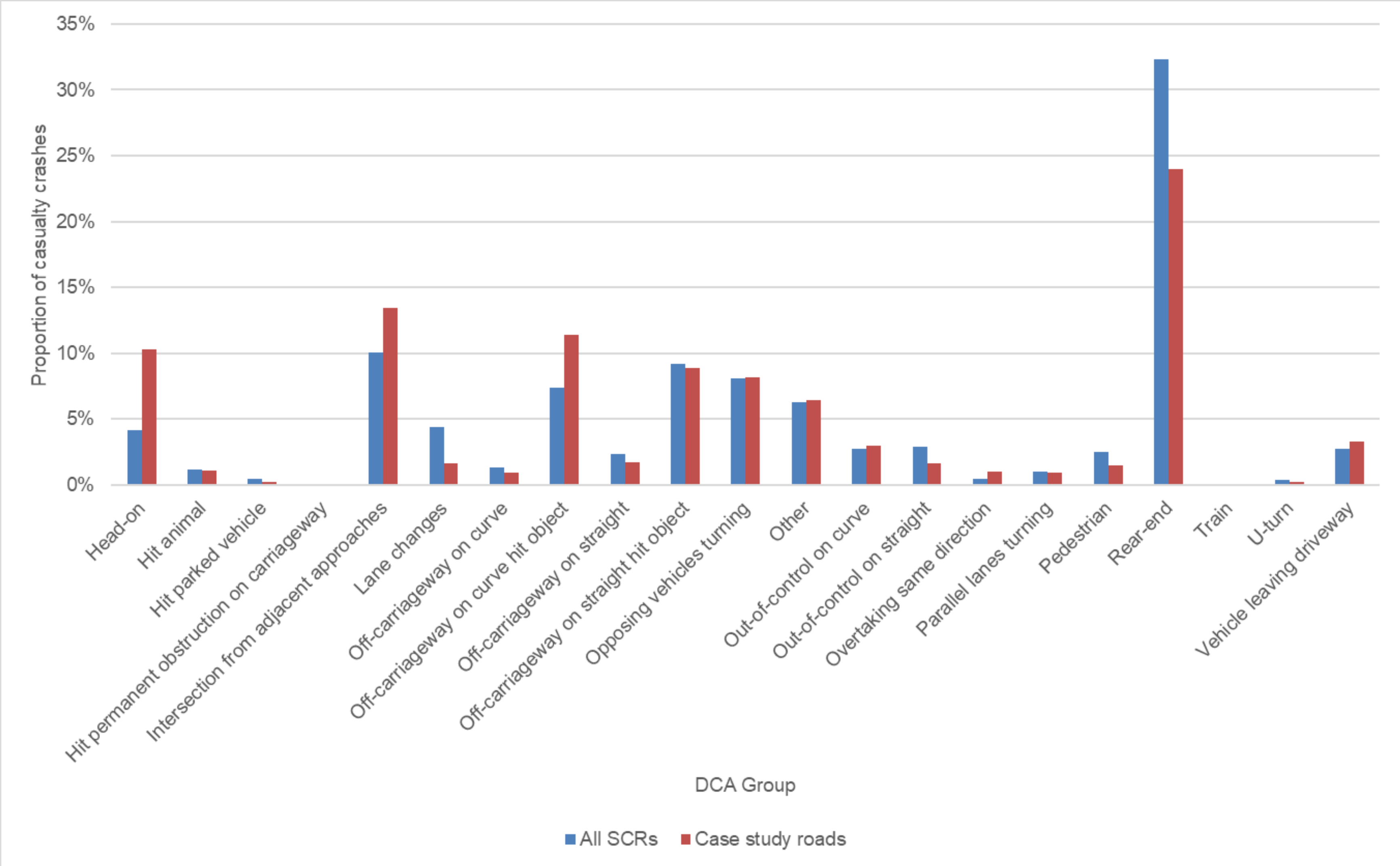
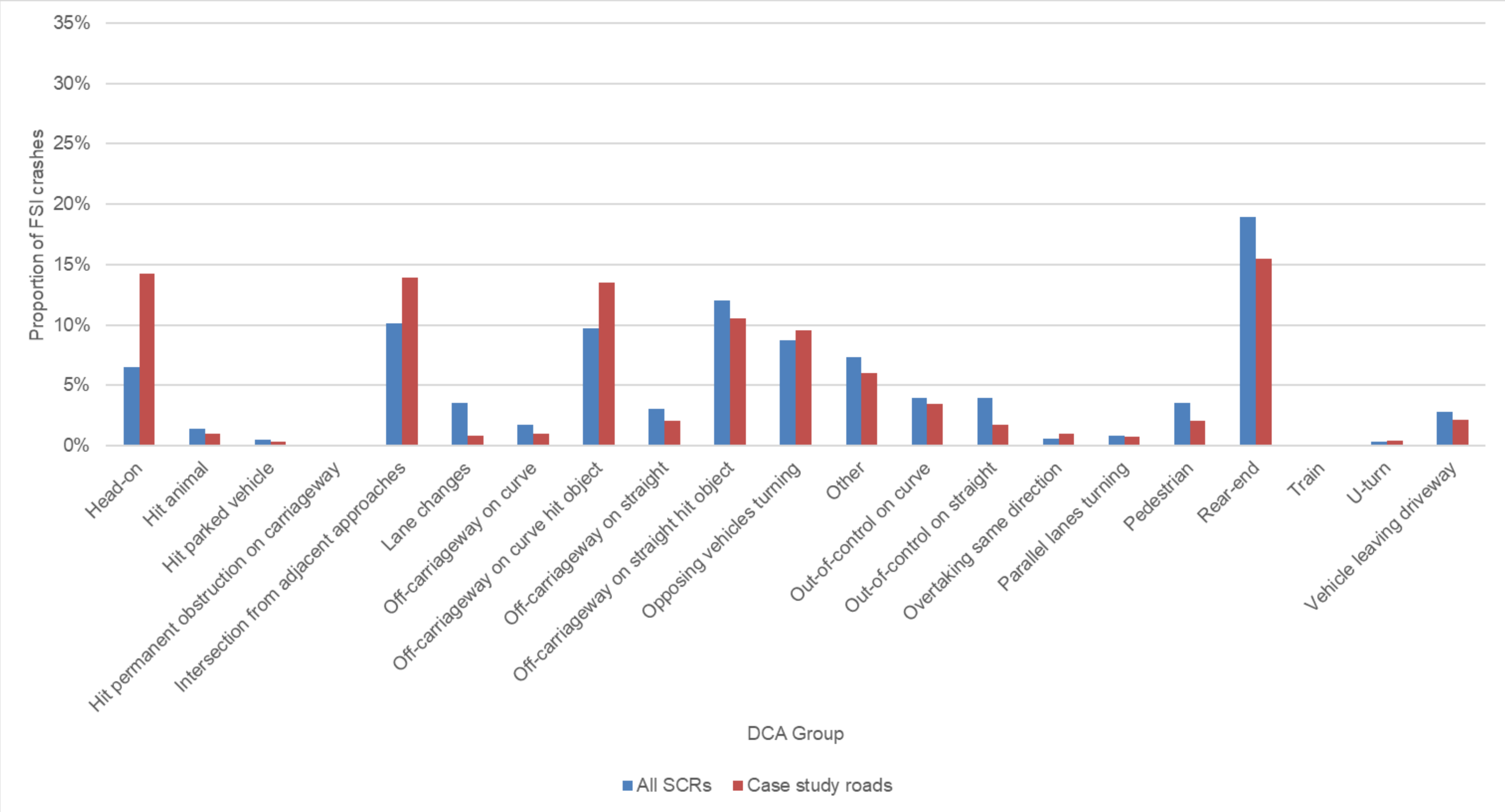


Figure 3.5: FSI crashes by DCA group



3.3 Temporal Distribution of Crashes

Figure 3.6 and Figure 3.7 show the crashes by each month for all casualty crashes and FSI crashes, respectively. Figure 3.8 and Figure 3.9 show all casualty crashes and FSI crashes for the days of the week, respectively. There was a higher proportion of crashes occurring on the weekend days on urban fringe roads relative to all state-controlled roads, particularly FSI crashes on Saturdays. Figure 3.10 and Figure 3.11 show crashes per time of day for all casualty crashes and FSI crashes, respectively. There was a higher proportion of crashes occurring between commuting hours on urban fringe roads compared to all state-controlled roads.

Figure 3.6: Casualty crashes by month

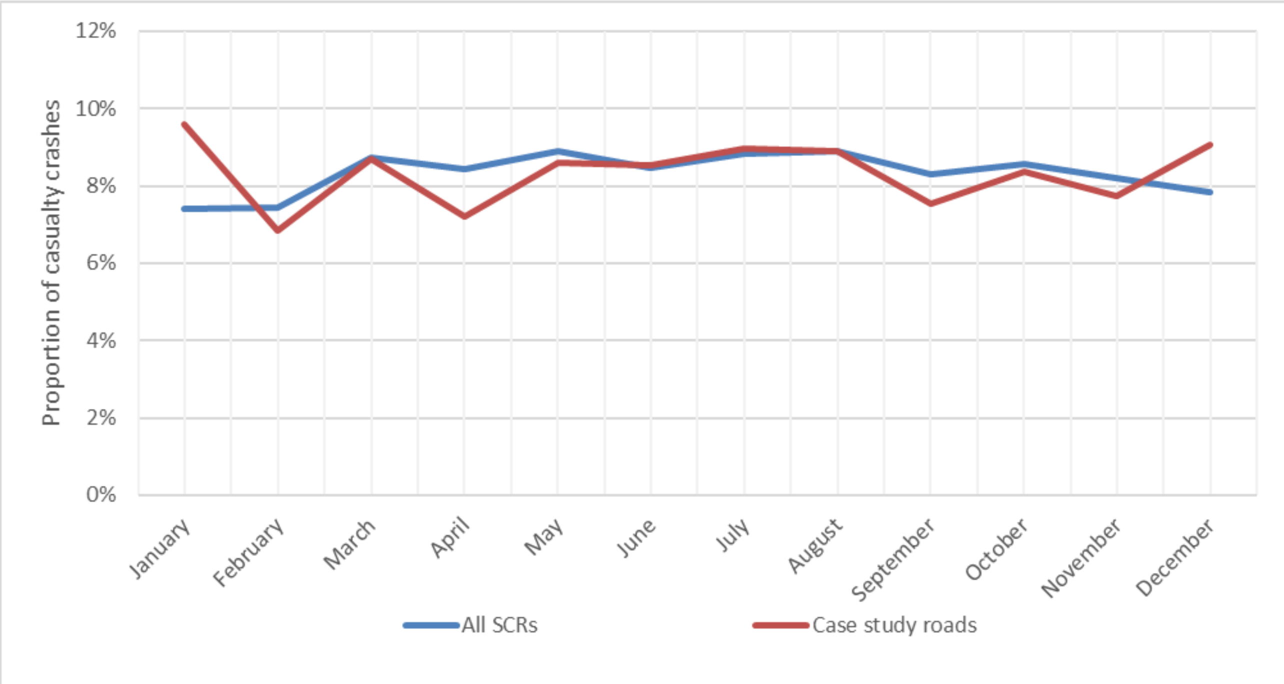


Figure 3.7: FSI crashes by month

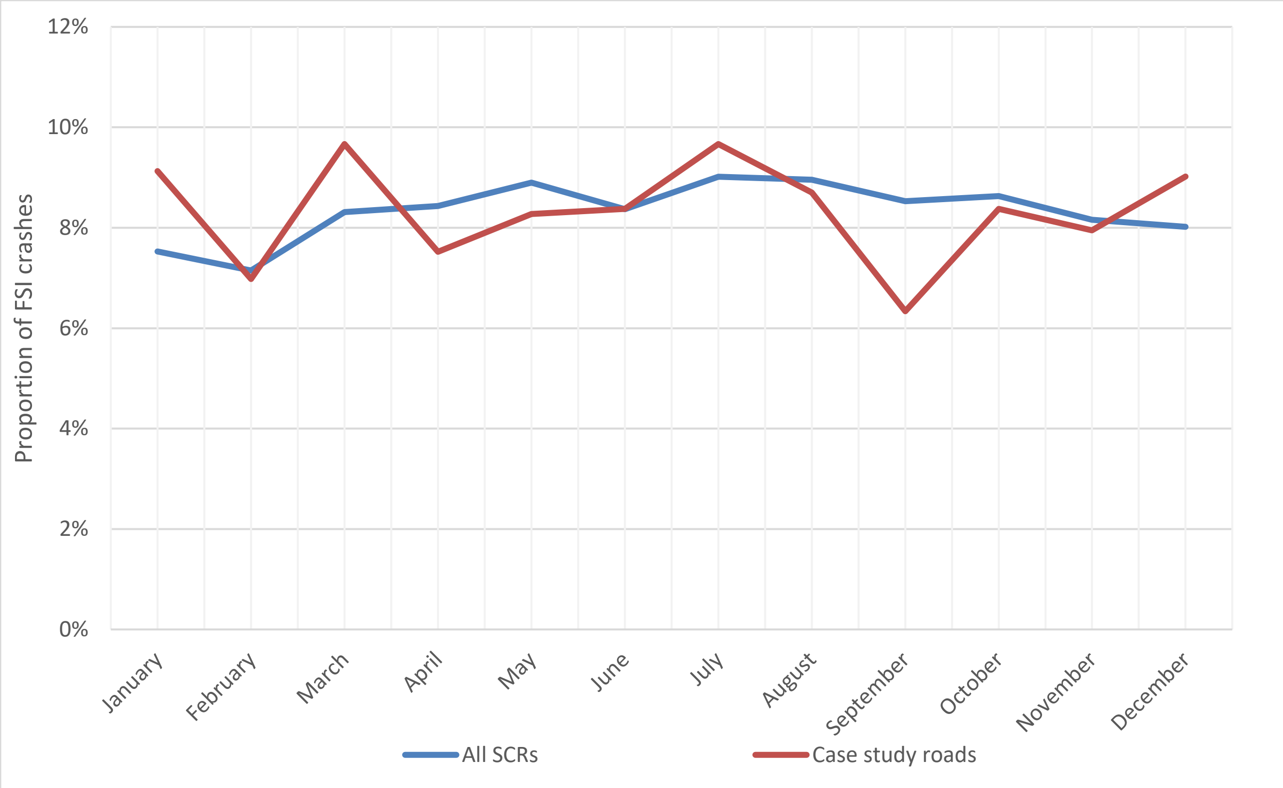


Figure 3.8: Casualty crashes by day of the week

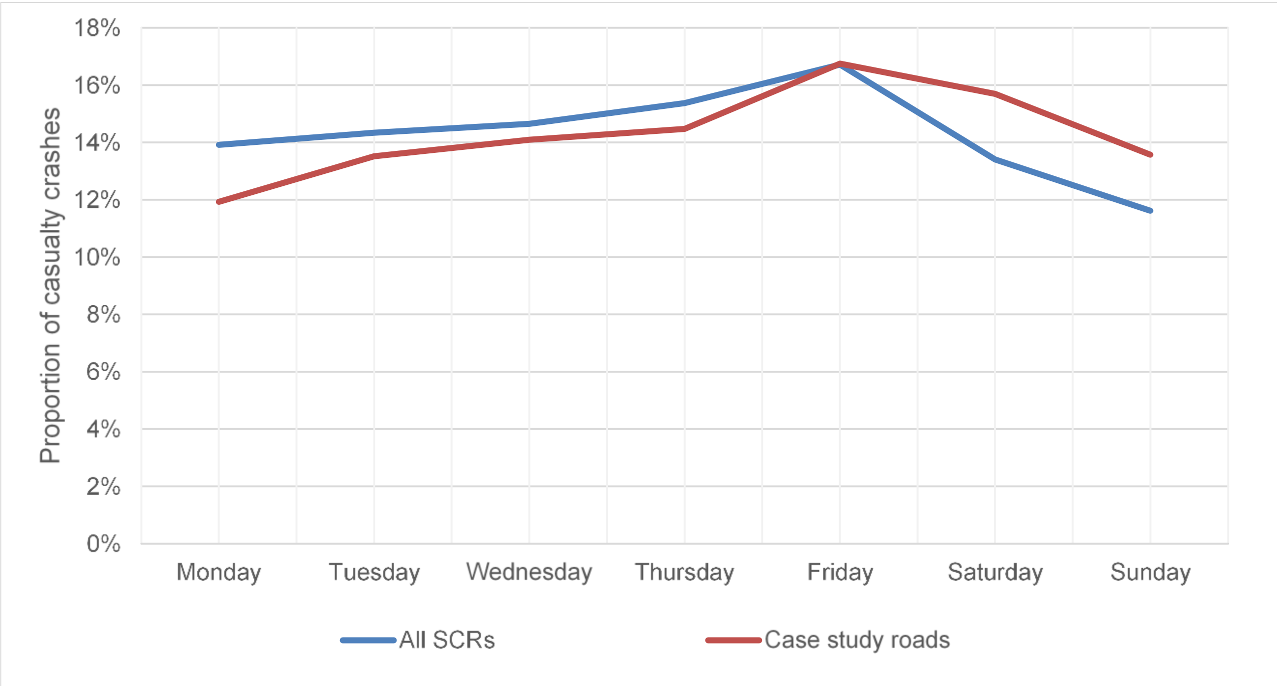


Figure 3.9: FSI crashes by day of the week

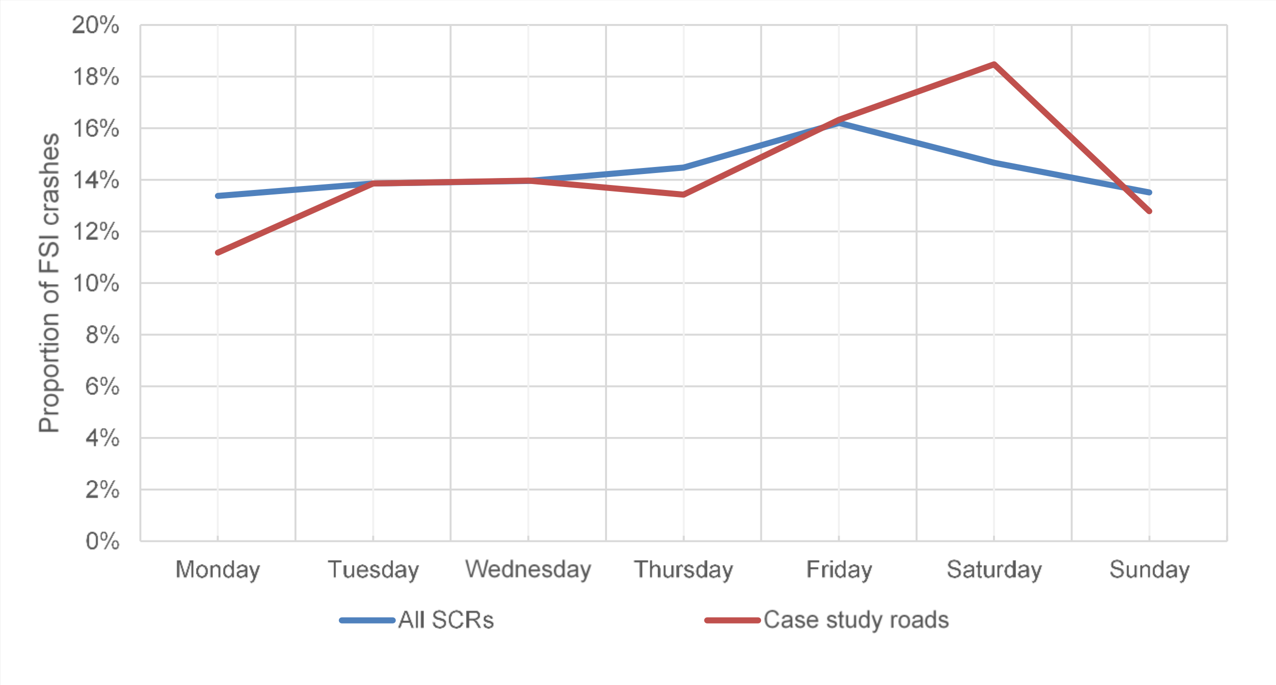
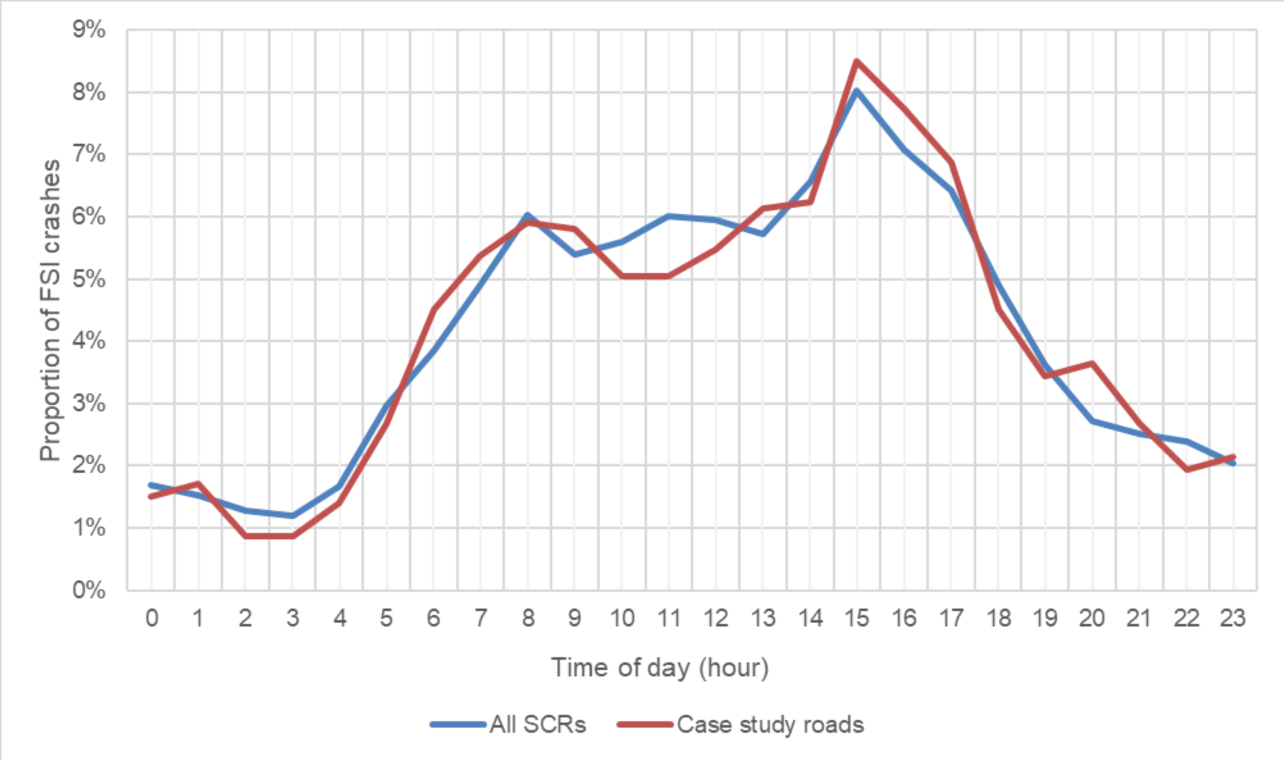


Figure 3.10: Casualty crashes by time of day

Figure 3.11: FSI crashes by time of day



3.4 Speed Limit

Crashes per km by speed limit for all casualty crashes and FSIs are shown in Figure 3.12 and Figure 3.13, respectively. Crashes were overrepresented in the 70, 80 and 90 km/h speed zones for casualty and FSI crashes when compared to all state-controlled roads. However, this is not the case for the 100 km/h speed zone.

Figure 3.12: Casualty crashes by speed limit

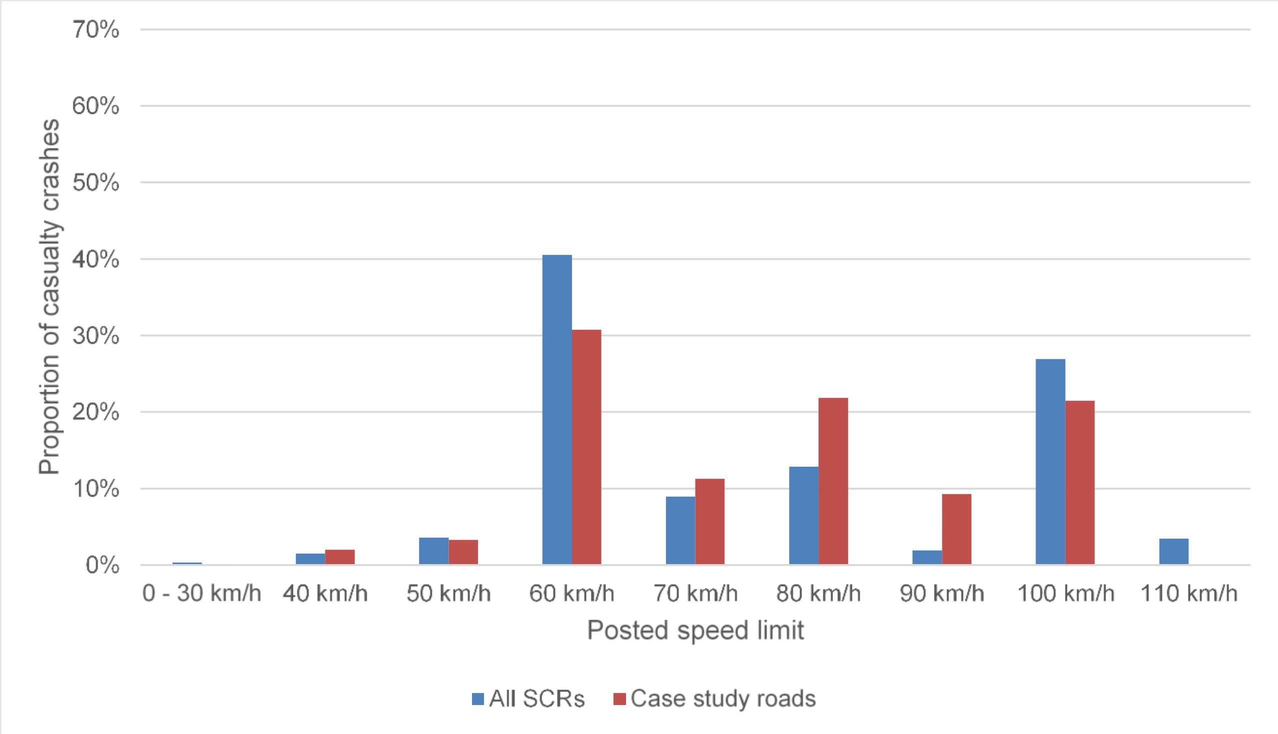


Figure 3.13: FSI crashes by speed limit

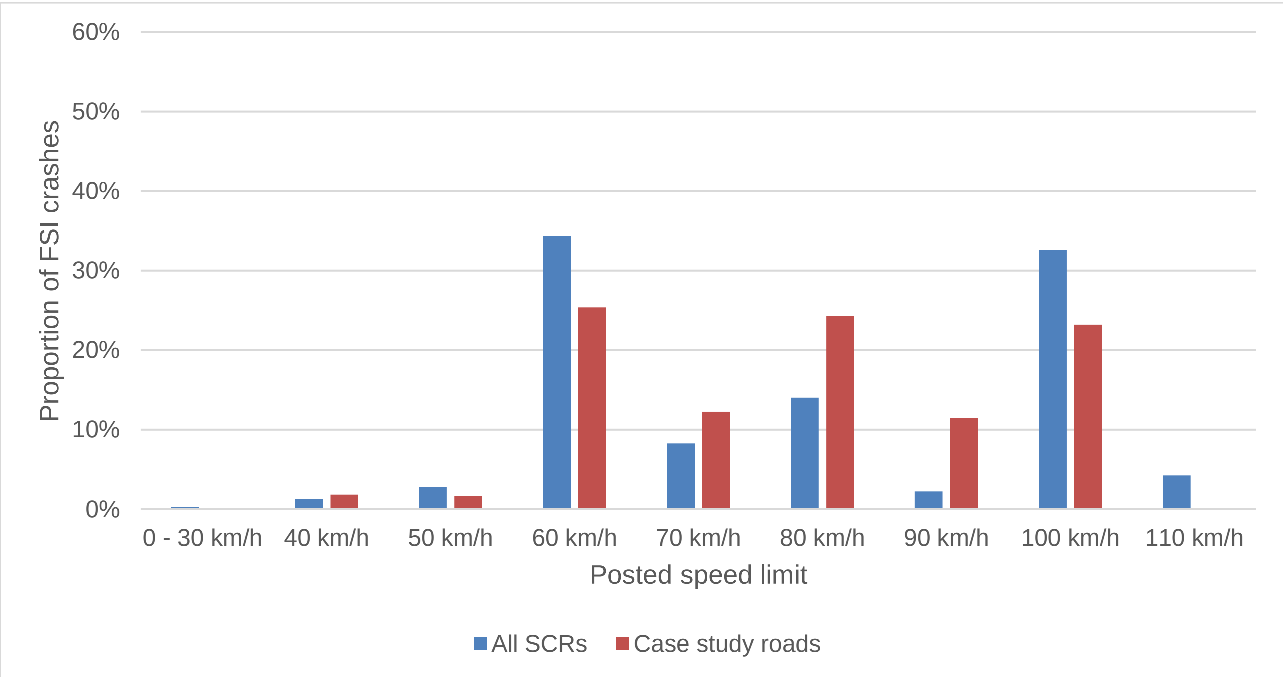


Table 3.1 shows the percentage of FSI crashes relative to casualty crashes for both case study roads and all state-controlled roads. The percentage of FSI crashes for the case study roads was higher or equal for all speed zones other than 50 km/h when compared to all state-controlled roads. This may suggest that the current speed limits may not be appropriate for the roads.

Table 3.1: Crashes by speed limit

Speed Limit	Case study roads			All state-controlled roads		
	Casualty crashes	FSI	Per cent FSI	Casualty crashes	FSI	Per cent FSI
0–30 km/h	2	0	0%	201	72	36%
40 km/h	38	17	45%	892	333	37%
50 km/h	62	15	24%	2147	726	34%
60 km/h	580	236	41%	24448	8986	37%
70 km/h	213	114	54%	5392	2167	40%
80 km/h	412	226	55%	7757	3670	47%
90 km/h	175	107	61%	1154	579	50%
100 km/h	405	216	53%	16228	8539	53%
110 km/h	0	0	NA	2093	1113	53%
Total	1887	931	49%	60312	26185	43%

3.5 Road Feature

Figure 3.14 and Figure 3.15 show the proportion of crashes which have occurred for each road feature. The road features where the proportion of all casualty and FSI crashes were higher compared to all state-controlled roads include T-intersections and mid-block sections.

Figure 3.14: Casualty crashes by road feature

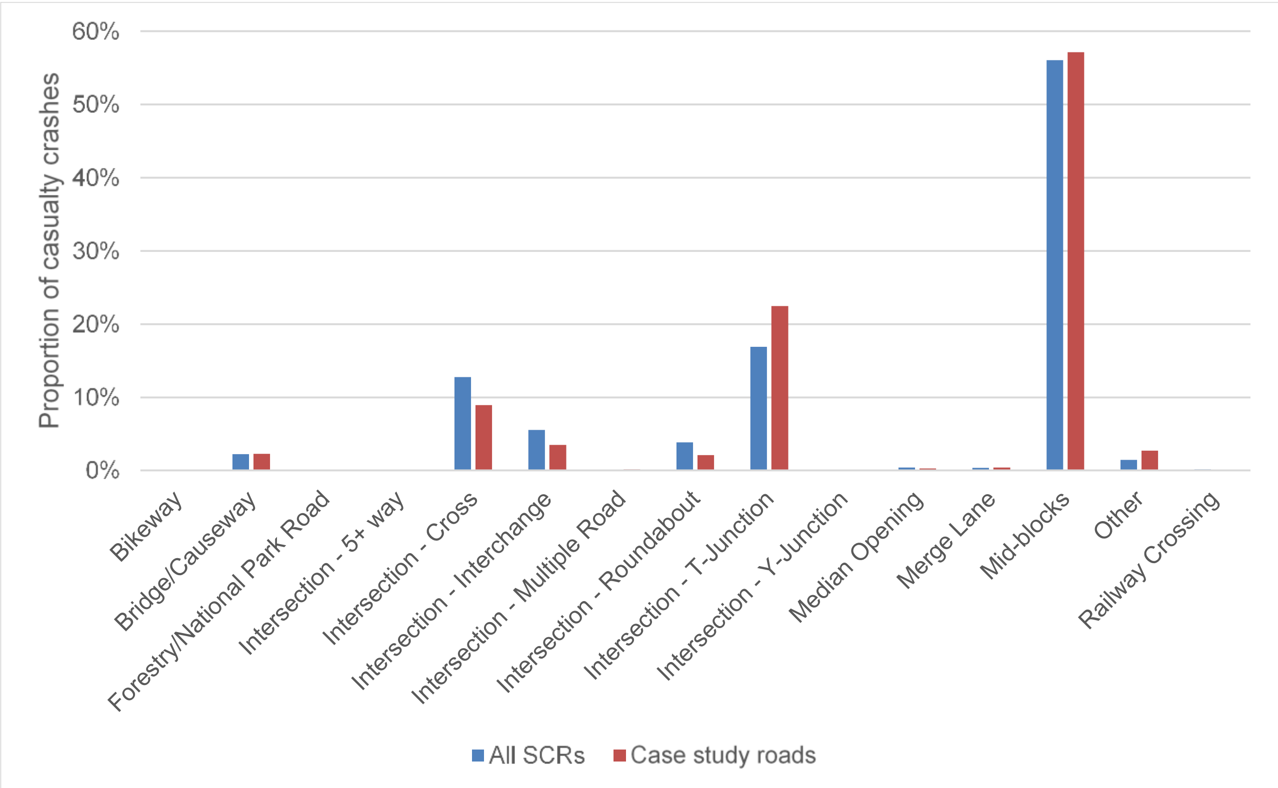
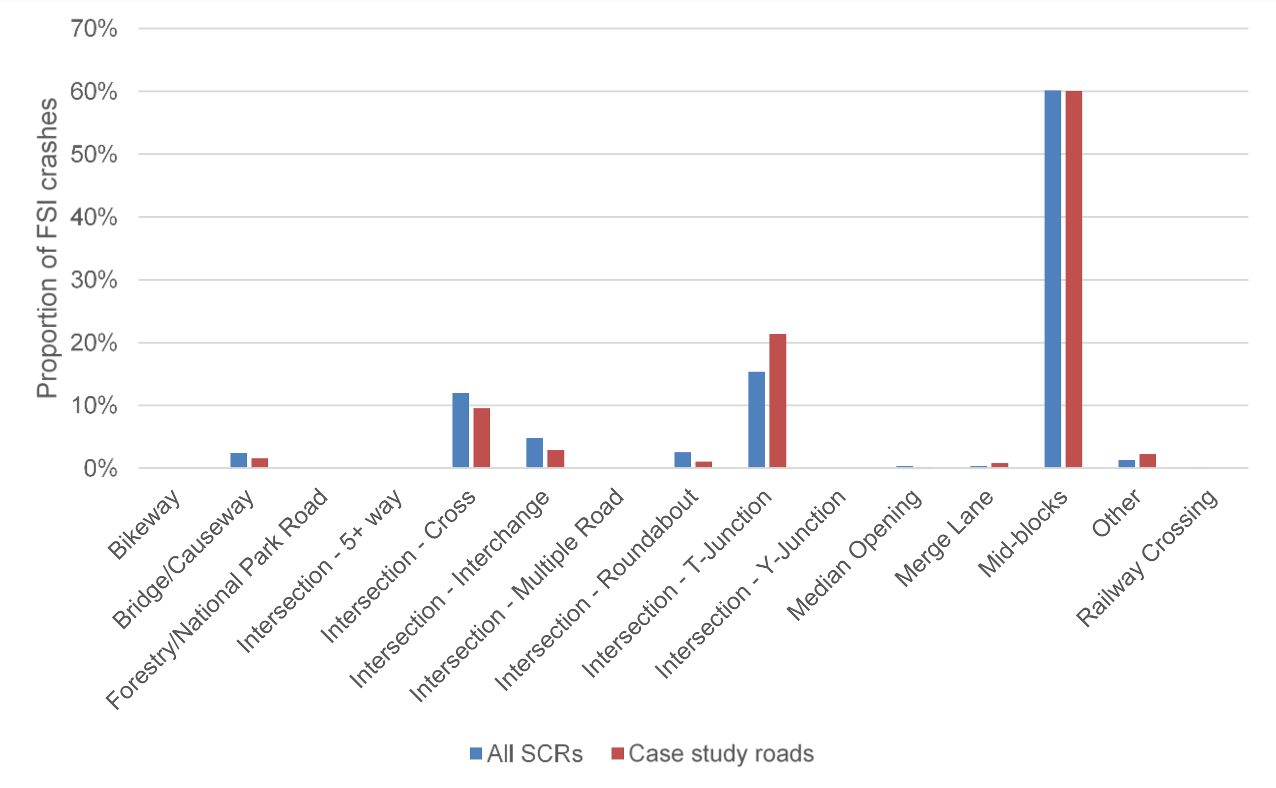


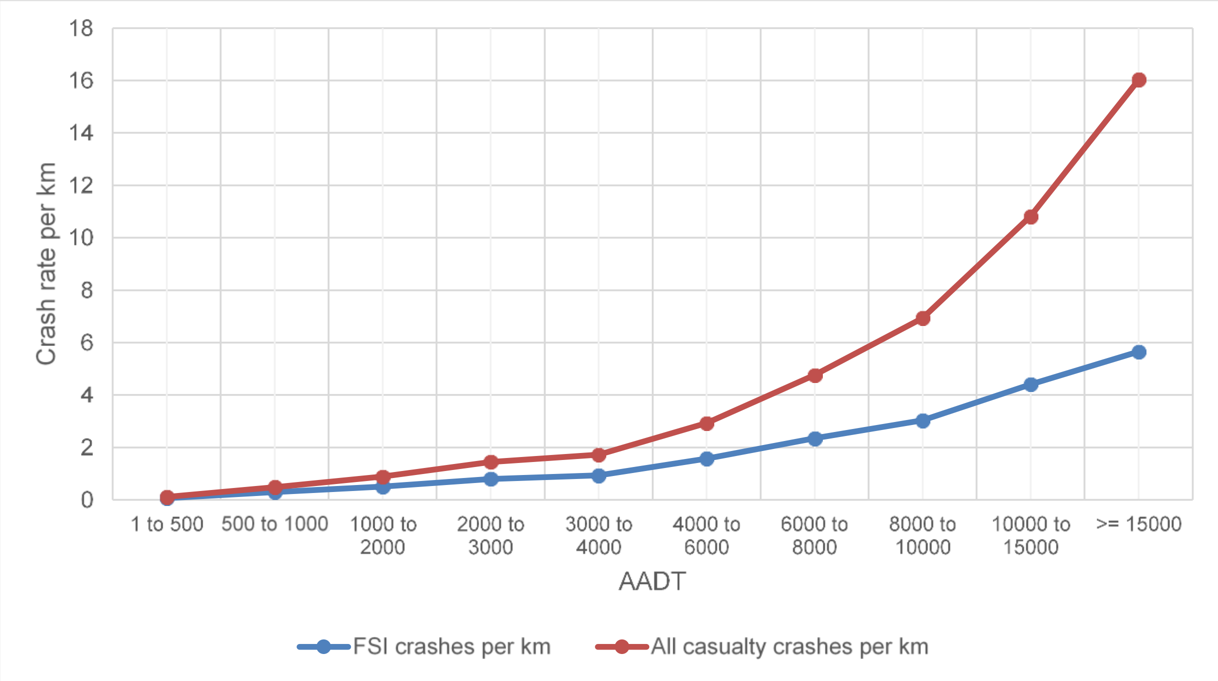
Figure 3.15: FSI crashes by road feature



3.6 Crash Rate

An analysis was undertaken to examine the crash rates for all casualty crashes and head-on crashes on state-controlled roads to determine whether there was a point where once a particular AADT was reached the crash rate increased. Figure 3.16 shows the relationship between AADT and crash rate per kilometre for FSI and all casualty crashes for all state-controlled roads. It shows a change in grade at around AADT 4 000 and 10 000.

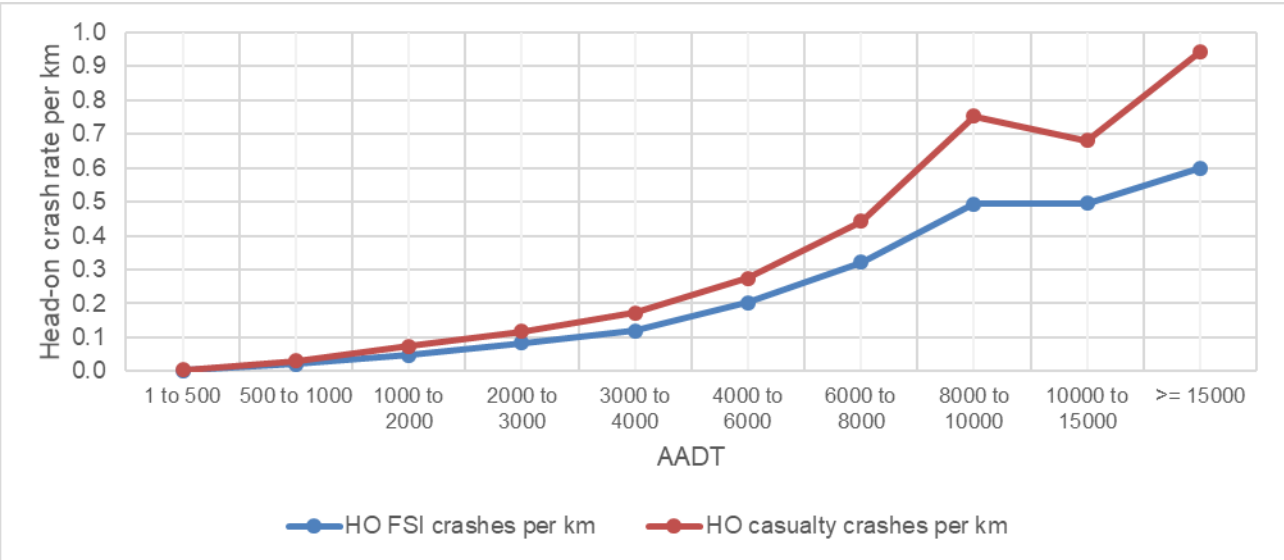
Figure 3.16: AADT and crash rate relationship



Note: Crash rate computed separately for both directions of divided carriageways.

Figure 3.17 shows the relationship between the AADT and head-on crash rates for all state-controlled undivided roads. It shows a change in grade from AADT 4 000 and 8 000–10 000.

Figure 3.17: AADT and head-on crash rate relationship (undivided roads only)



3.7 Summary

The following were the main findings of the crash analysis:

- There were no specific trends in the annual crashes on case study roads.
- The proportion of crashes on urban fringe roads was higher than on all state-controlled roads for:
  - head-on crashes (both casualty crashes and FSI crashes)
  - off-carriageway on curve (hit object) (both casualty crashes and FSI crashes)
  - adjacent approaches intersection crashes (both casualty crashes and FSI crashes)
  - overtaking (although the proportions were low) (both casualty crashes and FSI crashes)
  - vehicle leaving driveway crashes (casualty crashes only).
- The road features where a higher proportion of casualty and FSI crashes occurred compared to all state-controlled roads included T-intersections and mid-block sections.
- A higher proportion of casualty and FSI crashes occurred on the weekend days on urban fringe roads relative to all state-controlled roads, particularly FSI crashes on Saturdays.
- A higher proportion of casualty and FSI crashes occurred between commuting hours on urban fringe roads compared to all state-controlled roads.
- When examining the crash rate for casualty crashes on state-controlled roads there was a change in grade for the crash rate AADT relationship at ADDT 4 000 and 10 000.
- When examining the crash rate for head-on crashes on all state-controlled roads there was a change in grade at AADT 4 000 and 8 000 to 10 000.

4 STAKEHOLDER CONSULTATION

The stakeholder consultation consisted of a focus group meeting, a meeting with planning groups within TMR, and a questionnaire to state road agencies.

4.1 Focus Groups

A focus group meeting was held at TMR on 6 February 2019 to gather TMR stakeholders associated with the development of road safety programs and projects relating to urban fringe environments. The purpose of the meeting was to provide the opportunity for input from a variety of sections within TMR to identify contributing road safety risk factors and to ensure the project outcomes considered and accommodated the stakeholders' needs.

The focus group members were presented the background to the study, the project tasks and the findings of the literature review and crash analysis. Group discussion was encouraged to confirm the safety risk factors associated with the urban fringe environment as well as possible ways forward for the delivery of the project. A list of focus group attendees is provided in Appendix B.

The outcomes of the meeting included group consensus that:

- there is minimal if any guidance available for the treatment of urban fringe roads
- the urban fringe is a complex environment with typically no one solution that can be applied across all roads to solve the many associated issues
- there is a responsibility at the planning stage of developments to consider the impacts of increased traffic volumes on the surrounding roads and to appropriately plan for traffic growth and the relevant upgrades required to the road network
- TMR planning groups need to provide input into the study (consultation with planners discussed in Section 4.2)
- consideration should be given to the direction of the study given the complexity of the issues and the large gap in knowledge in management of urban fringe roads.

4.2 Consultation with TMR Planning Groups

A meeting with members from TMR planning sections was held on 3 May 2019, to capture how the impact of development on the road network is managed by the planning process. A list of attendees is provided in Appendix B.

The planners indicated how TMR's planning sections have difficulty influencing or controlling development in some areas. Developments are approved and built and then the pressure is placed back onto TMR to build or upgrade the infrastructure. It was discussed how more pressure could be placed on developers to provide greater contributions to the cost of infrastructure upgrades; however, it was noted that the level of funding required is unlikely to be met by developers.

Some upgrades to infrastructure can be achieved if safety issues have been identified through the traffic impact assessment process. However, these tend to be localised to the development area, and impacts on the network further downstream are not considered.

TMR can also apply conditions on developments, but these are not always attended to by the developer.

4.3 Questionnaire to Road Agencies

A questionnaire was sent to road agencies to determine what processes they have in place to manage the transition between rural and urban roads from a road safety perspective. The questionnaire was sent to state road agencies in Victoria, New South Wales, Northern Territory, South Australia, Western Australia, Tasmania and ACT.

Two responses were received. Both of these indicated there were no specific guidelines or processes in place to manage urban fringe roads.

The questionnaire and the responses received are provided in Appendix B.

5 IDENTIFICATION OF RISK FACTORS

Urban fringe roads have characteristics which differentiate them from other road environments. In order to develop guidance to manage the transition between rural and urban road environments, it is important to identify and understand the safety risk factors associated with urban fringe roads.

Based on the findings of the literature review, the crash analysis, and the feedback provided at the focus group meeting, the following risk factors have been identified for urban fringe roads:

- traffic volume
- road function
- crash risk
- land use/road user
- property access
- road features.

These issues are discussed in the following sections.

5.1 Traffic Volumes

As development occurs along the urban fringe areas, traffic volumes increase resulting in greater demand on the road network. What were high-speed rural roads are now becoming higher volume roads with potential capacity and safety issues, whereby additional traffic lanes and infrastructure improvements are required.

The higher traffic volume increases exposure and, combined with high speeds, increase the risk of a crash occurring. The historical crash data for these types of roads showed it can be expected that increases in crashes will occur, particularly head-on, property access, run-off-road, and intersection crashes unless road improvements are implemented.

The traffic growth will increase AADT volumes and may also change the proportion of traffic during peak times i.e. peak traffic volumes. Changes in peak traffic volumes need to be considered, particularly at intersections.

5.2 Road Function

The function of a road relates to the relationship between the roadway and the land uses it serves. The urban fringe roads have conflicting functions of carrying through traffic efficiently and safely while providing access for vulnerable roads users and access to and from adjacent land uses.

As development occurs along the urban fringe and the mix and modes of traffic change and traffic volumes increase, the function of the road changes. These roads typically are high-speed roads given their rural origin.

The function of an urban fringe road can be to provide for:

- through traffic between arterial roads
- connections between local areas and arterial roads
- direct access to properties
- access to public transport
- through movement of public transport

- regional-local cycle movements
- pedestrian movements.

The challenge is how to manage the needs and safety risk of all road users as well as higher traffic volumes travelling at high speeds.

5.3 Crash Risk

As development occurs and traffic volumes increase on urban fringe roads crashes are more likely to occur. From the crash analysis undertaken, the crash types having a greater risk of occurrence include:

- head-on crashes
- property access crashes
- run-off-road on curve crashes
- intersection crashes
- overtaking crashes.

The increase in crash risk is not only due to greater exposure to traffic but also due to the combination of higher volumes of traffic travelling at high speeds on roads designed for lower traffic volumes. Some road features may have become substandard for the new traffic volumes and travel speeds increasing the risk of certain crashes.

There are a range of treatments available to reduce the risk of these crashes occurring. Ideally these treatments should be considered at the planning stage or implemented when appropriate to prevent the increase in crashes occurring.

5.4 Road Users

As development occurs there is a change in land use and, therefore, a change in modes of transport, with a potentially greater demand for pedestrian and cyclist facilities. A range of land uses may be present within the urban fringe environment including residential areas, schools, shops, light industrial, and farming resulting in a mix of transport modes and road users. A key concern is vulnerable road users mixing with high-speed traffic including cars and heavy vehicles. The challenge is how to identify the demand of each of these road user groups and how to best manage the interaction between them to minimise safety risk.

The types of road users that may require consideration in an urban fringe environment include:

- cyclists
- pedestrians
- public transport
- heavy vehicles including farm machinery and other special vehicle types
- motorcyclists.

5.5 Property Access

People require access to and from residential properties or commercial activities along roads which have previously carried low traffic volumes but now have higher traffic volumes, making access difficult.

Austroads (2000) outlines the dual roles of a road:

- the safe and efficient movement of people and goods by road-based modes (car, truck, bus, tram, motorcycle, bicycle and foot); and
- provision of access to abutting land (either directly or indirectly via intersecting local roads), and social interaction arising from local activities and land uses.

Generally, these two roles conflict with each other.

There are two main safety issues associated with access to properties. Firstly, as traffic volumes increase drivers of vehicles may take risks when leaving a property to access the road i.e. accept a smaller gap in traffic. Secondly, as urban growth occurs, larger properties may be subdivided into smaller lots over time increasing the frequency of accesses along a road. This type of development may be ad hoc and occur gradually over time. Therefore, the risk of property access crashes has increased due to increased traffic volumes as well as the cumulative effects over time of providing access to properties along the road.

Table 5.1 has been taken from TMR's *Infrastructure Risk Rating Manual*. It shows how the level of risk increases as a greater number of accesses are located along the road.

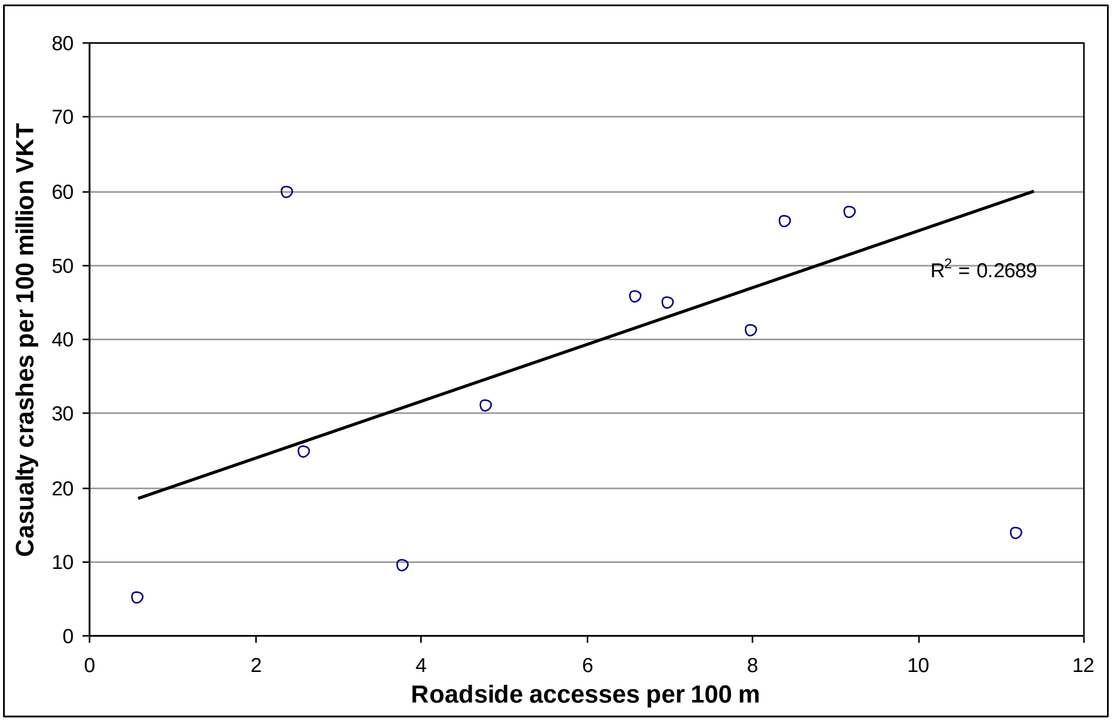
Table 5.1: Access density risk scores

Category	Risk Score
20+ accesses / km	1.30
10 to <20 accesses / km	1.10
5 to <10 accesses / km	1.06
2 to <5 accesses / km	1.03
1 to <2 accesses / km	1.01
<1 accesses / km	1.00

Source: TMR (2018b).

Jurewicz and Zivanovic (2011) carried out an analysis to determine the effect of more frequent road access points on crash risk. Figure 5.1 shows the result for 60 km/h single carriageway urban arterial roads in a fully built-up urban environment. The relationship was similar for divided arterials. Note the correlation was low but the relationship was reproduced for different types of urban arterials.

Figure 5.1: Effect of road access frequency on casualty crash risk for fully built-up single carriageway arterials



Source: Jurewicz and Zivanovic (2011).

Jurewicz and Zivanovic (2011) showed the combined data for fully built-up areas on average, to have the following relative risk relationship for access points along the road:

$$RR_{cas} = 1.00 + 0.25 \text{ x No accesses per 100 m}$$

For roads in partially built-up, sparsely built-up and rural areas, the relationships were generally unclear. Driveways were less frequent on these roads (Jurewicz & Zivanovic 2011). However, it is suggested that the urban relationship be used for rural roads.

The challenge is managing access to achieve a balance between safe traffic movement along the road whilst providing safe access to the road from adjacent land.

5.6 Road Features

Urban fringe roads were originally designed for lower volumes of traffic and are now experiencing higher traffic volumes. The road features may now be substandard with the additional traffic volumes on the road network.

Increased traffic growth increases the likelihood of crashes. Key road features that influence crash likelihood and may need upgrading as traffic growth occurs include:

- intersections – number of and types of intersections
- curves
- lane width
- lane capacity – single versus divided carriageways
- sealed shoulder width
- posted speed limit and the speed environment
- overtaking opportunities

- lighting
- roadside hazard removal/protection.

Cost-effective treatments to upgrade urban fringe roads need to be planned and installed at the appropriate time to prevent crashes occurring due to substandard infrastructure.

6 URBAN FRINGE ROAD TREATMENT FRAMEWORK

6.1 The Challenge

The urban fringe environment is experiencing increasing traffic volumes as a result of development on roads that were originally designed for low volumes of traffic. The mix and modes of transport are changing, with high-speed traffic mixing with vulnerable road users. If nothing changes on these roads, crashes are expected to increase.

There are several roads that are already classified as urban fringe roads; some of these roads are experiencing traffic volumes greater than 20 000 vpd. These roads require significant costly upgrades to operate safely under the current traffic demand. Other roads will experience traffic growth from surrounding development and will also transition. As developments continues to occur on the outer urban areas more and more, roads will fall into the category of urban fringe roads. Hence the importance of a proactive framework to manage the safety risks associated with these roads.

6.2 The Objective

The objective is to identify urban fringe roads and develop and implement a framework to proactively manage the safety risks to prevent loss of life, serious injury and other crashes occurring in the urban fringe environment.

6.3 Treatment Framework

Based on the study findings and the broad risk factor categories, a treatment framework has been developed to assist TMR in the management of the urban fringe road environment.

As discussed previously in Section 5, there are specific risk factors that have been identified for the urban fringe road environment which include increased traffic volumes, increased crash risk, changes to the mix of land uses and road users, property access and road features. These have been incorporated into the framework below.

The framework has been developed to proactively manage the identified risk factors and to provide guidance for when to implement measures as roads transition from rural to urban environments. Note, there may be duplication of treatments across sections as some solutions may be appropriate for different safety risks experienced e.g. both increased traffic volumes and risk of head-on crashes may lead to duplicating the road.

A road may be classified as an urban fringe road when it is experiencing traffic growth due to development occurring on the outer urban areas. Once a road has been identified or meets the criteria to be classified as an urban fringe road, then the treatments outlined in the framework should be applied. If treatments are unable to be installed, then the posted speed limit should be reduced until infrastructure upgrades can be provided.

The framework has been developed for general application across urban fringe roads. It is acknowledged that the treatments may not be appropriate in some cases due to specific site conditions and road features present, and a more tailored solution may be warranted.

A summary of the framework with the suggested treatments and the respective trigger points are provided in Appendix C.

6.3.1 Traffic Volumes

As traffic volumes increase, the road may need to be upgraded to reflect the new traffic volumes. Traffic impacts the capacity of the road/traffic lanes, the operation of intersections, the risk of crashes occurring and exposure of vulnerable road users to traffic. The increase in traffic volumes may include growth in AADT or peak hourly volumes.

Duplication and number of lanes

An increase in traffic volumes may impact the capacity and flow of traffic along roads particularly at peak times. Additional traffic lanes may be warranted and should be analysed in accordance with the *Guide to Traffic Management Part 3: Traffic Studies and Analysis (*Austroads 2017b*)* to achieve the desired level of service acceptable for urban fringe roads. It is suggested that a level of service D be adopted.

The most effective way to reduce the risk of head-on crashes occurring is to provide physical separation of opposing traffic. This may involve a road upgrade or duplication to construct a central median to provide an area for errant vehicles to recover in the event of leaving the roadway. This is a high-cost treatment and traffic volumes may not be enough to justify this treatment as a road is transitioning between rural and urban areas. However, once traffic volumes approach 15 000 vpd duplication may be required.

Overtaking

The crash analysis showed overtaking (same direction) crashes were higher for most of the roads when compared to all state-controlled roads although the percentages were low. As traffic volumes increase, the opportunity to overtake becomes limited resulting in driver frustration and risk taking.

Overtaking lanes allow motorists to overtake slower-moving vehicles without moving into the opposing traffic lane. An overtaking lane provides increased road capacity and helps to reduce the incidence of a head-on collision due to overtaking. However, a recent study conducted by Austroads (2019) examined the safety performance of passing lanes and found mixed results, indicating that situational factors may play a strong role in safety outcomes.

Austroads *Guide to Road Design Part 3: Geometric Design* (2016c) suggests that overtaking lanes be provided typically every 10 to 15 km. However, an analysis should be undertaken to consider characteristics of the road section such as grade, road geometry and existing overtaking opportunities when determining the overtaking requirements.

Road features

Typically, urban fringe roads were originally designed for lower volume rural roads. As development has occurred, these roads changed their function or classification and now require upgrading to the appropriate standard to meet the current or future needs. This may include looking at the gaps in the road based on the old classification/design and how to bring it to the new standard required to meet the new AADT and conditions.

It is recommended the following attributes should be provided for urban fringe roads:

- a minimum lane width of 3.25 m
- a minimum sealed shoulder width of 1.0 m
- delineation in good condition, which includes edge lines, centrelines, guideposts, raised reflective pavement markers (RRPM'S), and road lighting
- overtaking lanes determined by Austroads guidelines
- intersection standards as outlined in Section 6.3.2.

6.3.2 Crash Risk

The following sections provide treatments for the key crash types identified as high risk for urban fringe roads.

Speed environment

An urban fringe road may have previously operated as a high-speed rural road. As the road transitions from a rural to an urban road, the original speed limits may become inappropriate. The crash data showed that FSI crashes on urban fringe roads represent a higher proportion of injury crashes for most speed zones compared to all state-controlled roads indicating that current speed limits may not be appropriate anymore for those roads.

Table 6.1 below has been extracted from TMR (2018a). The table is part of the steps followed when calculating a risk-assessed speed limit. The table is specific to an urban fringe environment and suggests speed limits of 70 or 80 km/h for a trunk collector road depending on the level of risk calculated for the road risk metric.

Table 6.1: Risk-assessed speed limits: roads in a semi-urban environment

Road class	Functional description	Road Risk Metric		
		Low	Medium	High
Access / local street	Access to property	60 km/h	60 km/h	50 km/h
Collector street	Access to property and other streets; neighbourhood access	70 km/h	60 km/h	60 km/h
Trunk collector road	Transport of people and goods within suburbs; district movement	80 km/h	80 km/h	70 km/h

Source: TMR (2018a).

The Road and Transport Authority (2011) suggests typical speeds for application on NSW roads in their speed zoning guidelines and indicates a typical speed limit of 80 km/h for undivided arterial and sub-arterial roads on the fringes of urban areas.

The Department of Planning, Transport and Infrastructure (2017) provides guidance for speed zoning in South Australia and indicates a 70 km/h speed limit for urban fringe roads.

VicRoads (2017) suggests for undivided roads on the urban/rural fringe, or in a rural area where there is an elevated risk of crashes, the typical speed limit used should be 80 km/h.

Based on the crash history, access requirements and speed limits suggested within TMR and other road agencies' guidelines, it is recommended that the posted speed limit on urban fringe roads should not exceed 80 km/h. Note, there may be circumstances where a lower speed limit may be warranted. Where a lower quality road exists and road agencies are unable to invest in infrastructure improvements, further speed reduction may be required.

Head-on crashes

The following treatments are provided to reduce the risk of head-on crashes in an urban fringe environment.

Wide centreline

A wide centreline treatment is a lower cost solution compared to duplication and has been effective in reducing the risk of head-on crashes. However, in some cases, road widening is required to achieve the desired road cross-section, which can be costly.

Wide centreline treatments are a type of painted median treatment used to increase the separation of vehicles (Figure 6.1). The width of the median varies depending on the posted speed limit. TMR's interim advice is: for a speed limit of 60 km/h the width is 600 mm, and for 70–80 km/h the width is 800 mm (TMR 2017). The treatment may be enhanced by using reflective markers to further highlight the median strip.

It is recommended that wide centrelines be provided on urban fringe roads when a road reaches AADT of 4000 vpd based on TMR's Safety Intervention and Improvement Guidelines (TMR 2018d) and the head-on crash rate analysis in Section 3.6.

Figure 6.1: Wide centreline treatment on Mt Cotton Road

Source: ARRB.

For further technical information refer to the *Guidelines for road design on brownfield sites* (TMR 2013).

Median turn lanes

The main function of the median turn lane treatment is to allow turning into driveways and entrances with minimal rear-end crashes. However, studies have found that median turning bays have helped to reduce head-on crashes as these bays serve as a buffer between the opposing streams of traffic.

Two-way turning lanes are typically used in more urban areas with closely spaced access points. A single lane is marked in the centre of the road to provide an area for vehicles travelling in either direction to slow down before turning across traffic into driveways (Figure 6.2). This type of lane also provides a space for drivers of turning vehicles who must wait for an adequate gap in the oncoming traffic. In areas where there is pedestrian activity, these lanes may provide some protection to pedestrians crossing the road; they can be coupled with pedestrian treatments such as pedestrian refuge islands to provide added security (iRAP 2010).

Figure 6.2: Example of a median turning lane

Source: ARRB.

TMR (2014b) states that median turn lanes should be restricted to the urban environment with travel speeds of 70 km/h or less. TMR also discourages the use of these in high-density residential areas due to potential conflict with uncontrolled pedestrian movements. It is suggested they be considered for urban fringe roads once the number of accesses along the road exceeds 20 per kilometre.

For further technical information refer to the *Supplement to Austroads Guide to Road Design Part 4A: Unsignalised and Signalised Intersections* (TMR 2014b).

Curve treatments

The crash case studies indicated head-on road crashes were over-represented on urban fringe roads. We also know that a significant number of head-on crashes occur on horizontal curves. Drivers tend to use more of the travel lane when negotiating a horizontal curve compared to a straight section of road, and head-on crashes may occur when drivers swing wide or ‘cut the corner’. This highlights the importance of the treatment of curves and the provision of good, clear curve delineation with appropriate advanced warning to allow road users to predict the road alignment and adjust their speeds accordingly.

Curve widening and improvements may prevent vehicles from travelling outside their lane and travel closer to the centre of the road (Figure 6.3). These include increasing the curve radius, providing transition curves between the straight and the bend, eliminating compound curves and improving superelevation.

All sharp curves (radius of 200–500 m) on urban fringe roads should be treated to ensure they are clearly delineated with linemarking and guideposts, have advanced warning signs, speed advisory signs and chevron alignment markers (CAM’s). Consistent application of delineation, signage and other treatments should be applied on a route basis. For any high-risk curves, vehicle-activated signs and perceptual countermeasures should be considered to reduce the risk of crashes on these curves.

Figure 6.3: Curve widening on shoulders

Source: Austroads (2015).

For technical information, refer to the *Guidelines for road design on brownfield sites* (TMR 2013) and *the Supplement to Austroads Guide to Road Design Part 3: Geometric Design* (TMR 2018c).

Run-off-road

The following treatments are provided to reduce the risk of run-off-road crashes in an urban fringe environment.

Curve treatments

The crash case studies showed that run-off-road crashes on a curve involving hitting an object were high compared to all crashes on state-controlled roads. This highlights the importance of the treatment of curves and the provision of good, clear curve delineation with appropriate advanced warning to allow road users to predict the road alignment and adjust their speeds accordingly.

Curve treatments should be provided as recommended for head-on crashes in Section 6.3.2.

Hazard protection, removal, and clear zone

A clear zone is an area adjacent to the edge of the travel lane where errant vehicles may travel without striking any hazards. Ideally, the clear zone should be free of unforgiving roadside objects such as trees, poles, deep ditches and other street furniture; however, in an urban fringe environment that may not be the case.

Where a roadside hazard exists, road users should be protected/shielded with a safety barrier or designed to be frangible.

This is particularly important on curves as the crash analysis showed urban fringe roads to be over-represented for run-off-road on curve involving hitting an object, compared to all crashes on state-controlled roads.

It is recommended that urban fringe roads have hazard protection, where possible, for roads with a posted speed limit of 70 km/h or more.

For technical information refer to the *Supplement to Austroads Guide to Road Design Part 6: Roadside Design, Safety and Barriers* (TMR 2014a).

Sealed shoulder

The provision of a sealed and unsealed shoulder provides an area whereby a vehicle may successfully recover during a run-off-road event. Run-off-road crashes can be significantly reduced if wide shoulders are provided (Figure 6.4), particularly where none existed previously.

Figure 6.4: Recently sealed shoulder on two-lane road

Source: ARRB.

It is suggested that urban fringe roads have a minimum sealed shoulder width of 1.0 m as recommended in the road features listed in Section 6.3.1.

Intersection crashes

The following treatments are provided to reduce the risk of intersection crashes in an urban fringe environment.

Roundabouts

Roundabouts are commonly used to replace intersections to reduce the number of right-angle crashes and crashes related to high speeds, both of which are factors which lead to crashes of a more serious nature. While among the most expensive of intersection crash treatments, roundabouts, whether signalised or unsignalised, have staggering safety advantages over other types of intersections. They are also suitable where other crash treatments have not proven effective. Roundabouts are often viewed as the ideal at-grade intersection option for improved safety outcomes based on the Safe System approach. A typical roundabout in a rural area is shown in Figure 6.5.

Figure 6.5: High-speed roundabout on a rural arterial

Source: Austroads (2015).

Installation of a roundabout is appropriate where there is equal demand on each approach. If the demand is unbalanced, then further analysis should be undertaken to determine whether a roundabout is the best solution for the intersection.

Smaller roundabouts may restrict some larger service vehicles and emergency vehicles and buses unless the central island is mountable. Roundabouts are not suited to locations where large heavy vehicles are likely to be present.

Roundabouts induce a higher number of cyclist-involved crashes. Provisions for cyclists, either by the use of on or off-road facilities, can reduce the risk to cyclists. Pedestrians can be at greater risk at roundabouts; however, as indicated in Austroads (2015), a well-designed roundabout does not increase the risk to pedestrians.

It is recommended consideration be given to the installation of roundabouts at intersections on urban fringe roads where appropriate.

For technical information, refer to the *Supplement to Austroads Guide to Road Design Part 4B: Roundabouts* (TMR 2014c) and Technical Note 136 *Providing for Cyclists at Roundabouts* (TMR 2015b).

<u>Left-turn provision and channelisation</u>

Consideration should be given to left-turn treatments and channelisation where appropriate at intersections along urban fringe roads. Left-turn treatments on rural roads should be applied in accordance with TMR's *Road Safety Policy* (TMR 2018d) to manage the risk of left-turning vehicles obscuring sight distance for vehicles entering from the minor road.

<u>Intersection turn lanes (unsignalised)</u>

Dedicated turn lanes (channelised turn treatments) allow vehicles to decelerate or stop prior to turning without affecting the flow of through traffic behind them, thus reducing the risk of rear-end crashes. It also provides a sheltered location for vehicles to wait for a suitable gap in opposing traffic before turning. A median can provide further separation between vehicles in the turn lanes and opposing traffic. The introduction of turning lanes can improve traffic flow and increase intersection capacity.

Turning lanes require clear delineation and need to have good sight distance and be of suitable length to allow a vehicle time to stop within it. The provision of turning lanes can increase the width of the intersection and cause problems for pedestrians crossing the road. This can be improved by providing a pedestrian refuge island in the median.

Turn lanes are often indented and kerbed in urban areas (Figure 6.6), whereas in rural areas, they may consist of pavement markings and linemarking in conjunction with sealing the shoulder (Figure 6.7).

Figure 6.6: Right-turn lane in urban area

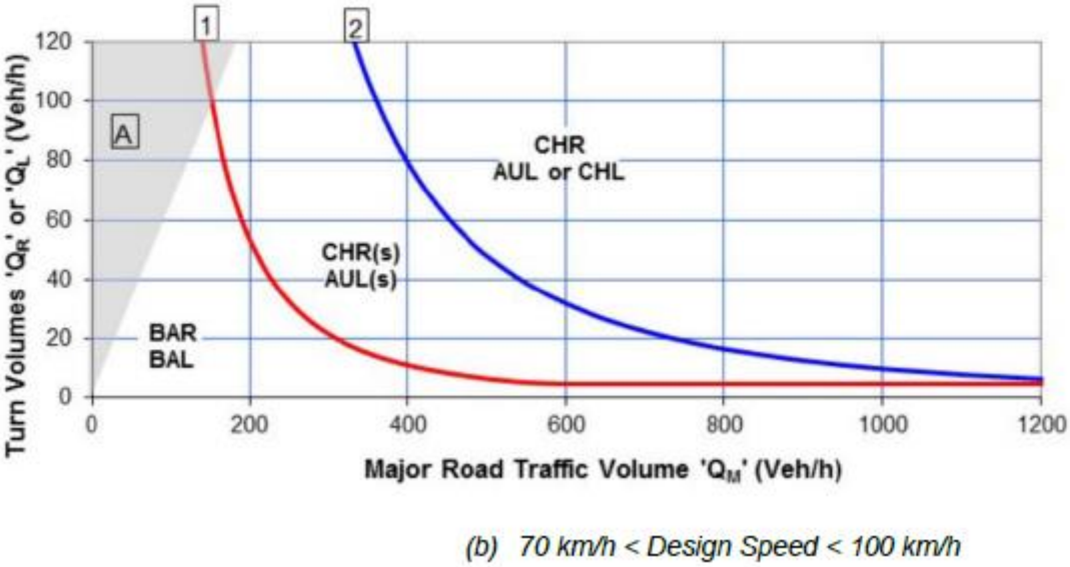
Source: Austroads (2015).

Figure 6.7: Right-turn lane in rural area

Source: ARRB.

TMR provides warrants for turn treatments for major roads in the *Supplement to Austroads Guide to Road Design Part 4A: Unsignalised and Signalised Intersections* (TMR 2014b). It provides warrants for basic turn treatments (BA), auxiliary turn treatments (AU) and channelised turn treatments (CH). Figure 6.8 shows the graph provided for speed zones greater than 70 km/h and less than 100 km/h which applies to higher speed urban roads, including those on the urban fringe and lower speed rural roads. TMR's *Road Safety Policy* (TMR 2018d) requires auxiliary right-turn lanes at rural intersections be replaced with at least a CHR(s). Intersection turning provision on urban fringe roads should be provided in accordance with these warrants and TMR's *Road Safety Policy* (TMR 2018d).

Figure 6.8: Warrants – major road turn treatments – normal design domain



Source: TMR (2014b).

Refer to the *Supplement to Austroads Guide to Road Design Part 4A: Unsignalised and Signalised Intersections* (TMR 2014b) and *Traffic and Road Use Management Volume 1: Guide to Traffic Management Part 6: Intersections, Interchanges and Crossings* (TMR 2019b) for technical information.

Left in – left out only

As traffic increases, right-turn manoeuvres may become high-risk at some intersections. Although not always feasible, some intersections may benefit from providing a left in and left out intersection treatment. This involves restricting right-turning movements by prohibiting right turns or installing a median to prevent right-turn movements occurring, with provision for U-turns within proximity to the access.

Consideration should be given to converting intersections to left in and left out where appropriate at intersections along urban fringe roads.

Sight distance improvements

Adequate sight distance is essential to enable approaching drivers to be able to (Austroads 2017c):

- recognise the presence of an intersection in time to slow down or stop in a controlled and comfortable manner
- see vehicles approaching in conflicting traffic streams and give way where required by law or avoid a crash in the event of a potential conflict.

Types of sight distances required at intersections include safe intersection sight distance and approach sight distance. Sight distance may be obstructed by road furniture, vegetation, parked vehicles, the road geometry, batters, signs, etc. An example of limited sight distance due to the intersection being on the inside of a curve, and by vegetation, is shown in Figure 6.9.

Figure 6.9: Sight distance limited due to intersection being on the inside of a curve and by vegetation

Source: Federal Highway Administration (FHWA) (2016).

Some low-cost solutions to improve sight distance include:

- remove or cut back vegetation
- relocate structures, signs, or roadside furniture impeding sight distance
- ban or indent parking
- bring forward stop line (if safe to do so)
- install traffic mirror (low volume, low speed location only).

Intersections along urban fringe roads should have the recommended sight distance available on all approaches.

For technical information, refer to the *Supplement to Austroads Guide to Road Design Part 4A: Unsignalised and Signalised Intersections* (TMR 2014b).

<u>Installation of traffic signals</u>

Traffic signals are installed at T-junctions and cross-intersections to separate oncoming traffic by phases to reduce the likelihood of right-angle crashes (Figure 6.10). Traffic signals can also produce a more efficient movement of traffic and in some cases, may increase the capacity of the intersection.

Although traffic signals can reduce overall crashes, this can result in an increase in some crash types such as rear-end crashes and opposing-turn crashes if separate turning phases are not provided (no turning arrows).

Visibility of the signals needs to be considered in the more urban environment. Mast arms can be used to increase the visibility of the signals. In high-speed environments and where visibility is poor the signals may also be accompanied by warning signs or vehicle-activated signs.

Figure 6.10: Traffic signal displays mounted on a mast arm

Source: Austroads (2015).

Before installing traffic signals, consideration should be given to traffic volumes, pedestrian movements, intersection approach speeds and crash history at the site.

It is recommended consideration be given to the installation of traffic signals at intersections on urban fringe roads where appropriate.

Refer to *Traffic and Road Use Management Volume 1: Guide to Traffic Management Part 9: Traffic Operations* (TMR 2019a) for technical information.

<u>Delineation</u>

All intersections should be properly delineated, and intersections should be clearly visible on all approaches. A combination of appropriate signage and linemarking, lighting and advanced warning signs should be present to achieve a clearly delineated intersection as recommended in the road features listed in Section 6.3.1.

Property access crashes

For details regarding the treatment to reduce the risk of property access crashes refer to Section 6.3.4.

6.3.3 Road Users

Changes in land use and surrounding development may lead to a change in the mix of road users. The range of road users that urban fringe roads may need to cater to within the road corridor include heavy vehicles, buses, cyclists, motorcyclists and pedestrians.

Heavy vehicles

A heavy vehicle assessment should be undertaken to determine specific treatments required to improve heavy vehicle safety along urban fringe roads.

Treatments to reduce the risk and severity of head-on crashes involving heavy vehicles may include:

- physical separation of opposing traffic through road duplication

- consideration of heavy vehicles in barrier design – heavy vehicles will not be contained by a normal roadside safety barrier and a car may be extensively damaged by an impact with a barrier designed for trucks (a rigid barrier, depending on height and other details, provides the highest level of containment of heavy vehicles)
- separation of vehicles or road users of different size
- improved delineation and signage
- curve treatments, including curve widening and advisory signs on sharp curves
- speed management
- improved road surface condition
- the use of wide centreline treatments
- the provision of overtaking opportunities.

Pedestrians

An assessment of the pedestrian demand should be undertaken to determine whether a footpath and/or crossing facilities are required in accordance with the applicable relevant standard.

Cyclists

Table 6.2 from TMR Technical Note 128 *Selection and Design of Cycle Tracks* (TMR 2015a) guides the selection of bicycle facilities within the urban road corridor. It is dependent upon road function and speed. The table indicates for a collector/distributor road within an urban road corridor with a posted speed limit greater than 50 km/h, bicycle lanes are not preferred due to high speed difference, and a cycle track is appropriate.

TMR (2015a) states for arterial roads outside built-up urban areas, stand-alone off-road paths outside of the road corridor are appropriate. Where this cannot be achieved, adequate road shoulders with no parking permitted should be provided, along with safe intersection and crossing treatments.

Table 6.2: Urban road bicycle facility selection depending on road function

Road function	Vehicle operating speed (km/h)		Cycle tracks appropriate?	Explanation
Local access road with or without parking	Up to 30 km/h		No	Mixed traffic is appropriate. Cycle track with limited vehicle access may be appropriate (refer 3.2.1).
			Maybe	Bicycle lanes/cycle tracks may be appropriate on primary bicycle route.
Collector/distributor road	Up to 50 km/h	No kerbside parking		Bicycle lanes with no kerbside parking are most appropriate.
		With kerbside parking	Yes	Bicycle lanes <u>not</u> preferred due to door zone conflicts (refer 3.3.1).
Arterial road	More than 50 km/h		Yes	Bicycle lanes <u>not</u> preferred due to high speed difference.
Urban motorway	More than 70 km/h		No	High quality parallel off-road bicycle path with grade separated, signalised or priority crossings at intersections is appropriate.

Source: TMR (2015a).

It is recommended that urban fringe roads do not include cycle lanes and that alternate on-road routes or dedicated cycle paths be provided if there is a demand for cycling.

Motorcyclists

If the urban fringe road is a known motorcycle route, ensure treatments, in addition to those which have already been recommended, are motorcycle-friendly. Treatments to reduce the crash risk and severity of motorcycle crashes include (Austroads 2016b):

- improvements to the road surface (re-surfacing) on curves
- the use of curve warning/quality signage including motorcycle-specific signage schemes and standalone signs
- the provision of a smooth, consistent and predictable road surface, including not having changes in surface friction, delamination, potholes, water pooling or flowing on the surface, rutting, corrugations and depressions from surface covers or tram/train tracks
- the provision of frequent, safe and legal opportunities for motorcyclists to pass vehicles that are operating at a slower speed, particularly on roads in mountainous or rolling terrain which have narrow formations and poor sight distances
- a hazard-free clear zone – any hazards that are deemed necessary (e.g. signage, guideposts, light poles) should be set back as far as practicable from the road shoulder and be motorcyclist/cyclist-friendly or protected by a less severe hazard such as a motorcycle-friendly safety barrier.

6.3.4 Property Access

Management of access along urban fringe roads can be challenging as development occurs. More frequent accesses may be installed along the road as land is subdivided into smaller lots, traffic volumes increase and the mix of road users changes, resulting in a higher risk of property access crashes occurring.

Treatments to reduce the risk of property access crashes include:

- reducing the speed limit
- consolidating access points by combining driveways via a service road to reduce the number of access points along the road
- management of right-turning movements via restricting access (left in and left out) by prohibiting right turns or installing a median to prevent right-turn movements, with provision for U-turns within proximity to the access
- providing adequate sight distance to allow safe turning movements from accesses
- providing a median turn lane to allow for turning movements on more urban sections of the road (as discussed in Section 6.3.2)
- ensuring access close to intersections are not blocked by queuing traffic – when accesses are located close to intersections, queuing of traffic may restrict or prevent vehicles from turning out of property accesses along the side of the road. Use of a clear zone area may be used to avoid queuing vehicles blocking access.

It is recommended that median turn lanes be implemented when there are more than 20 accesses per kilometre on urban fringe roads and an assessment of treatments required for individual accesses be completed on a case-by-case basis.

7 CONCLUSION AND RECOMMENDATIONS

7.1 Conclusions

As development occurs, traffic volumes increase on roads designed for lower volumes resulting in an increase in the risk of crashes occurring. Guidance is required to proactively manage the safety risks to prevent loss of life, serious injury and other crashes occurring when roads are transitioning from rural to urban environments.

Despite being an issue for most road agencies and local governments, limited literature was available which identified current practices of engineering treatments in urban fringe environments. This has confirmed the gap in guidance available to practitioners when challenged with population growth, which places a greater demand on the road network and changes the mix of transport users and needs within the urban fringe environment.

Ten years of crash data was analysed for case study roads to determine the high-risk crash types. Head-on crashes, off-carriageway on curve (hit object) crashes, adjacent approaches intersection crashes, overtaking (although the proportions were low) and vehicle leaving driveway crashes were found to be over-represented when compared to all state-controlled roads.

From undertaking a literature review, stakeholder consultation, and the crash analysis, safety risk factors were identified for urban fringe roads. These included increasing traffic volumes, changes in road function, increased crash risk, changes in land use and the mix of road users, access management, and inappropriate road features for increased traffic volumes.

Based on the research conducted, a treatment framework was developed to enable TMR to proactively manage the identified safety risk factors and to target future funding to address the infrastructure requirements as roads transition from rural to urban environments. Although this study focused on state-controlled roads, the issues are equally relevant to local government which are experiencing the same issues as development occurs.

7.2 Recommendations

Based on the research undertaken, a treatment framework has been developed to provide guidance to manage roads in the urban fringe environment. It is recommended that this be adopted to proactively manage the transition of roads from rural to urban environments.

To effectively manage the transition of rural roads to urban roads it is important to determine the extent of traffic growth resulting from development and the likely impacts on the road network. It is recommended that TMR identify existing and future roads which are or are likely to be classified as urban fringe roads, to gain a better understanding of the future infrastructure upgrades required and to prioritise the works required.

Although a framework of solutions has been provided the issue remains regarding identifying where current and emerging risk will arise on the road network. Further research is recommended to develop a process to enable urban fringe roads to be identified and assessed so that the treatments can be applied to reduce the risk of crashes on these roads and to identify possible ways to obtain funding from additional sources.

It is recommended that the impacts of development on the urban fringe roads be given greater attention at the planning stage to allow TMR to more effectively manage the impacts on the network and to potentially seek greater contributions from developers.

The framework provides guidance specifically for urban fringe roads which is not currently available in TMR’s technical documents and guidelines. It is recommended that guidance provided in the framework be included in TMR’s technical documents and guidelines where appropriate.

REFERENCES

Austroads 2000, *A framework for arterial road access management*, AP-R163-00, Austroads, Sydney, NSW.

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

Austroads 2015, *Austroads road safety engineering toolkit*, database, Austroads, Sydney, NSW, viewed 12 August 2019, <www.engtoolkit.com.au>.

Austroads 2016a, *Achieving safe system speeds on urban arterial roads: compendium of good practice*, AP-R514-16, Austroads, Sydney, NSW.

Austroads 2016b, *Infrastructure improvements to reduce motorcycle casualties*, AP-R515-16, Austroads, Sydney, NSW.

Austroads 2016c, *Guide to road design part 3: geometric design*, 3rd edn, AGRD03-16, Austroads, Sydney, NSW.

Austroads 2017a, *Safe system infrastructure on mixed use arterials*, AP-T330-17, Austroads, Sydney, NSW.

Austroads 2017b, Guide to traffic management part 3: traffic studies and analysis, AGTM03-17, 3rd edn, Austroads, Sydney, NSW.

Austroads 2017c, Guide to road design part 4A: unsignalised and signalised intersections, 3rd edn, AGRD04A-17, Austroads, Sydney, NSW.

Austroads 2019, *Passing lanes: safety and performance*, AP-R596-19, Austroads, Sydney, NSW.

Buxton, M & Choy, DL 2007, 'Change in peri-urban Australia: implications for land use policies', *State of Australian cities national conference, 2007, Adelaide, SA*, Australian Cities Research Network, Adelaide, SA.

Cambridge County Council 2018, *Vertical speeding treatment,* webpage, Cambridgeshire County Council, Cambridge, UK, viewed 13 August 2019, <https://www.cambridgeshire.gov.uk/residents/travel-roads-and-parking/roads-and-pathways/improving-your-local-highway/speeding/vertical_speeding/>.

Corben, B, Tingvall, A, Fitzharris, M, Newstead, S, Les, M & Johnston, I 2001, 'Crash analysis for the review of guidelines for median barriers', Monash University Accident Research Centre, Clayton, Vic.

Department of Planning, Transport and Infrastructure 2017, *Speed limit guideline for South Australia*, DPTI, Adelaide SA.

European Environment Agency 2006, *Urban sprawl in Europe: the ignored challenge*, EEA report 10/2006, EEA, Copenhagen, Denmark.

Federal Highway Administration 2016, *Low-cost treatments for horizontal curve safety 2016*, FHWA-SA-15-084, FHWA, Washington, DC, USA.

iRAP 2010, *Road safety toolkit*, webpage, iRAP, London, UK, viewed 13 August 2019, <www.toolkit.irap.org>.

Jurewicz, C & Zivanovic, A 2011, 'Speed limits incorporating road environment risk', contract report 002208, ARRB Group, Vermont South, Vic.

Larsson, M, Candappa, N & Corben, B 2003, *World's best practice in the use of flexible barrier systems along high-speed roads,* Australasian College of Road Safety, Pearce, ACT, viewed 13 August 2019, <http://acrs.org.au/files/arsrpe/RS030025.pdf>.

Main Roads Western Australia 2015, *Roundabouts and traffic signals: guidelines for the selection of intersection control*, MRWA, Perth, WA.

Queensland Department of Transport and Main Roads 2013, *Guidelines for road design on brownfield sites*, TMR, Brisbane, Qld, viewed 13 August 2019, <https://www.tmr.qld.gov.au/business-industry/Technical-standards-publications/Brownfields-guidelines.aspx>.

Queensland Department of Transport and Main Roads 2014a, *Supplement to Austroads guide to road design part 6: roadside design, safety and barriers*, TMR, Brisbane, Qld.

Queensland Department of Transport and Main Roads 2014b, *Supplement to Austroads guide to road design part 4A: unsignalised and signalised intersections*, TMR, Brisbane, Qld.

Queensland Department of Transport and Main Roads 2014c, *Supplement to Austroads guide to road design part 4B: roundabouts*, TMR, Brisbane, Qld.

Queensland Department of Transport and Main Roads 2015a, *Selection and design of cycle tracks*, technical note 128, TMR, Brisbane, Qld.

Queensland Department of Transport and Main Roads 2015b, *Providing for cyclists at roundabouts*, technical note 136, TMR, Brisbane, Qld.

Queensland Department of Transport and Main Roads 2017, *Wide Centre Line Treatment – Interim Advice*, technical note 155, TMR, Brisbane, Qld.

Queensland Department of Transport and Main Roads 2018a, *Queensland manual of uniform traffic control supplement part 4: speed controls*, TMR, Brisbane, Qld.

Queensland Department of Transport and Main Roads 2018b, *Infrastructure Risk Rating (IRR) manual*, TMR, Brisbane, Qld.

Queensland Department of Transport and Main Roads 2018c, *Supplement to Austroads guide to road design part 3: geometric design,* TMR, Brisbane, Qld.

Queensland Department of Transport and Main Roads 2018d, *Road Safety Policy Organisation Policy*, TMR, Brisbane, Qld.

Queensland Department of Transport and Main Roads 2019a, *Traffic and road use management volume 1: guide to traffic management part 9: traffic operations*, TMR, Brisbane, Qld.

Queensland Department of Transport and Main Roads 2019b, *Traffic and road use management volume 1: guide to traffic management part 6: intersections, interchanges and crossings*, TMR, Brisbane, Qld.

Ravetz, J, Fertner, C & Nielsen, TS 2013, 'The dynamics of peri-urbanization', in K Nilsson, S Pauleit, S Bell, C Aalvers & TA Sick Nielsen (eds), *Peri-urban futures: scenarios and models for land use change in Europe,* Springer, Berlin, Germany, pp 13-44.

Roads and Traffic Authority 2011, *NSW speed zoning guidelines*, RTA, North Sydney, NSW.

VicRoads 2017, *Traffic engineering manual volume 3: additional network standards & guidelines speed zoning guidelines*, VicRoads, Kew, Vic.

APPENDIX A CRASH ANALYSIS – INDIVIDUAL ROADS

A.1 Annual Distribution of Crashes – Individual Study Roads

Figure A 1: Annual proportion of casualty crashes by road

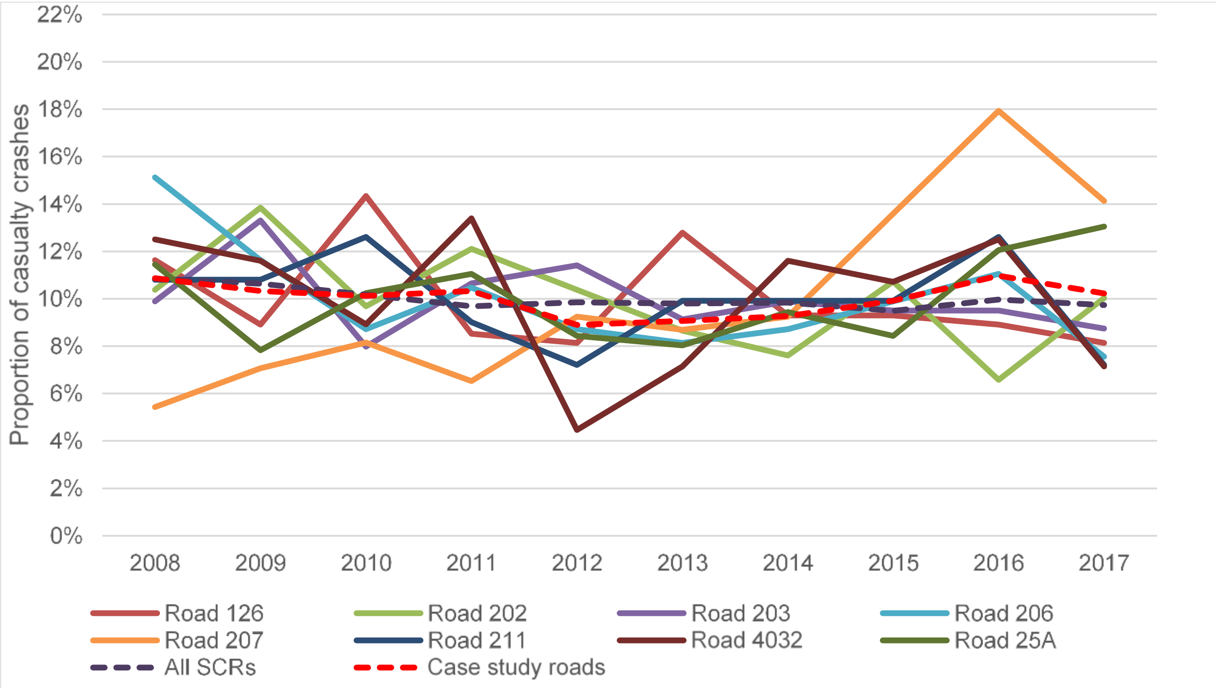
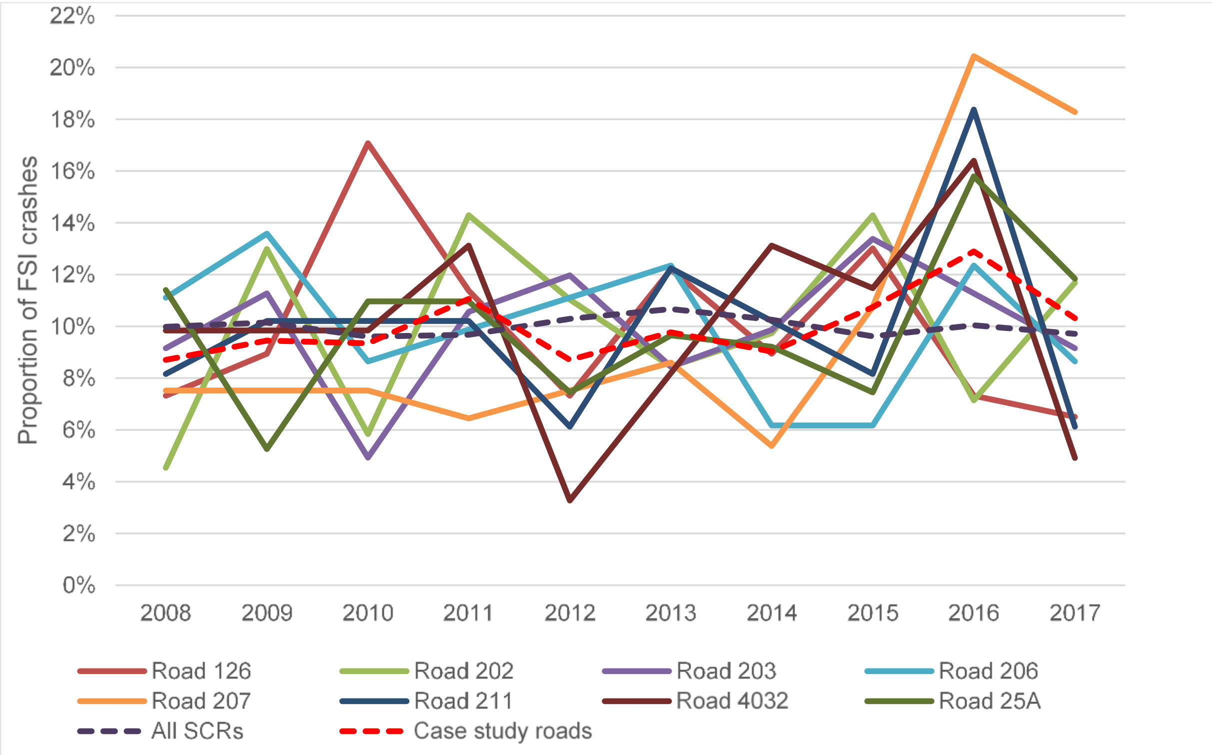


Figure A 2: Annual proportion of FSI crashes by road



A.2 Crashes by DCA Group – Individual Study Roads

Figure A 3: Casualty crashes by DCA group – individual roads

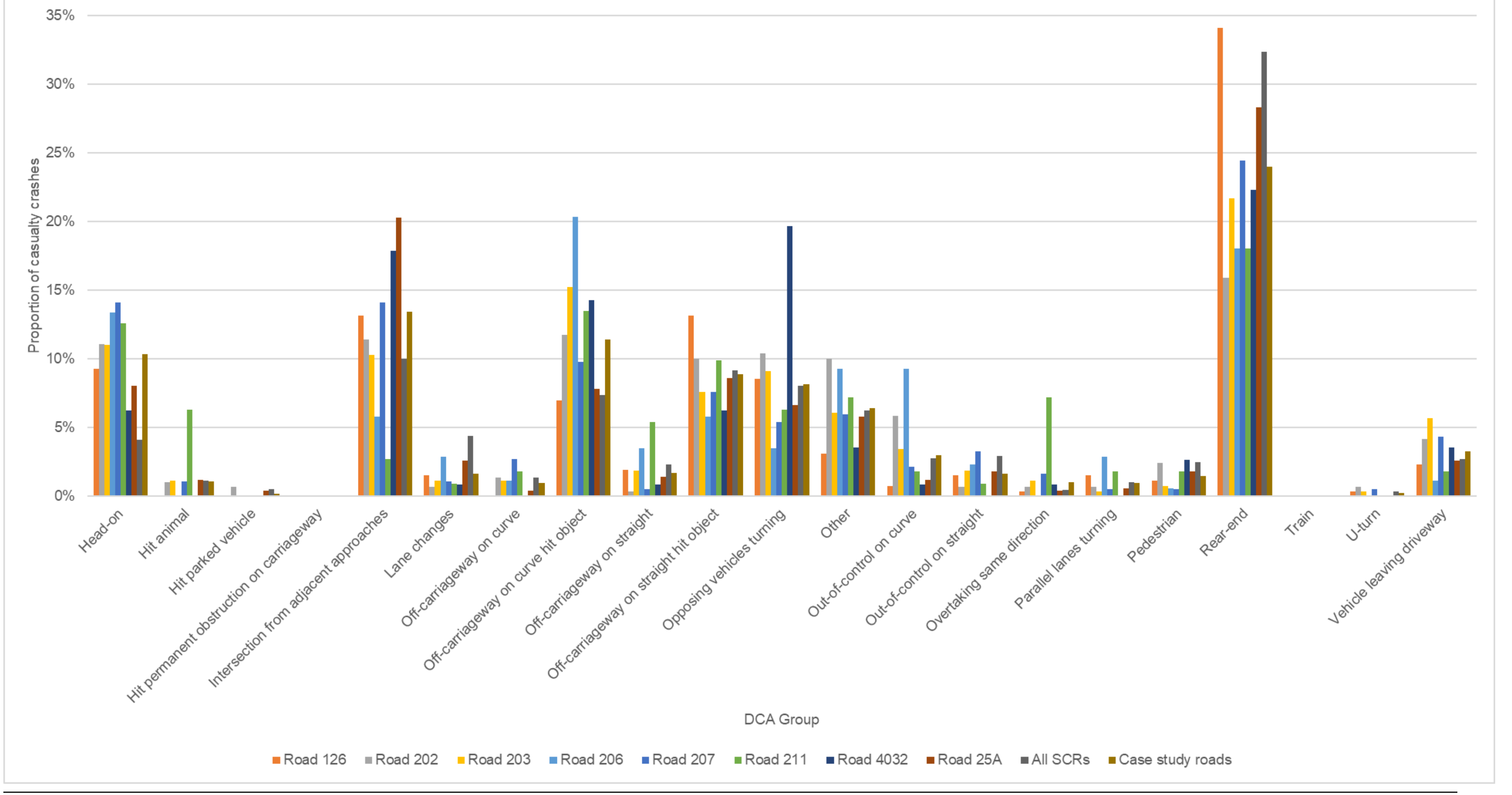
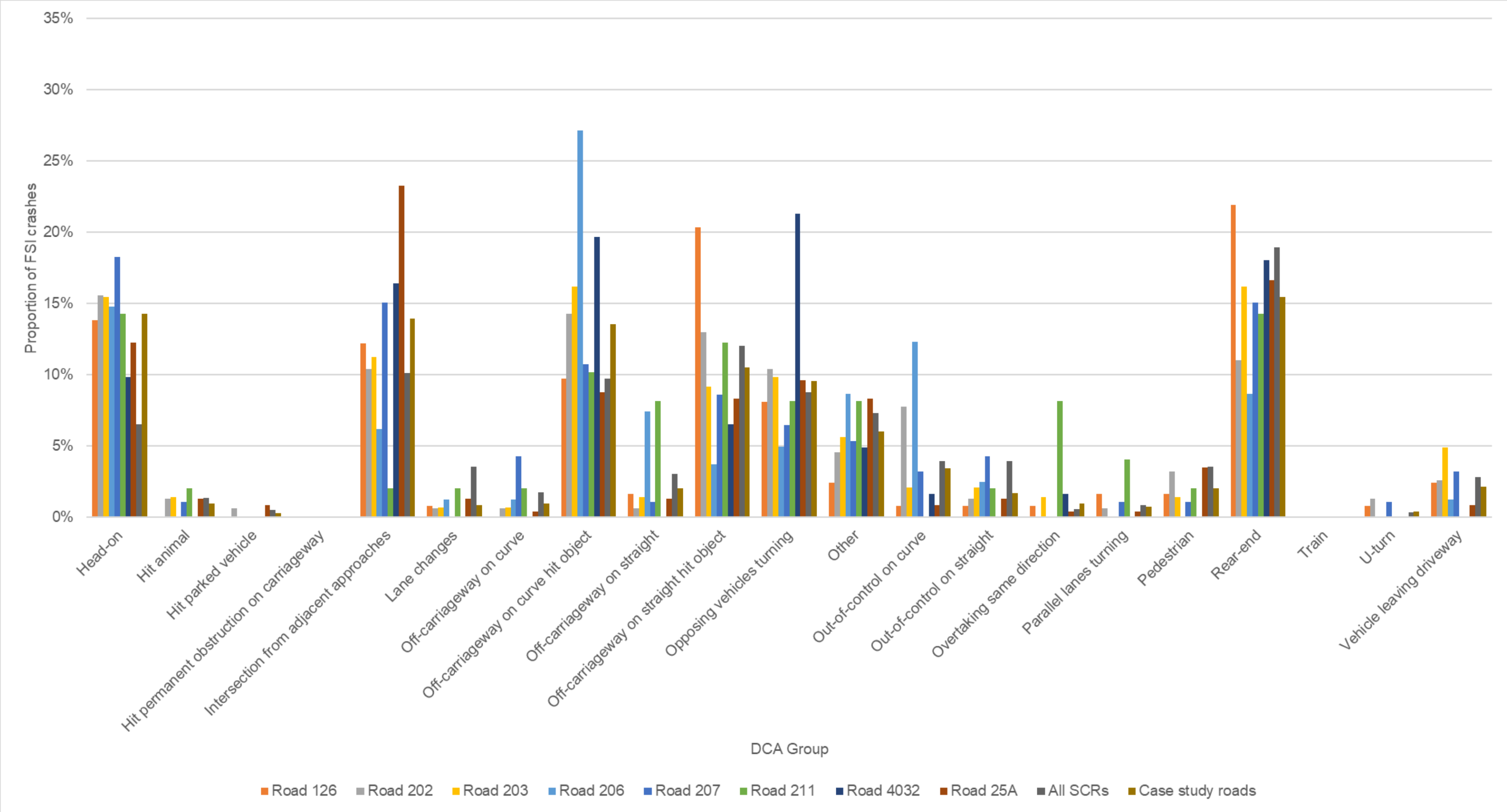


Figure A 4: FSI crashes by DCA group – individual roads



A.3 Temporal Distribution of Crashes – Individual Study Roads

Figure A 5: Monthly casualty crashes by road

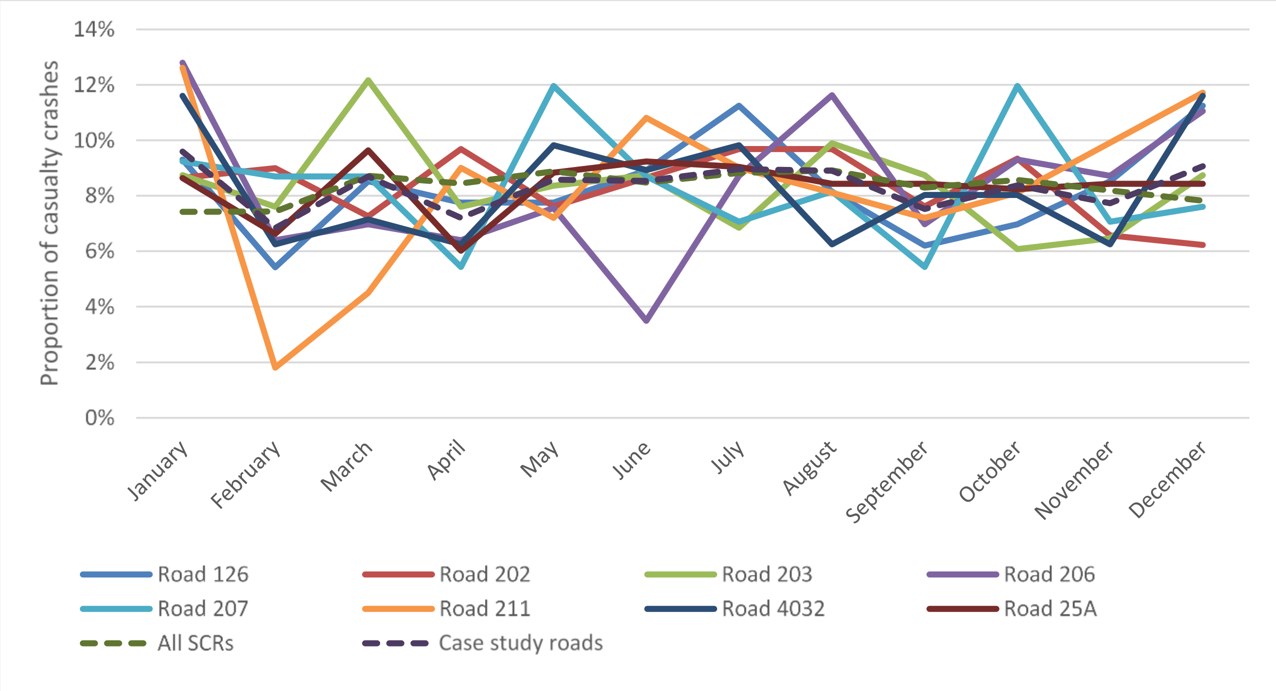


Figure A 6: Monthly FSI crashes by road

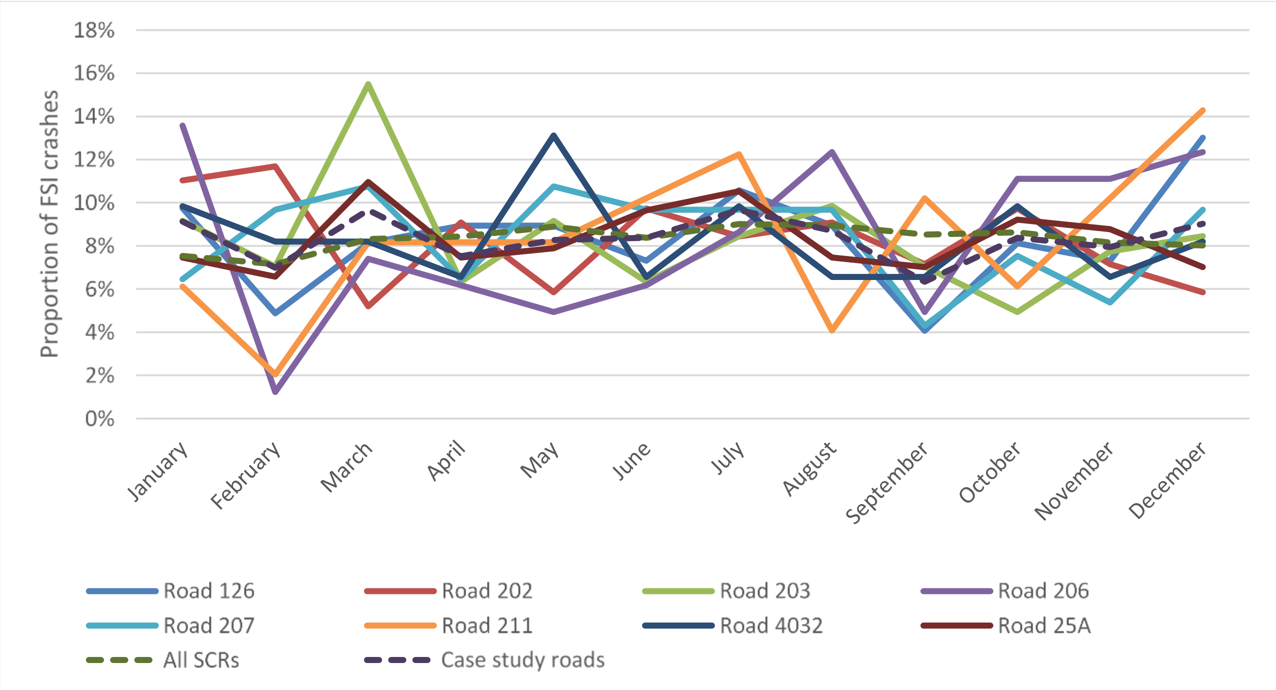


Figure A 7: Daily casualty crashes by road

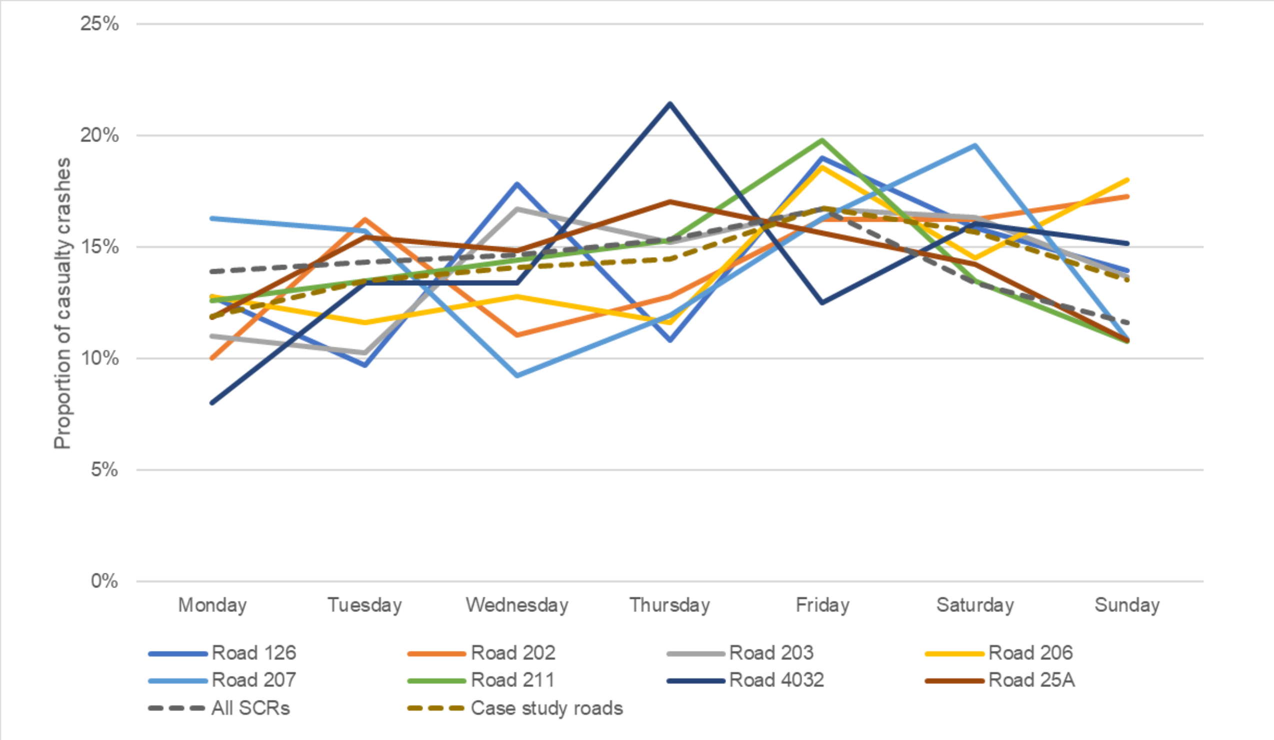


Figure A 8: Daily FSI crashes by road

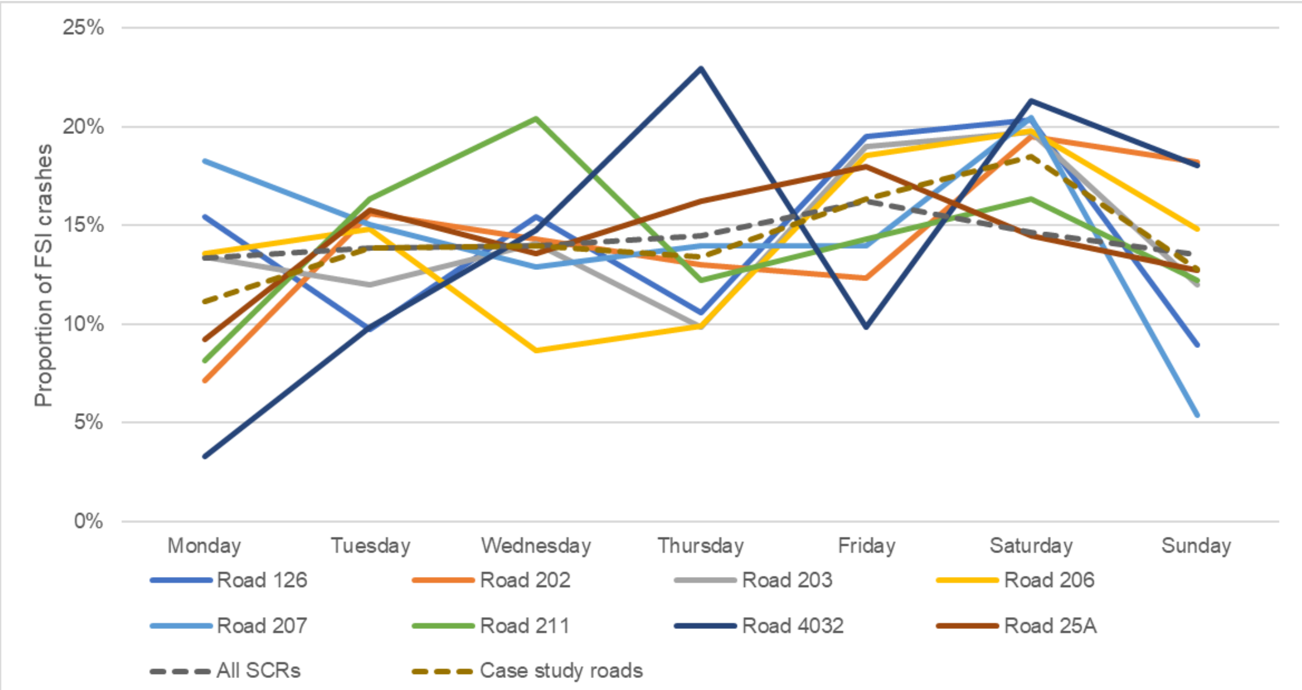


Figure A 9: Hourly casualty crashes by road

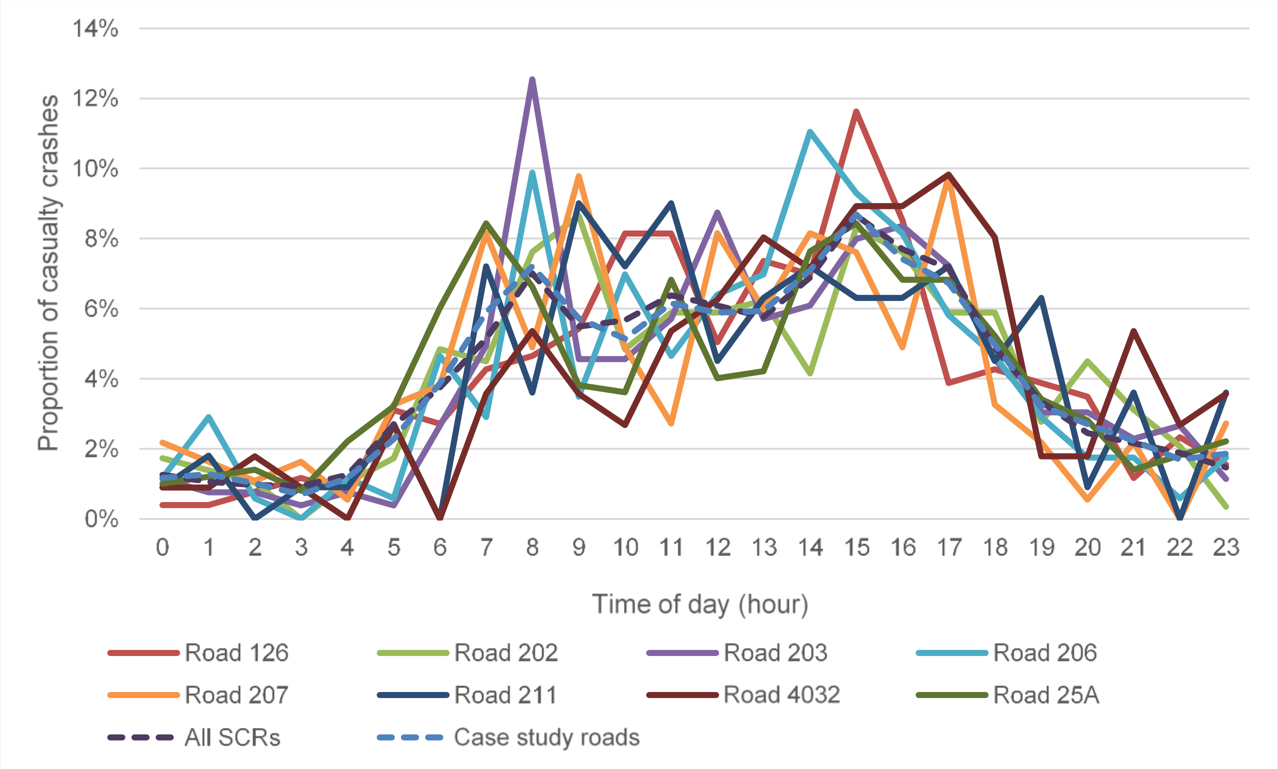
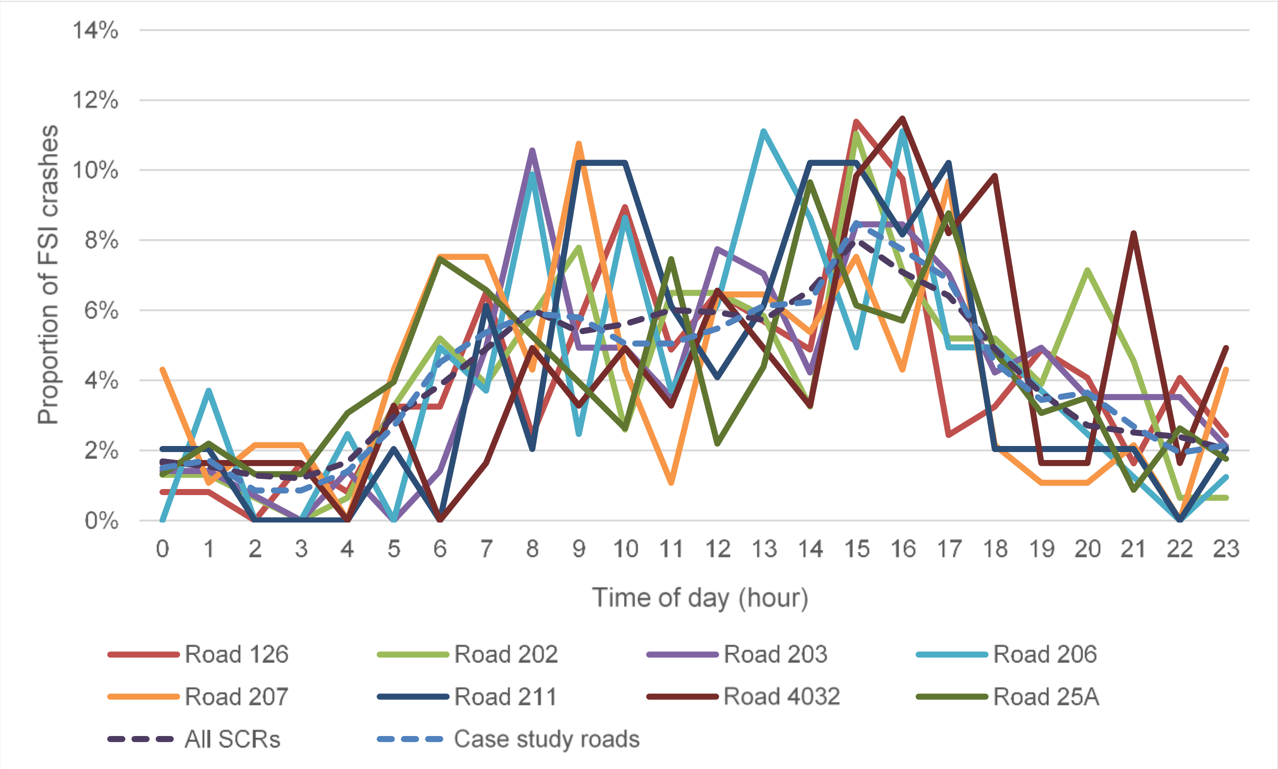


Figure A 10: Hourly FSI crashes by road



A.4 Crashes by Speed Limit – Individual Study Roads

Figure A 11: Casualty crashes by speed limit

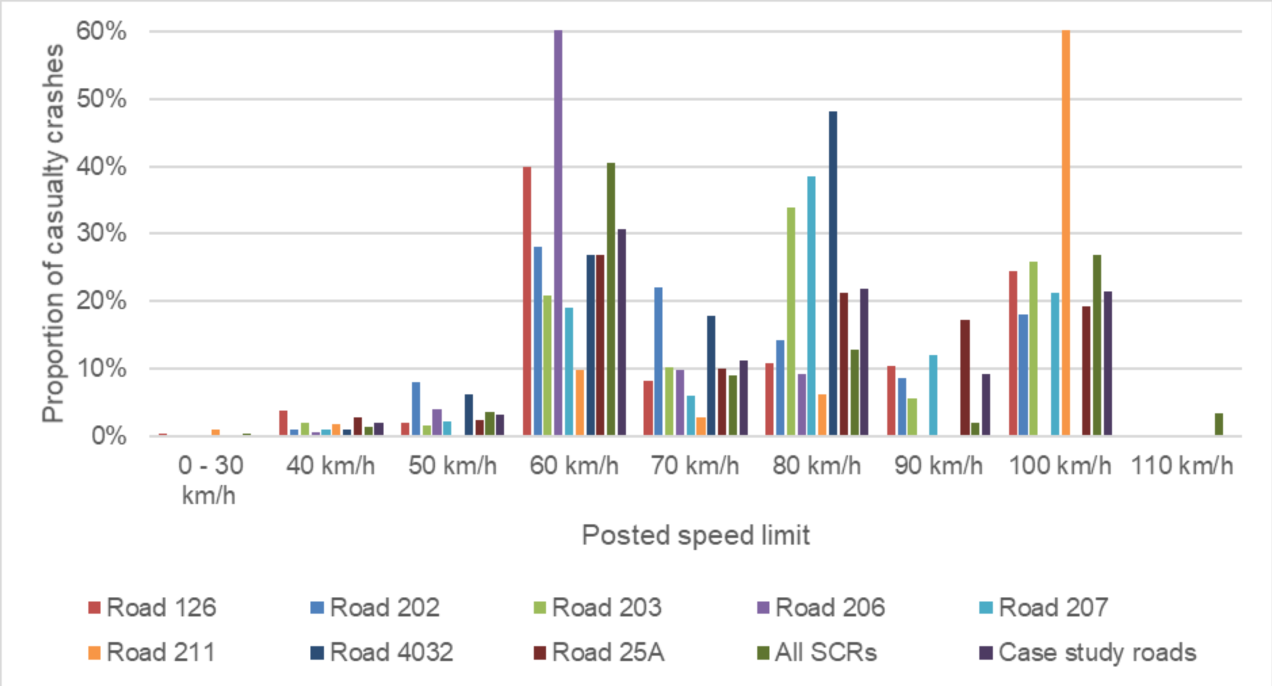
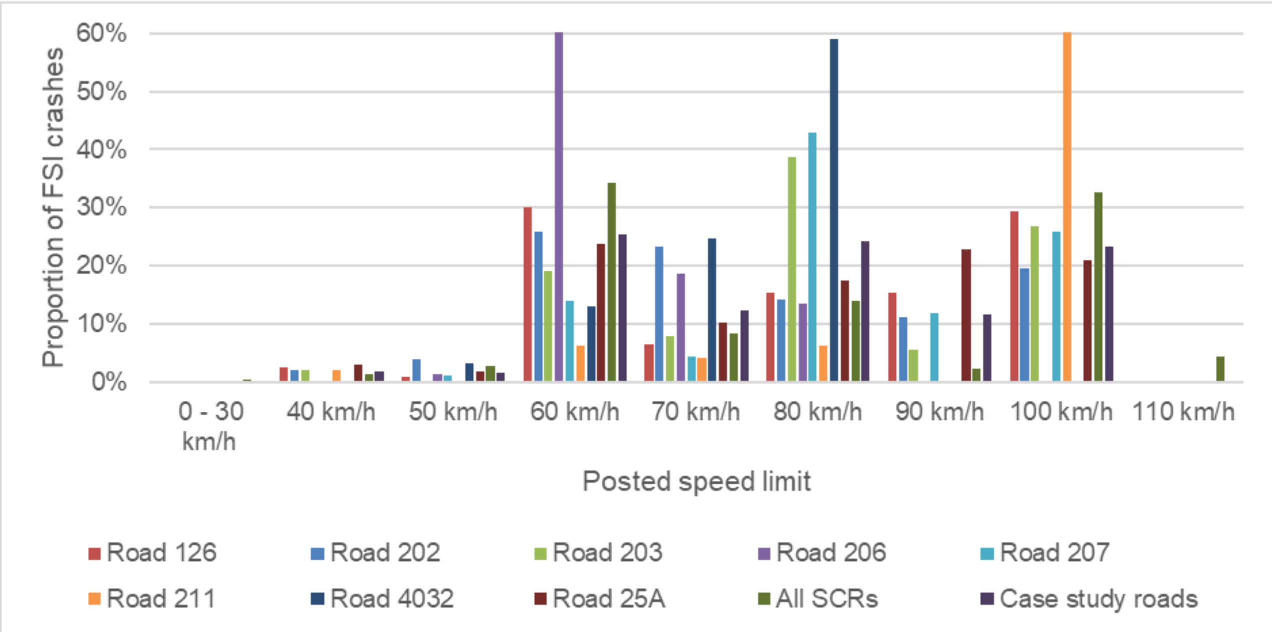


Figure A 12: FSI crashes by speed limit



A.5 Crashes by Road Feature – Individual Study Roads

Figure A 13: Casualty crashes by road feature by road

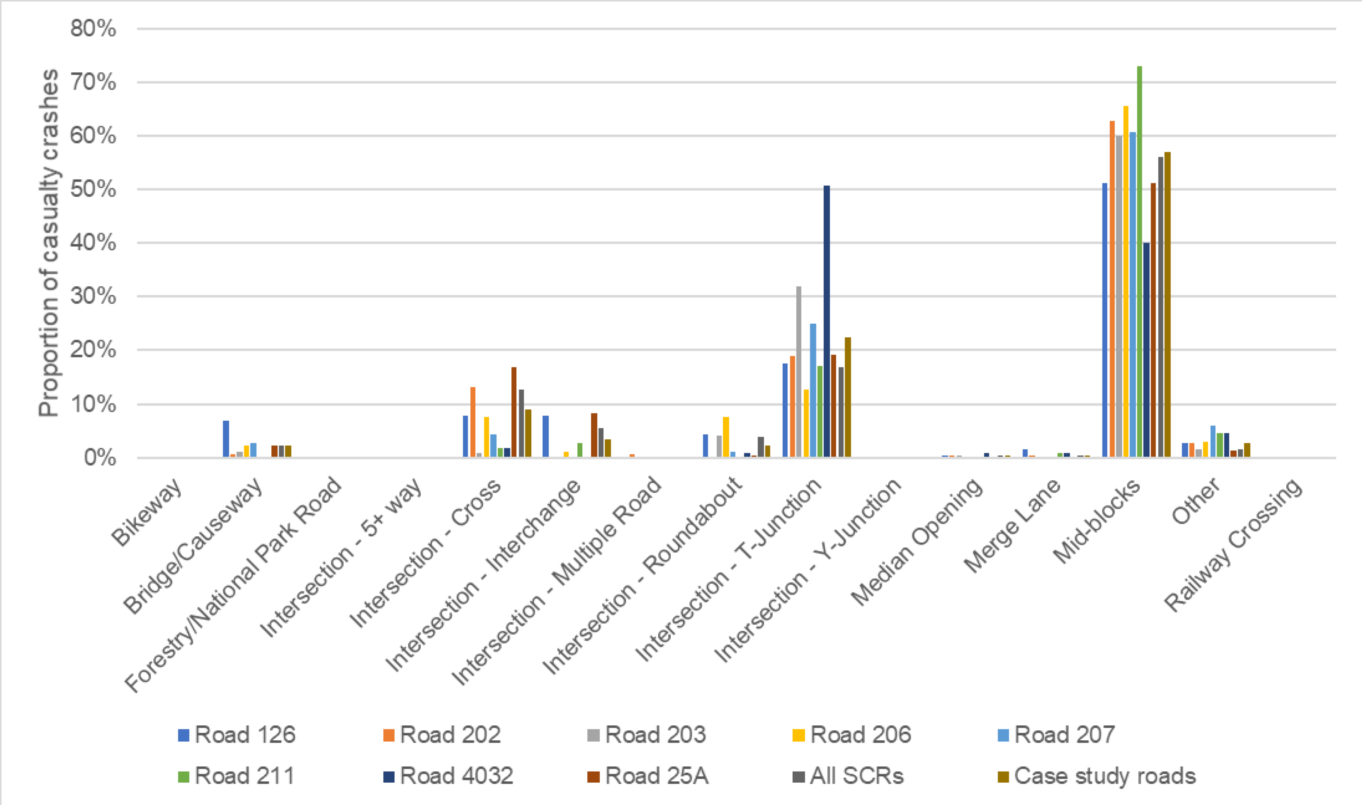
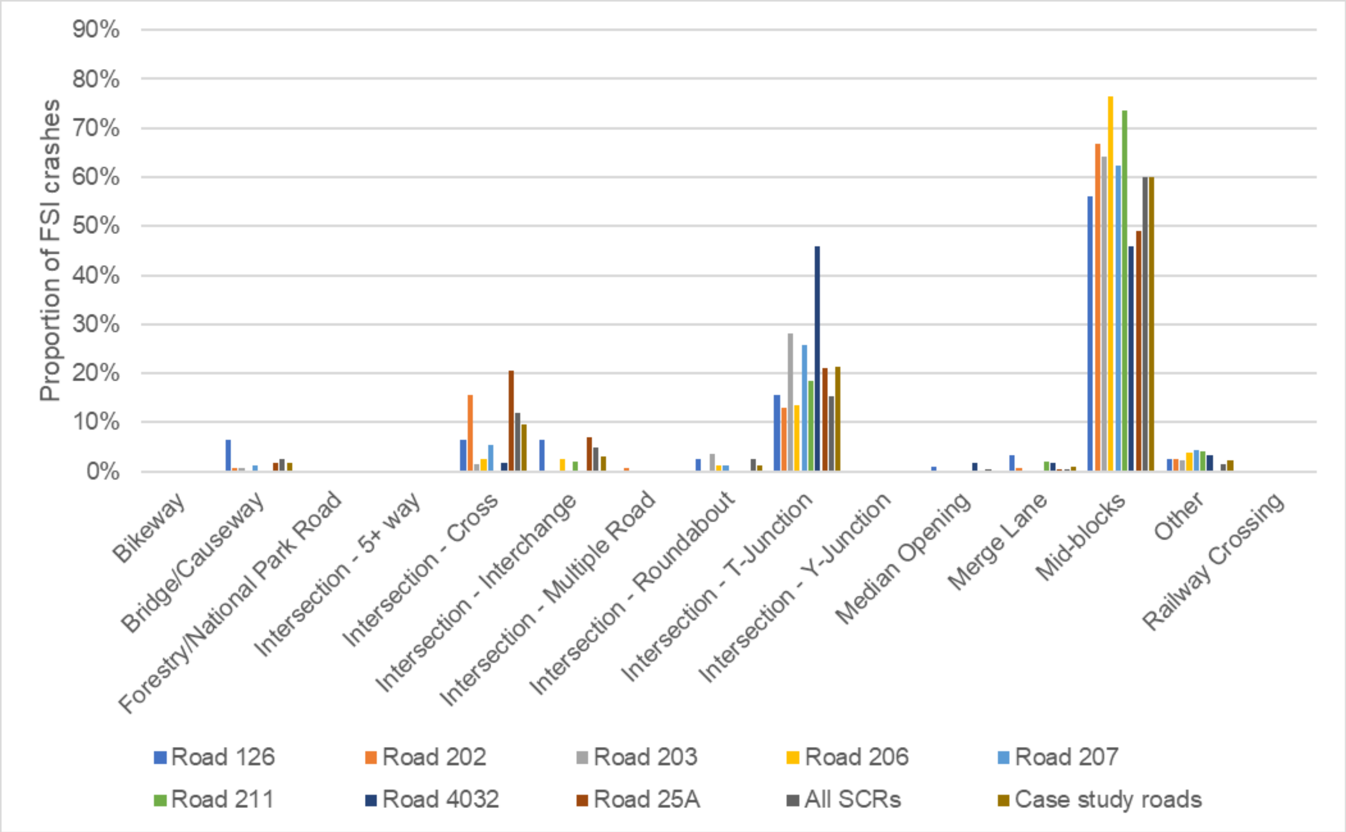


Figure A 14: FSI crashes by road feature by road



APPENDIX B STAKEHOLDER CONSULTATION

B.1 List of Attendees

Focus Group Meeting Attendees

Lachlan Moir (TMR)

Joseph Affum (ARRB)

Samantha Taylor (ARRB)

Sam Atabak (TMR)

Siva Jeevaratnam (TMR)

Martin Jones (TMR)

Pooya Saba (TMR)

Daniel Craig (TMR)

Janet Smith (TMR)

Planning Section List of Attendees

Lachlan Moir (TMR)

Joseph Affum (ARRB)

Samantha Taylor (ARRB)

Michael Gillies (TMR)

Daniel Johnson (TMR)

Andrew Martin (TMR)

B.2 Questionnaire and Responses

Urban Fringe Roads Questionnaire

ARRB is undertaking a study for Queensland Department of Transport and Main Roads to determine how the rising trend in crashes happening in the urban fringe, predominantly due to the increasing volumes on roads designed for lower volumes or original alignments, can be addressed. The purpose of the study is to identify how to manage urban fringe environments at a planning, development, design and operations stage to improve road safety outcomes.

The key challenges encountered within the urban fringe include:

- urban growth resulting from development of outer metropolitan areas
- increase demand on road networks
- increase in crashes occurring in these areas
- mix of land users e.g. industrial, residential, business, farming etc.
- change in mix of transport and mobility patterns
- roads were designed for lower traffic volumes.

The study has involved a literature review to determine current practice and whether there are specific treatments or guidelines available for urban fridge roads.

To supplement the literature review, ARRB has prepared the questionnaire below to determine how other road agencies deal with the urban fringe environment and what processes are in place to manage the transition between rural and urban roads from a road safety perspective.

Question 1: How do you manage the transition between rural and urban roads? Are road safety issues dealt with in a planned or ad hoc nature?
Answer 1: • Generally by reduced speed limit. Changes to linemarking, traffic lane width. (ACT) • Ad hoc (NT)
Question 2: Do you have any specific guidelines for the management of urban fringe roads e.g. guidelines for the implementation of treatments for urban fringe roads?
Answer 2: • No (ACT and NT).
Question 3: As development occurs, the number of property accesses and traffic volumes increase along the roads. Do you have any guidance/strategy in relation to the management of property access along roads, in particular within the urban fringe environment?
Answer 3: • Generally reduced speed limit. (ACT) • Yes, 'Development Guidelines' (NT)
Question 4: As development occurs in the urban fringe environment, roads approach capacity and ideally require duplication. Do you have AADT values you use to determine when a road should be duplicated (more in line with funding availability)?
Answer 4: • No. Generally follow relevant guides and standards. (ACT) • Austroads AADT values or LOS criteria. (NT)
Question 5: Do you use any treatments specific to urban fringe roads?
Answer 5:

• No. (ACT and NT)
Question 6: Do you have any particular criteria or triggers used to determine the timing of treatments for urban fringe roads i.e. cut of values you use for urban fringe roads? E.g.: • What cross-section is adopted? • What interim measures are used? • When do you upgrade intersections? • When do you provide cycle lanes on these roads? • When are footpaths and pedestrian crossing facilities installed?
Answer 6: • No. Generally use relevant guides and standards. (ACT) • No, generally determined on a case-by-case basis. (NT)

APPENDIX C SUMMARY OF FRAMEWORK

Urban Fringe Road Framework

ISSUE	IMPACT	RECOMMENDED ACTION	TRIGGER
AADT			
The road is experiencing an increase in traffic growth due to development (peak flows and/or AADT)	Inadequate road capacity	Undertake capacity analysis to increase number of lanes when at LOS D	LOS D
		Road duplication when AADT >15 000	AADT > 15 000
	Lack of overtaking opportunity	Determine if overtaking lanes are required based on AADT /overtaking opportunities	Based on analysis of AADT/overtaking opportunities
	Road feature becomes inappropriate for the new volume of traffic	Provide the following minimum requirements: → lane width 3.25 m → sealed shoulder width 1.0 m → good delineation including edge lines, centrelines, RRPM's, guideposts and lighting where appropriate → determine if overtaking lanes are required based on AADT /overtaking opportunities → intersections as recommended below	When classified an urban fringe road
Speed Limit			
As development occurs traffic volumes increase, land use changes, mix of traffic changes and access needs increase.	Speed limit becomes inappropriate for the traffic volumes, mix of road uses, surrounding land use and access requirements.	Posted speed limit should not exceed 80 km/h	When classified an urban fringe road
Crash Risk			
Head-on crashes have a higher risk of occurring on urban fringe roads	Increase in cross centreline head-on crashes	Install wide centreline treatment	AADT 4 000
		Install median turn lanes when the number of property accesses exceeds 20 / km	AADT > 4 000 and > 20 property accesses per km
	Increase in head-on crashes on curves	Curve treatments including widening, elimination of compound curves, CAMs	All sharp curves (radius 200 to 500 m)
Run-off-road crashes have a higher risk of occurring on urban fringe roads	Increase in run-off-road crashes due to curvature	Treat sharp curves (radius 200 to 500 m) including curve widening and realignment	All sharp curves (radius 200 to 500 m)
		Provide good delineation of curves including linemarking, guideposts, advanced warning signs, speed advisory signs and CAMs.	All sharp curves (radius 200 to 500 m)
	Increase in run-off-road crashes due to poor sight distance on curves	Provide clear sight distance at curves	All sharp curves (radius 200 to 500 m)
	Increase in run-off-road hit object crashes due to roadside hazards	Provide a 10 m clear zone/ buffer zone. Where hazards cannot be removed provide protection from the hazard e.g. safety barrier or use frangible posts.	Speed limits 70 km/h or more
	Increase in run-off-road crashes due to inadequate road shoulder	Provide a 1.0 m sealed shoulder	When classified an urban fringe road
Intersection crashes have a higher risk of occurring on urban fringe roads	Increase in intersection crashes due to inadequate intersection features	Provide right-turn provision at intersections	In accordance with TMR warrants and TMR's Roads Safety Policy
		Consider installing roundabout and signalised intersection where appropriate	Consider where appropriate
		Consider left in and left out intersection treatment where appropriate	Consider where appropriate
		Intersection should be appropriately delineated so they are clearly visible on all approaches	Consider where appropriate
		Provide required sight distances on all approaches	When classified an urban fringe road
Access			
As development occurs there is an increase in the number of property accesses along the road.	Higher risk of property access crashes occurring	Provide median turn lane when the number of property accesses exceeds 20 / km	AADT > 4 000 and > 20 property accesses per km
		If unable to provide median turn lane reduce the speed limit.	AADT > 4 000 and > 20 property accesses per km and unable to provide median turn lane.
As traffic volumes increase it is more difficult to gain access into and out of properties.	Higher risk of property access crashes occurring	Case-by-case assessment considering the available options including preventing access via median, prohibiting movements and providing alternate U-turn opportunities close by, sight distance improvements, consolidation of accesses.	Case-by-case basis
		If unable to provide median turn lane reduce the speed limit.	If unable to provide safe access then reduce the speed limit
Road Users			
Urban fringe roads need to cater for a range of road users and be able to provide for through traffic and some level of local access.	Increased number of heavy vehicle interacting with vulnerable road users	A heavy assessment should be undertaken to determine specific treatments required to improve heavy vehicle safety.	When classified an urban fringe road
	Increased demand for cycling facilities	On-road cycling facilities are not recommended along urban fringe roads. Provide alternate on-road cycling routes or dedicated cycle paths.	Based on demand
	Increased demand for pedestrian facilities	Assess pedestrian demand to determine the need for footpaths and crossing facilities in accordance with the relevant standard.	Based on demand
	Increased demand for motorcyclists facilities	Provide motorcycle friendly treatments along known motorcycle routes or where the proportion of motorcyclists > 5%. All new installation of road safety barriers shall be fitted with motorcyclists injury countermeasures as per TMR's Road Safety Policy.	If known motorcycle route or proportion on motorcyclists >5%. All new safety barriers to be fitted with motorcyclists injury countermeasures.