

**Development of new strategic directions for the
automated traffic enforcement program in WA**

**Point to Point Safety Camera Zones in Western
Australia: Candidate Locations**

C-MARC

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Abstract

The aim of this project is to use the outcomes from the evaluation of the WA ATE program to provide further strategic directions for expansion and optimisation of the program. Through leveraging the extensive data set on camera operations and crash outcomes developed for the ATE evaluation, the project will address the following objectives

1. To provide additional insight into optimal operating practices for mobile speed cameras in terms of site coverage and revisitation frequency.
2. To examine the potential for the use of point to point camera systems in both metropolitan Perth and regional WA in order to build upon the current trial of this technology.
3. To explore the potential road safety and economic benefits associated with various strategic expansions of the program, building on the original strategic work of Cameron (2006), which has informed expansion of the program to date, but refined through use of estimates of camera effectiveness specific to WA derived from the completed ATE evaluation.

This report gives the outcomes from Stage 2 of the project examining potential sites for additional point to point speed camera systems in W.A.

Keywords

Speed Camera, Crash, Injury, Statistical analysis, GIS

Disclaimer

This report is disseminated in the interest of information exchange. The views expressed here are those of the authors and not necessarily those of Curtin University or Monash University.

Preface

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Contributorship Statement

BL – crash and GIS analysis, report preparation

SN – Project specification and manuscript review

Ethics Statement

Ethics approval was not required for this project.

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EXECUTIVE SUMMARY

Lower and safer vehicle speeds is central to the Government of Western Australia's road safety strategy. The Automated Traffic Enforcement program has been established to effect speed reductions on state roads, and additional *safety camera zones* are being considered. A workshop was initiated by the Road Safety Commission of Western Australia, to resolve the criteria against which potential sites for safety camera zones should be assessed. The workshop attendees resolved that the crash history of a road or section of road was of principal concern. In particular, the number of killed or serious injury (KSI) mid-block crashes per kilometre, and the sum of crashes weighted by severity per kilometre. The need to evaluate sites based on more specific 'secondary' criteria (e.g. available infrastructure, administrative conditions) was also raised.

This report presents an evaluation of potential state roads across Western Australia against the primary criteria (crash history), and recommends sections of roads that may be considered for safety camera zones. The candidate locations are presented as roads, roads demarcated by Local Government Area boundaries (road sections), and road sections by region (metropolitan and regional). The 5 year crash history (2011 to 2015) was assigned to each road or road section, and expressed as KSI crashes per kilometre, and the sum of weighted crashes per kilometre. The distribution of crashes along the road, and the average speed profile along metropolitan road sections was also considered.

The Mitchell Freeway, Graham Farmer Freeway, and the Kwinana Freeway were the highest ranked roads against the two crash metrics. The Mitchell Freeway was the highest ranked road, with 4.9 KSI crashes per kilometre between 2011 and 2015. The sum of weighted crashes along the Mitchell Freeway was of 214, which was 72% higher than the second highest ranked road, the Graham Farmer Freeway. The linear distribution of crashes along the Mitchell Freeway and the Kwinana Freeway, clearly indicated a reduction in the number of crashes travelling away from Perth. Half of the KSI crashes along the Mitchell Freeway occurred in the first 12 kilometres (of around 30 kilometres), and within the first 14 kilometres of the Kwinana Freeway (of around 70 kilometres). The linear distribution of crashes along the shorter Graham Farmer Freeway indicated two peaks in crashes near the Mitchell Freeway interchange and across the Swan River Bridge.

The road sections that ranked highest against the KSI crash history were different to those ranked highest against the sum of weighted crash history. Consistent between the two, was the Mitchell Freeway in Cambridge and Stirling. The five road sections that ranked highest on both criteria (product of ranking), were the Mitchell Freeway, Cambridge; the Mitchell Freeway, Stirling; the Kwinana Freeway, South Perth; the Kwinana Freeway, Melville; and the Kwinana Freeway, Cockburn. The Graham Farmer Freeway, Belmont, was ranked 4th highest on KSI crashes per kilometre.

The non-metropolitan road sections that ranked highest against the KSI crash history were similar to those ranked highest against the sum of weighted crash history. State roads in Bunbury feature most prominently, and three of the five road sections that ranked highest on both criteria (product ranking), were the Forrest Highway, Boynaip-Picton Road, and the Bussell Highway. The effectiveness of point-to-point speed cameras on these road sections is limited by the number of signalised at-grade intersections. The Forrest Highway, Dardanup, was ranked 3rd highest on both crash metrics, and there are sections that are currently uninterrupted by signalised at-grade intersections.

The findings of this evaluation indicate that an evaluation of the secondary criteria for safety camera zones should first be undertaken for the Mitchell Freeway incorporating at least Cambridge and Stirling, and second, the Kwinana Freeway in South Perth, Melville, and possibly Cockburn. Given the high ranking of the Graham Farmer Freeway, it may prove beneficial for this to be included in at least the Mitchell Freeway safety camera zone. Together, they represent approximately 7.8% of all KSI crashes on state roads.

POINT TO POINT SAFETY CAMERA ZONES IN WESTERN AUSTRALIA: CANDIDATE LOCATIONS

1. INTRODUCTION

1.1 AIM AND SCOPE

The Government of Western Australia's road safety strategy sets a target to reduce the number of persons killed or seriously injured on Western Australian roads by 40 per cent by the year 2020. Lower and safer vehicle speeds is central to the strategy, and the Automated Traffic Enforcement (ATE) program has been established to expand existing mobile and fixed speed and red-light cameras in Western Australia, and administer speed reduction systems new to the state.

As part of the ATE program, the state Government is trialling its first *safety camera zone* on the Forrest Highway using a point-to-point speed camera system. This system uses licence-plate recognition technology to calculate the average speed of individual vehicles between two points, and then indicate if this speed exceeds a designated limit. The system technology and administrative processes are currently being tested, and the proposed launch date for the Forrest Highway system is 3 July 2017.

The Roads Safety Commission of Western Australia is the states lead road safety agency responsible for scoping the ATE program. In this role, the Road Safety Commission initiated a workshop to establish criteria against which candidate safety camera zones will be assessed. This report uses these criteria to identify sections of state roads in Western Australia that may be considered for new safety camera zones, using a point-to-point camera system.

1.2 CRITERIA

The crash history was identified as the primary factor when considering new safety camera zones. It was recommended the crash history be calculated over 5 years, and preferably a 10 years, and expressed as:

- a. All non-intersections crashes
 - i. Number of killed and serious injury crashes per kilometre
 - ii. A sum of crashes weighted by severity per kilometre
 - Fatal (16)
 - Hospital admission (8)
 - Medical attention (3)
 - Major property damage only (1)
 - Minor property damage only (1)

Secondary factors were identified in the workshop, and whilst not incorporated in this report, these included considerations such as school zones, police intelligence, community complaints, historic speed data, and regional priority.

2. METHOD

2.1 OVERVIEW

The candidate locations for safety camera zones were largely identified through analysis of non-intersection crashes over a 5 year period (2011 to 2015). In addition to the crash history, the evaluation considered the linear distribution of crashes across candidate road sections. This was to identify if a fixed speed camera system (or similar) may be more suitable than the introduction of a safety camera zone.

This report presents candidate locations on highway and motorway roads only, and these are defined across three levels. First, by road number only (road), road number and local government area (road section), and by road section and region (i.e. metropolitan, non-metropolitan). The data used to arrive at the recommendations were largely accessed from the Western Australia Open Data website.

2.2 ASSIGNING CRASHES

2.2.1 Crash data

Crash data were obtained from the Open Data website, for the 5 year period 2011 to 2015 (inclusive). Crashes occurring in mid-block were identified using the attribute *Acc_Type*, which had values ‘midblock’ and ‘intersection’. The crash severity was identified using the attribute *Severity*, which in order of severity had the values ‘fatal’, ‘hospital’, ‘medical’, ‘property damage only (minor)’, and ‘property damage only (major)’. Where geospatial analysis was required, the crash data were downloaded from the Open Data website in vector format, and the geolocation of crashes were described in projected coordinate system GCS GDA 1994 Zone 50 (Perth central).

2.2.2 Roads

The crash data included the attribute *Road_No*, which was used to identify the road number assigned to each crash. All roads with the prefix ‘H’ or ‘M’ were included in the evaluation. It was noted that highway ramps are assigned a number different to the highway but with an ‘H’ prefix. These were included in the analysis, but not in the recommendations.

2.2.3 Road sections

The crash data included the attributes *Lat* and *Long*, which were used to locate the crash and pair it with the nearest Local Government Area using geospatial techniques. Local Government Areas were obtained in vector format from the Australian Bureau of Statistics digital library, which was last updated in 2011.

Some roads in Western Australia form the boundary between Local Government Areas. Where this occurred, crashes were allocated to one or the other (where there were a significant number). This was performed manually. Crashes occurring above waterways and not within a Local Government boundary (e.g. Swan River Bridge) were allocated to the nearest Local Government Area.

2.2.4 Region

Crashes occurring on a road in a metropolitan Local Government Area were identified by with reference to a list on Wikipedia.

https://en.wikipedia.org/wiki/Local_government_areas_of_Western_Australia.

2.3 CRASH RATE AND DISTRIBUTION

The crash data included the attribute *SLK*, which identified the chainage of the crash along the road. This was used to estimate the length of road (maximum and minimum *SLK* value) so to arrive at a crash rate per unit distance (per kilometre). The *SLK* values were also used to describe the linear distribution of crashes along the road and road sections.

2.4 MOTOR-VEHICLE SPEED

Speed data were obtained in vector format from the Network Operations Traffic Data MRWA suite, available through the Western Australia Open Data website. Speed data were available for all freeway and major arterial roads in the Perth metropolitan area, and were expressed as time mean speeds in 15 minute intervals across the period 1 July 2015 to 30 June 2016. Several speed measurements were available for each road and road section.

The medium and 85th percentile of all average speed measurements was used to indicate the speed profile of the road and road section, and for comparison to the posted speed limit. An additional measure of speed for all freeway and major arterial roads in the Perth metropolitan area was calculated. This was based on the average of all 15 minute average speed measurements between 12:00 and 13:00, on each weekday during November 2015.

3. RESULTS

3.1 CRASH HISTORY

3.1.1 Roads

The state roads with the highest number of reported crashes, independent of length, were The Albany Highway (H001), Kwinana Freeway (H015), Waneroo Road (H035), Great Eastern Highway (H005), and the Mitchell Freeway (H016). Together, they represent 12.4% of the total crashes with a reported road number, and 43.7% of all state roads. Intersections along the Albany Highway (H001), Waneroo Road (H035), and the Great Eastern Highway (H005) are predominantly at-grade, where intersections along the Kwinana Freeway (H015) and the Mitchell Freeway (H016) are predominantly grade separated. This is reflected in the ratio of intersection to midblock crashes, where nearly all crashes on the H015 and H016 were reported to be at midblock (see Figure 3).

There were seven roads with a 5 year crash history of 2 or more KSI crashes per kilometre. Three were short sections of road or highway ramp (H034, H775, and H024) (see Figure 4). The remaining four were the Mitchell Freeway (H016), Graham Farmer Freeway (H020), Kwinana Freeway (H015), and South Street (H032). The Kwinana Freeway (H016) had the highest number of midblock crashes per kilometre (130 per km), and the highest number of KSI crashes (5 per km). The weighted sum of crashes on the Mitchell Freeway was also markedly higher (214) than that that of the second highest (Graham Farmer Freeway, 124), (see Figure 5).

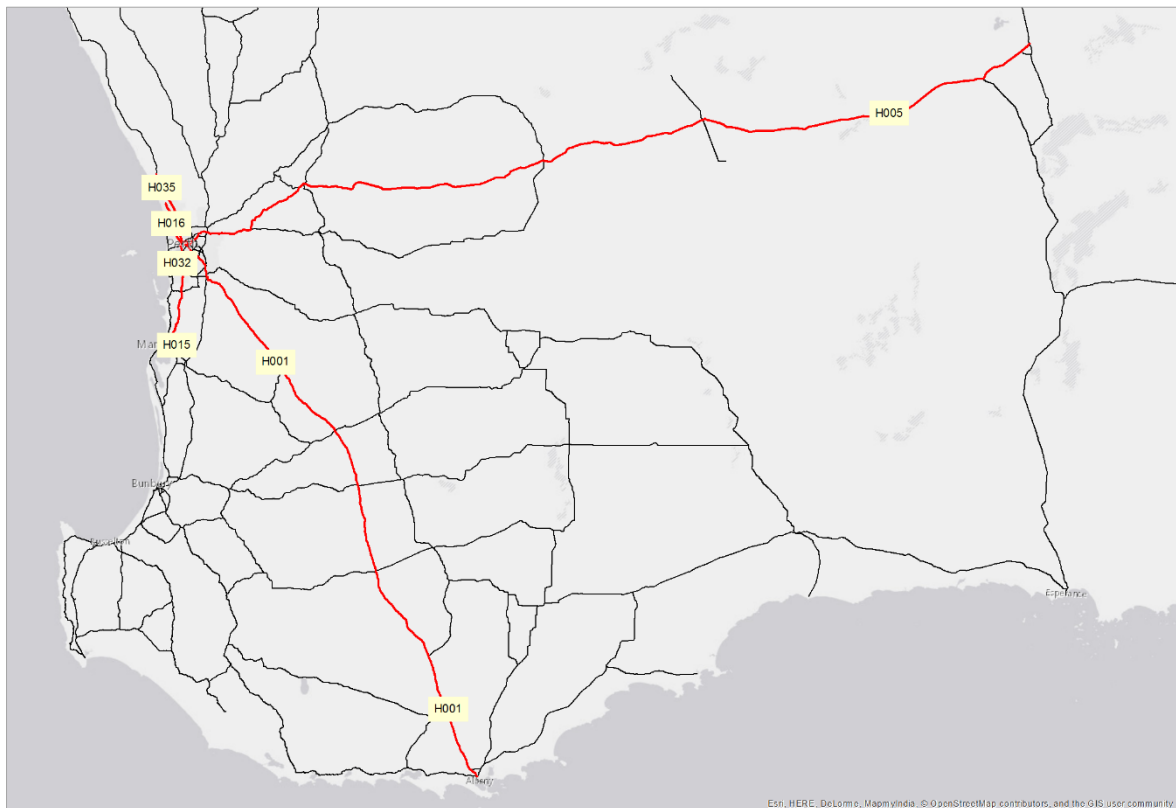


Figure 1
Roads with a high crash history



Figure 2
Roads with high crash history (Perth)

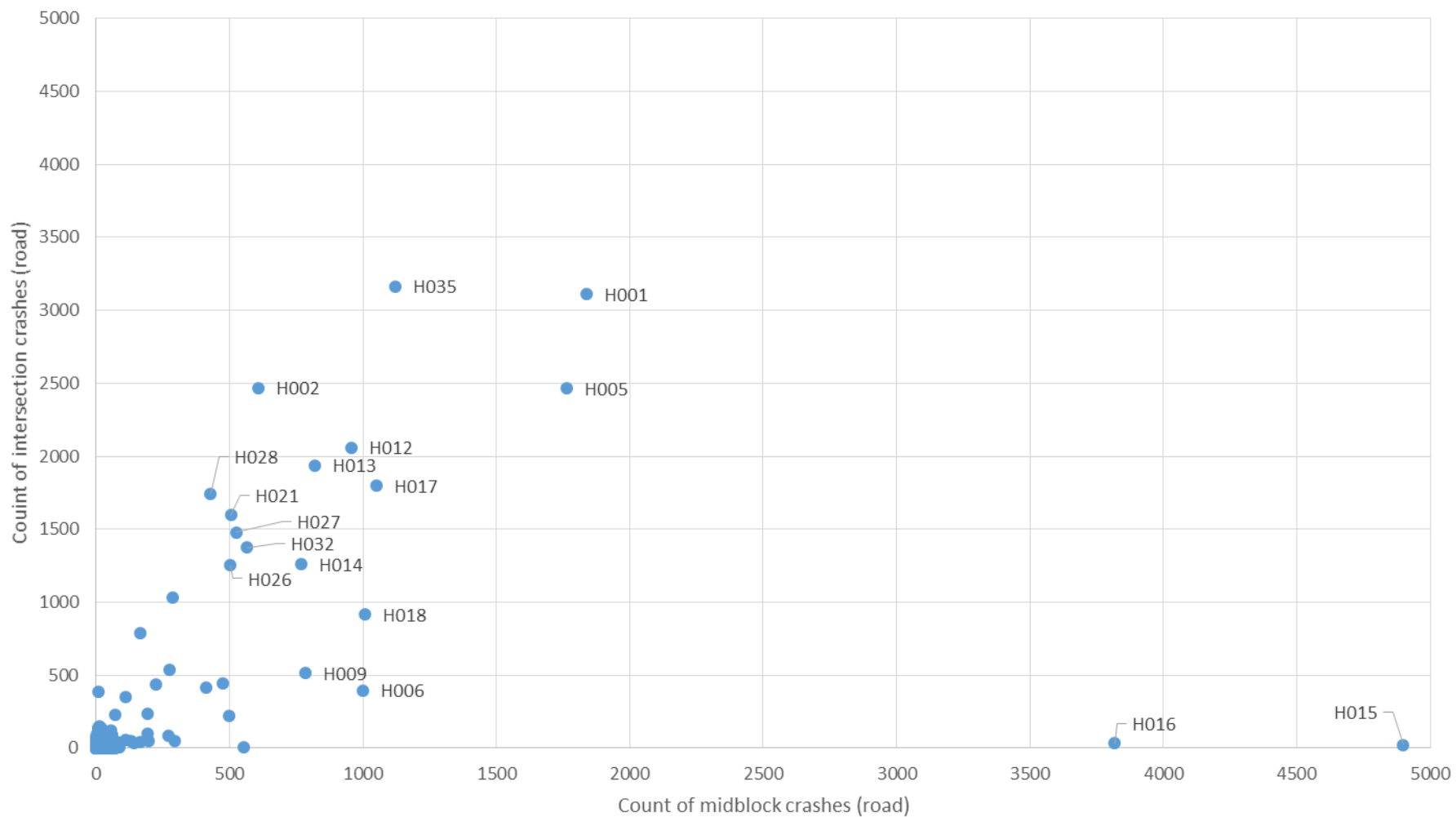


Figure 3
 Mid-block and intersection crash ratio; roads

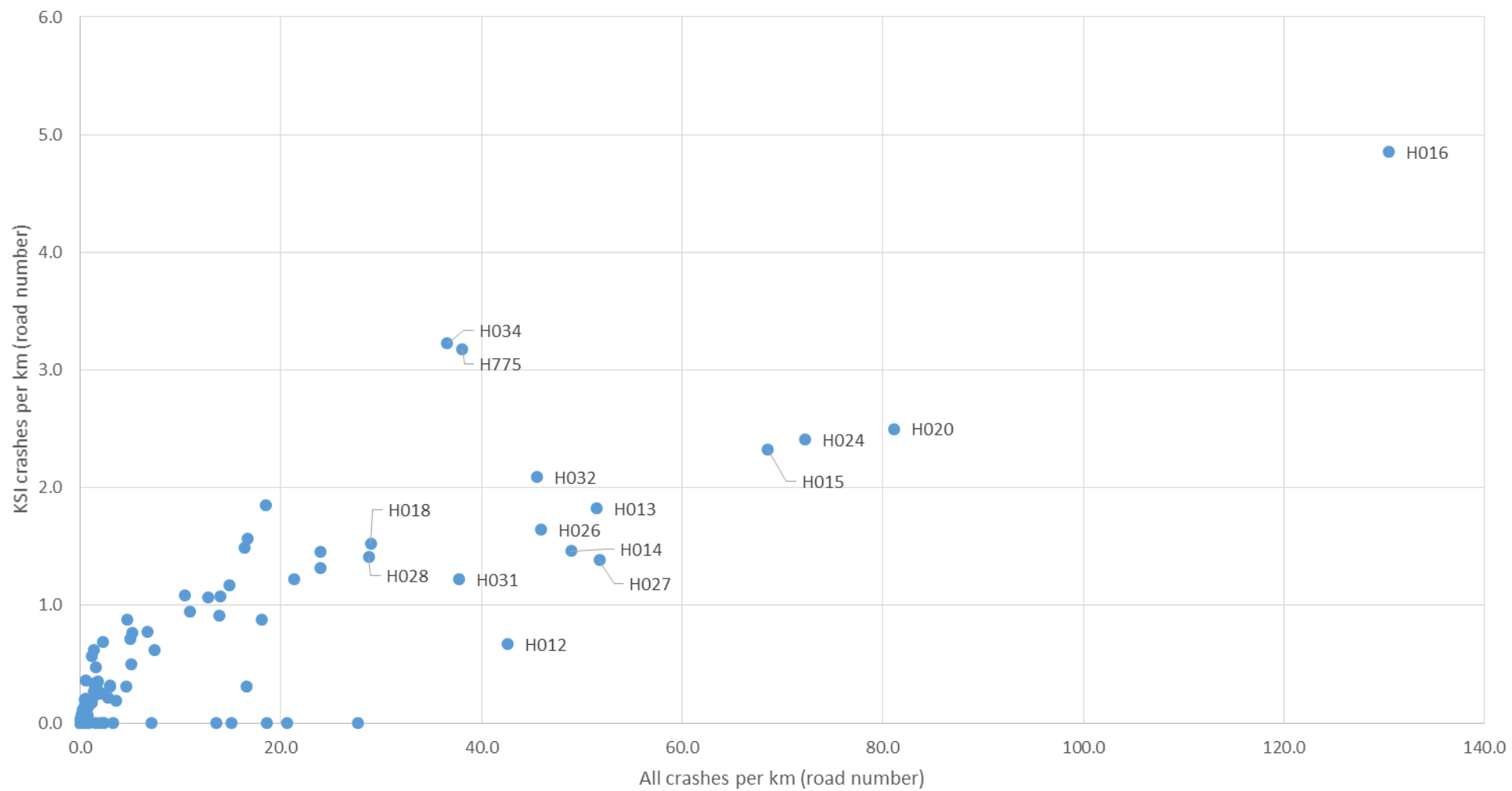


Figure 4
All crashes and KSI crashes (per km); roads state-wide

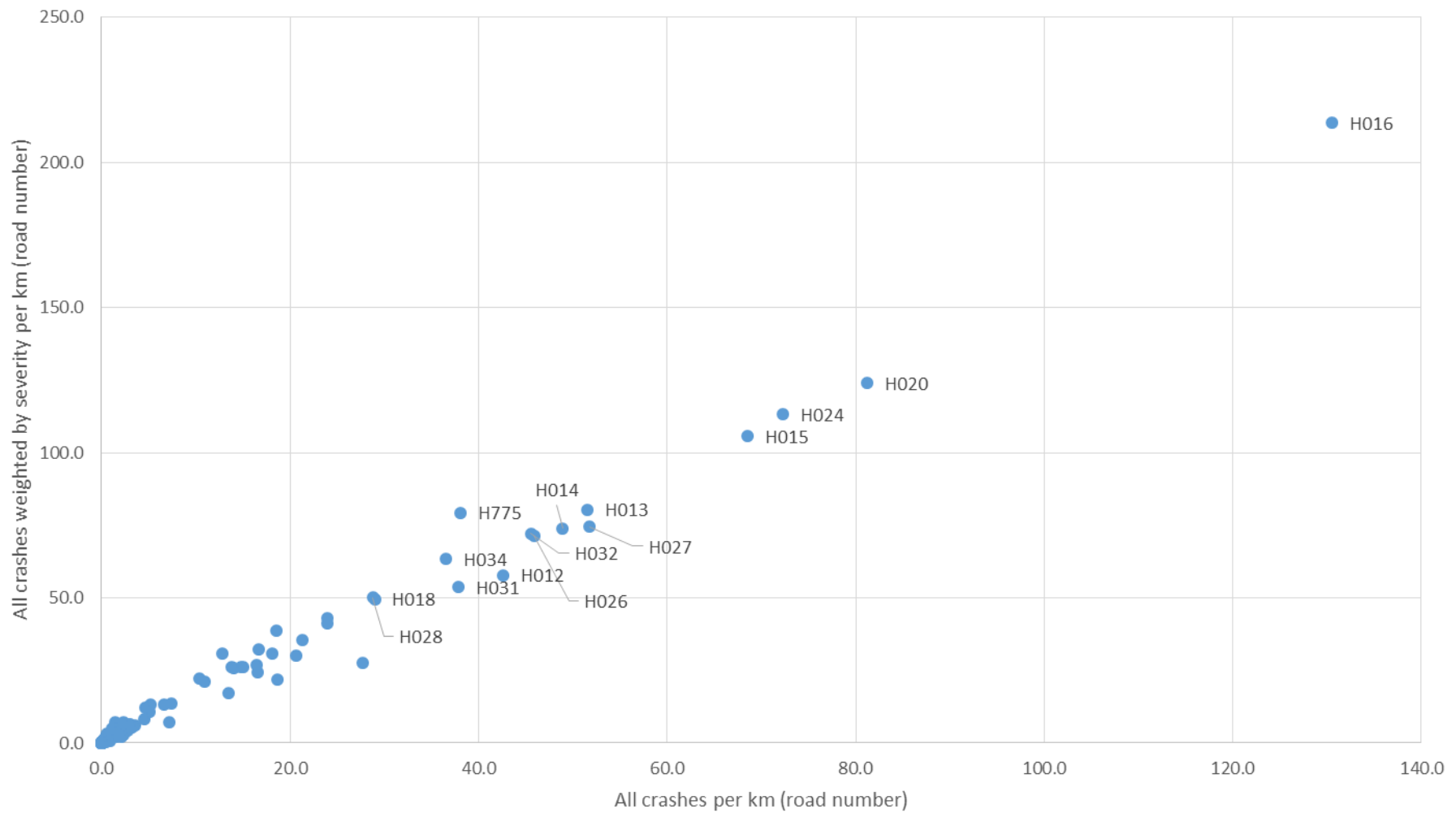


Figure 5
All crashes and weighted sum of crashes (per km); roads state-wide

3.1.2 Road sections

The five road sections with the highest number of reported crashes independent of length, were the Kwinana Freeway (H015) in Cockburn, South Perth, and Melville; and the Mitchell Freeway (H016) in Stirling, and Cambridge (not in order). Together, they represent 23.0% of the total crashes on state roads by road section. These remained in the top seven road sections with the highest number of KSI crashes per kilometre. The two additional road sections with high KSI crash rates were Graham Farmer Freeway (H020) in Belmont, and the Mitchell Freeway (H016) in Joondalup (see Figure 8).

The highest number of KSI crashes per kilometre were on the Mitchell Freeway (H016) in Stirling (6.3), and in Cambridge (6.2), and the Kwinana Freeway (H015) in South Perth (5.2). The weighted sum of crashes per kilometre was highest on the Mitchell Freeway (H016) in Cambridge, then a similar number reported on the Kwinana Freeway (H015) in Perth, and the Mitchell Freeway (H016) in South Perth (see Figure 9).

There were differences in the road sections with the highest number of KSI crashes, and weighted sum of crashes. Specifically, the road section on the Mitchell Freeway (H016) in Perth was not highly ranked on the KSI metric, yet was on the sum of weighted crash metric. In contrast, the road section on the Mitchell Freeway in Stirling had the highest number of KSI crashes per kilometre, but was only the fifth highest when the crashes were weighted. This reflects the different distributions across crash severity, in particular the different proportion of crashes requiring hospitalisation (KSI, weighted 8) and medical attention (non KSI, weighted 3).

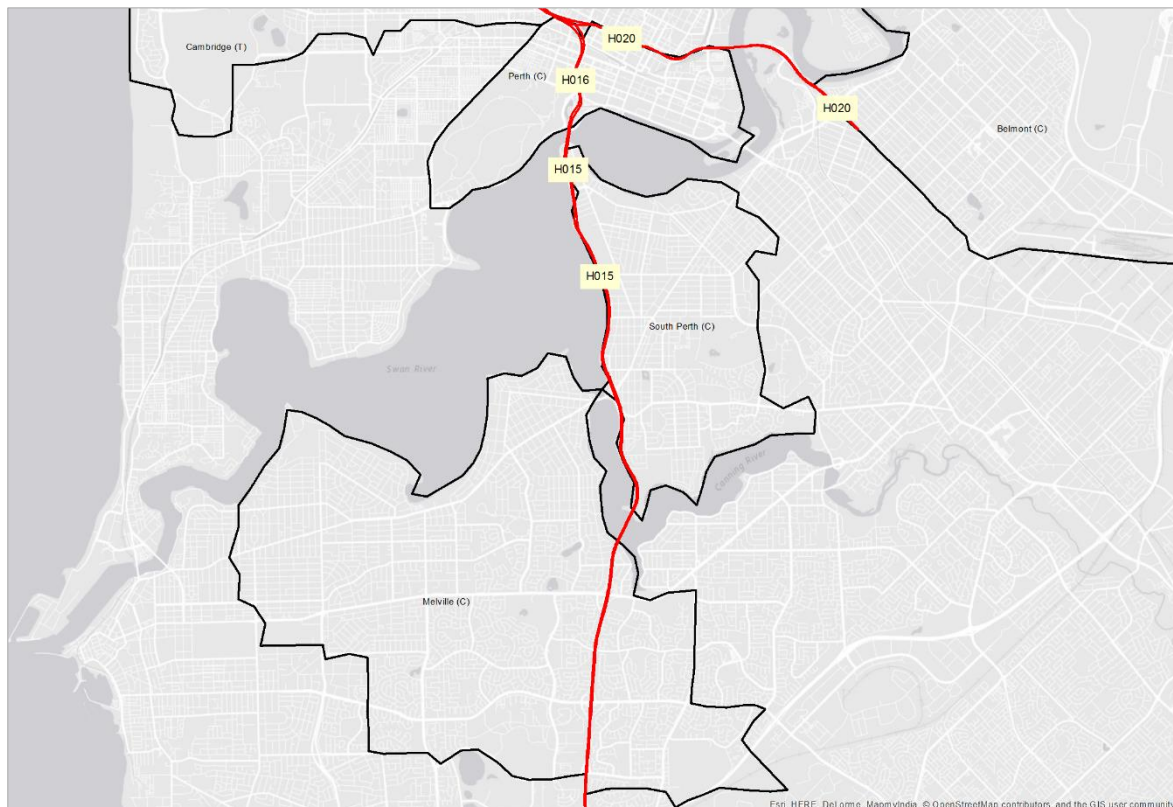


Figure 6
State road sections with high crash history (Perth and south)



Figure 7
State road sections with high crash history (Perth and north)

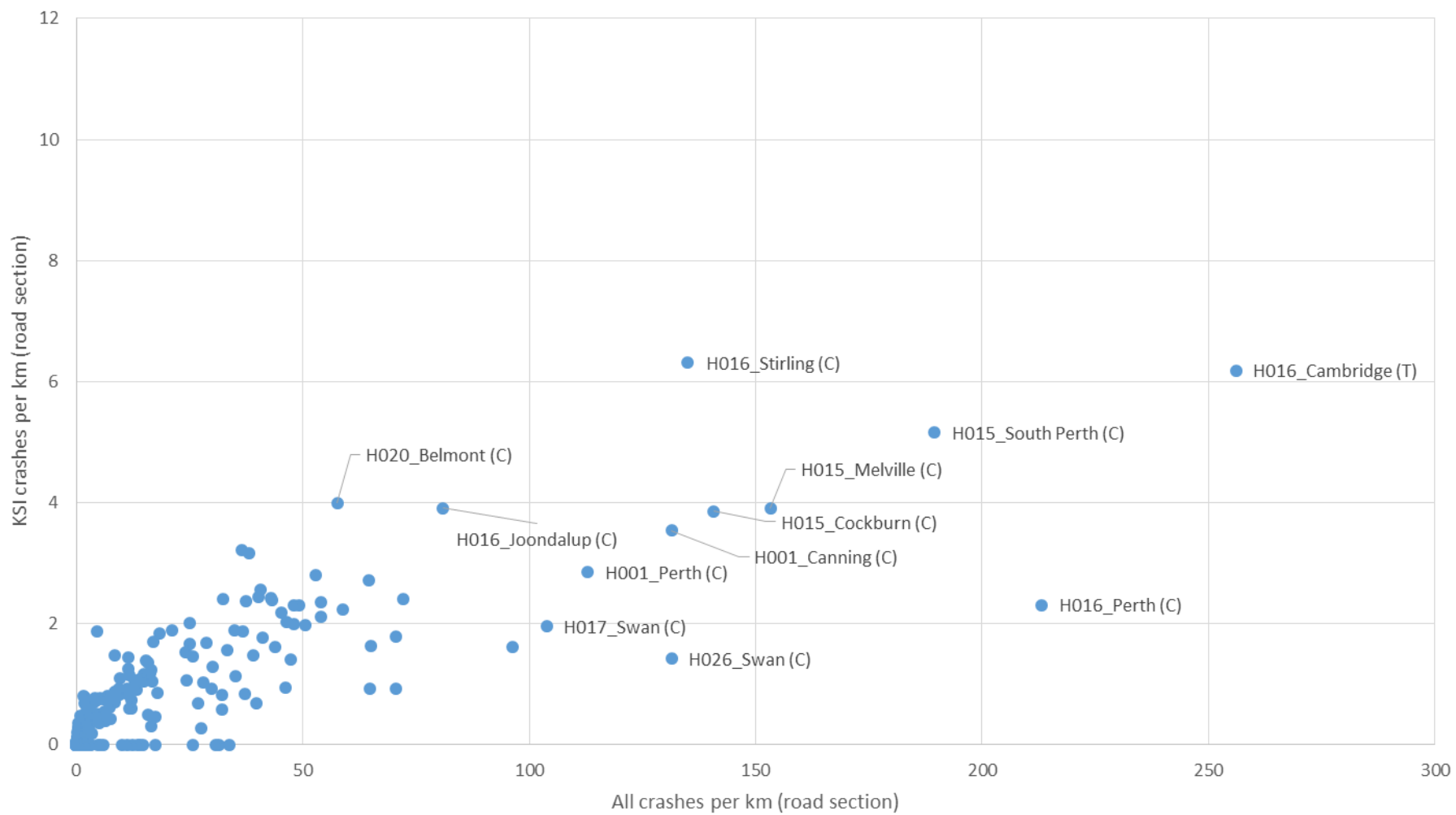


Figure 8
All crashes and KSI crashes (per km); road sections state-wide

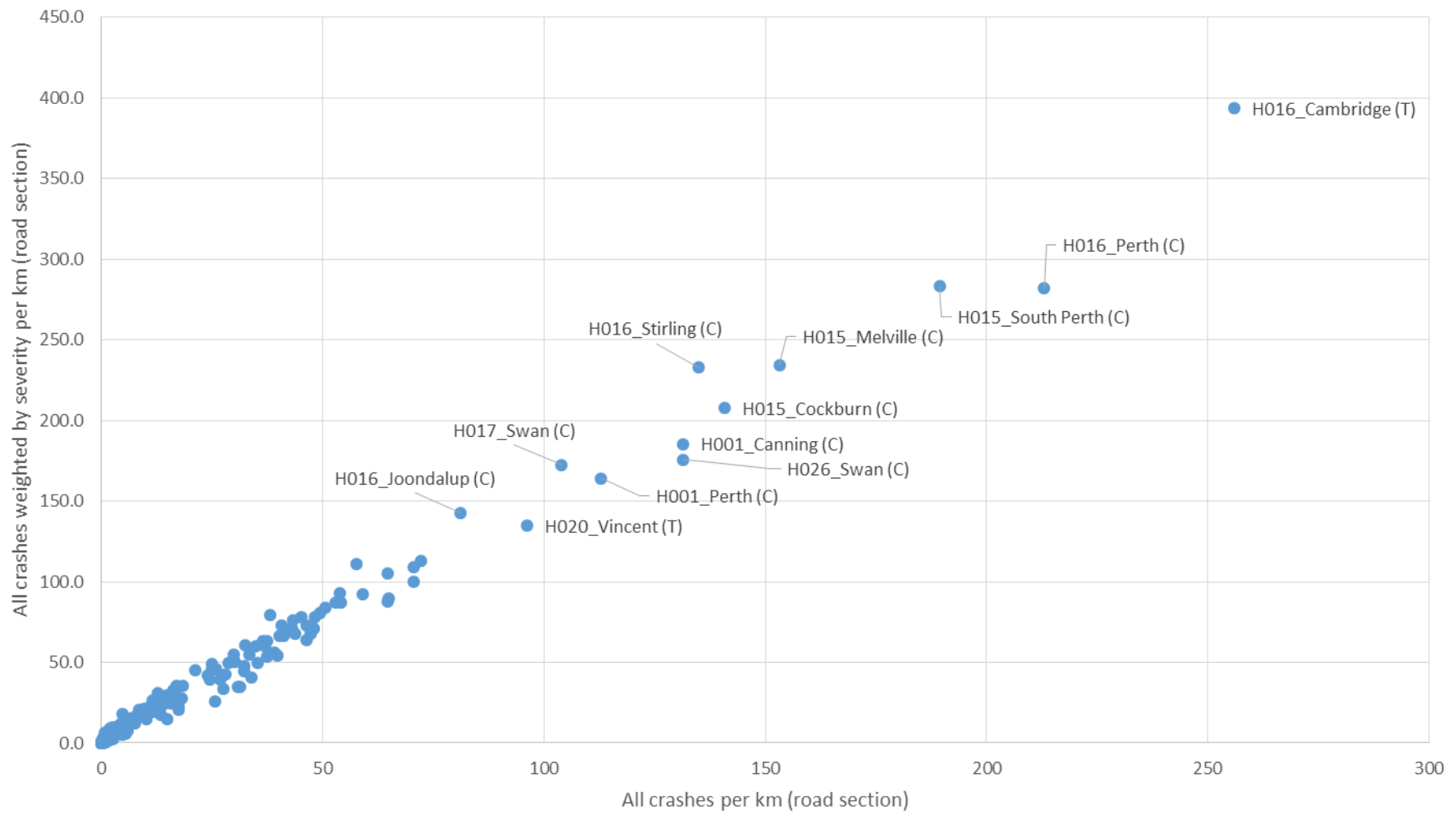


Figure 9
All crashes and weighted sum of crashes (per km); road sections state-wide

3.1.3 Road sections non-metropolitan

Three of the top five non-metropolitan road sections with the highest number of KSI crashes per kilometre were in Bunbury (see Figure 12). These were along the Boyanip-Picton Road (M052), the Forrest Highway (H057), and the Bussell Highway (H043). The other two were along the Forrest Highway (H057) in Darndanup, and the Melville-Mandurah Highway (H002) in Mandurah. The two road sections with the highest sum of the weighted crashes per kilometre were also in Bunbury. These were along the Forrest Highway (H057), and the Bussell Highway (H043). The next three road sections with the highest sum of weighted crashes were on the Forrest Highway (H057) in Darndanup, the Melville-Mandurah Highway (H002) in Mandurah, and Thomas Road (H038) in Serpentine-Jarrahdale (see Figure 13).

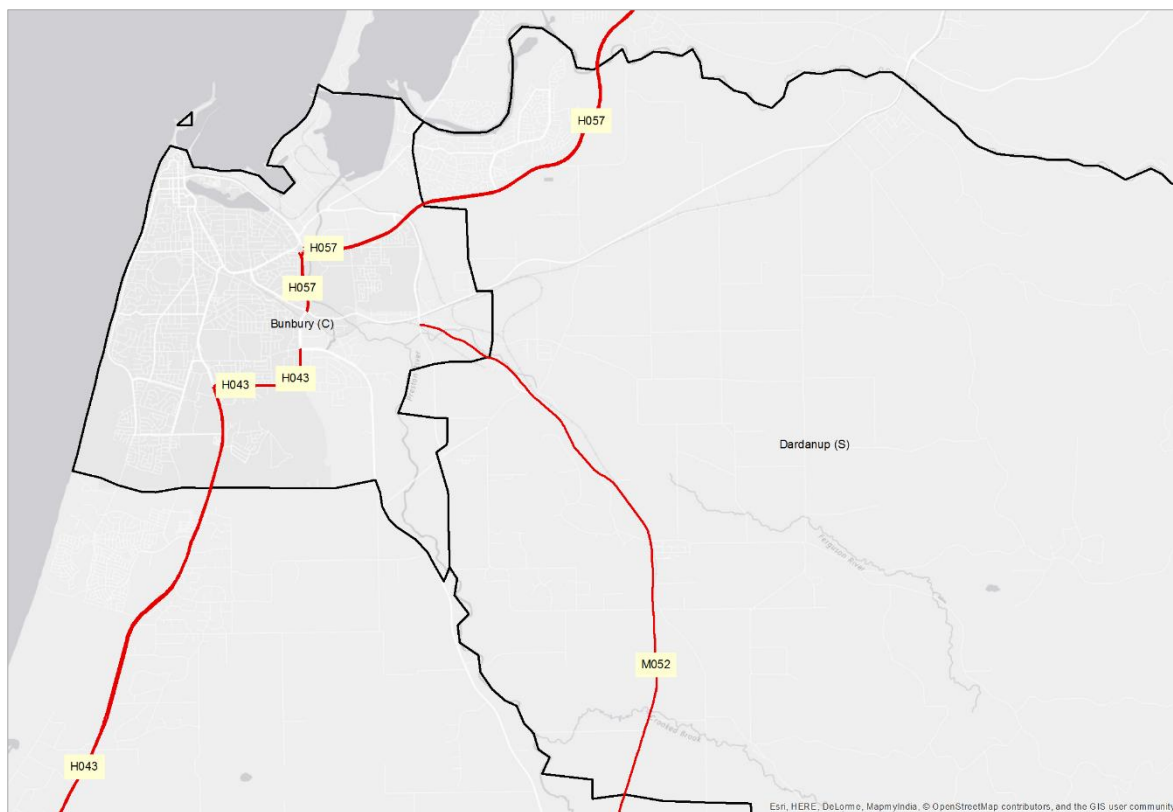


Figure 10
Non-metropolitan state road sections with high crash history (1)

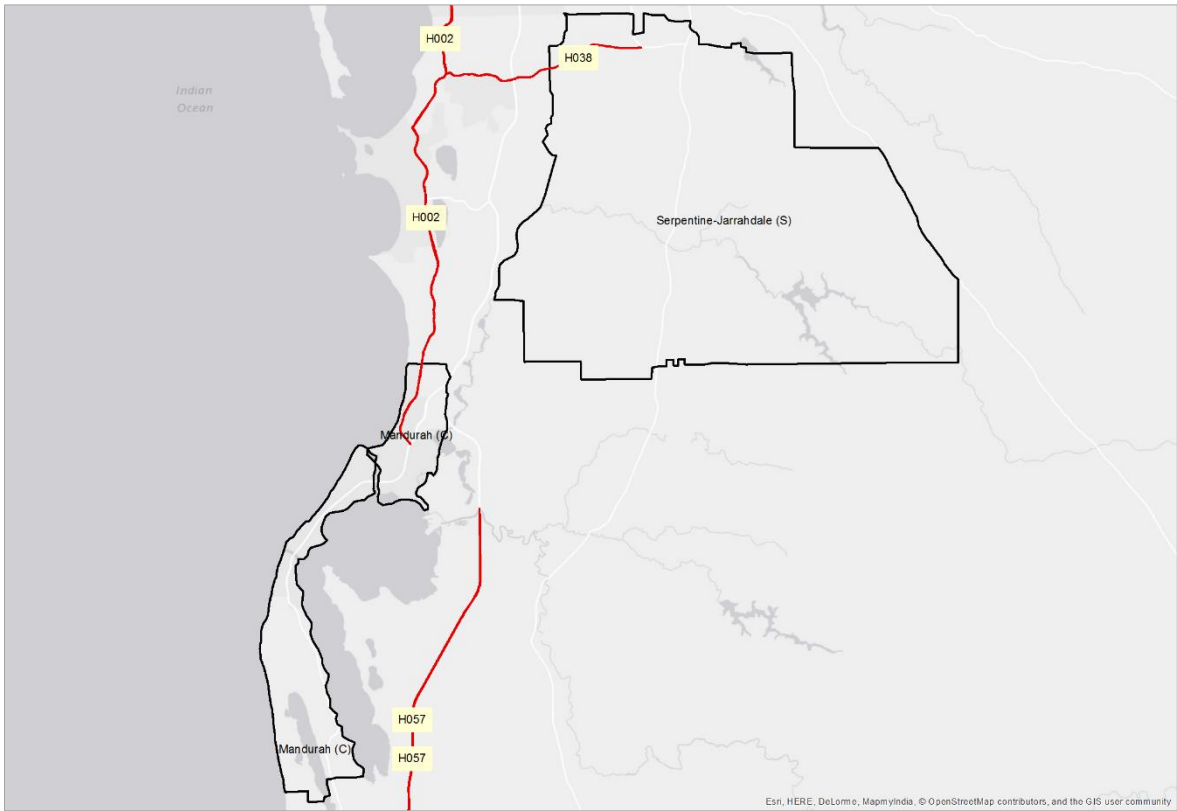


Figure 11
Non-metropolitan state road sections with high crash history (2)

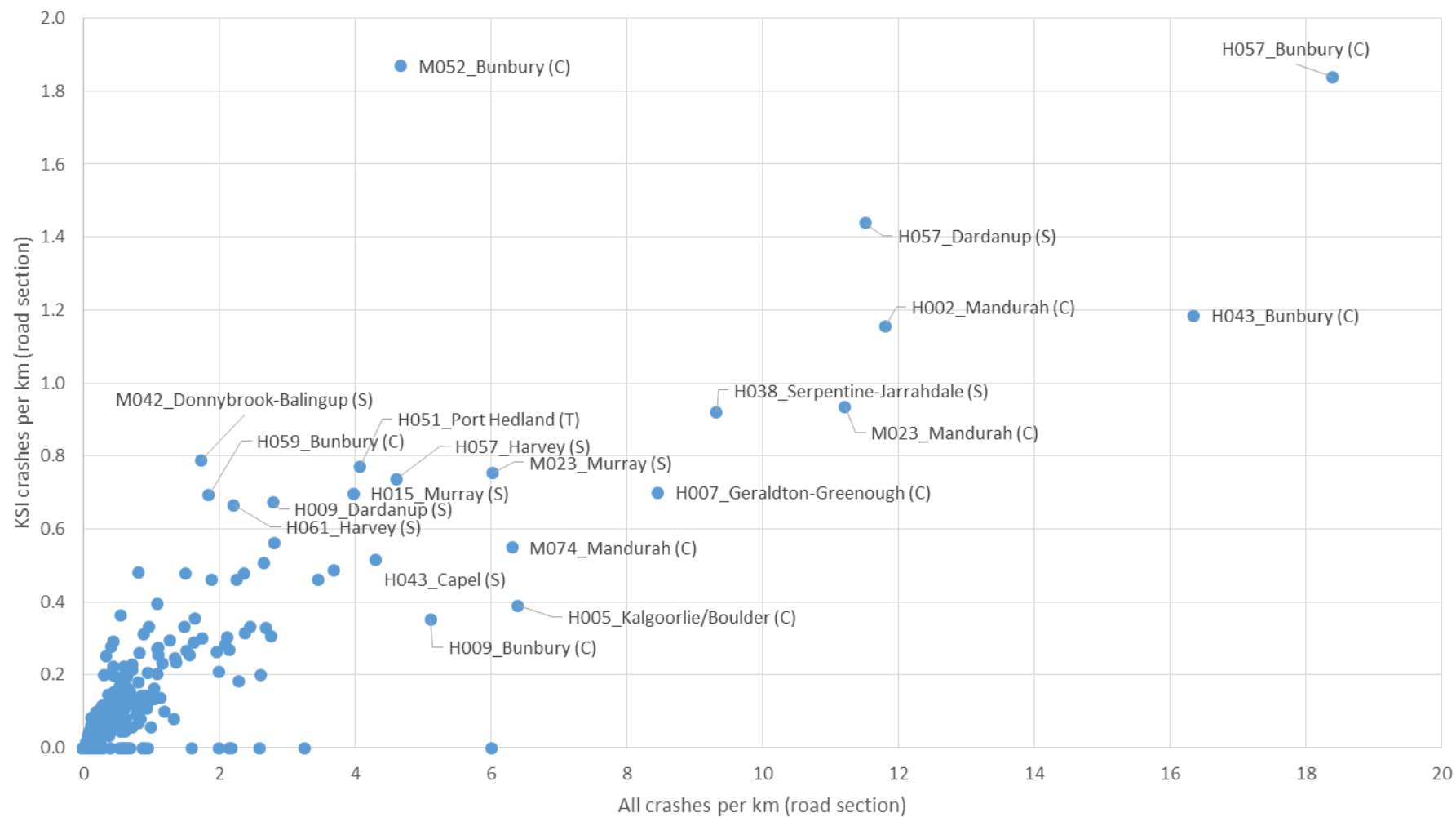


Figure 12
All crashes and weighted sum of crashes (per km); road sections non-metropolitan

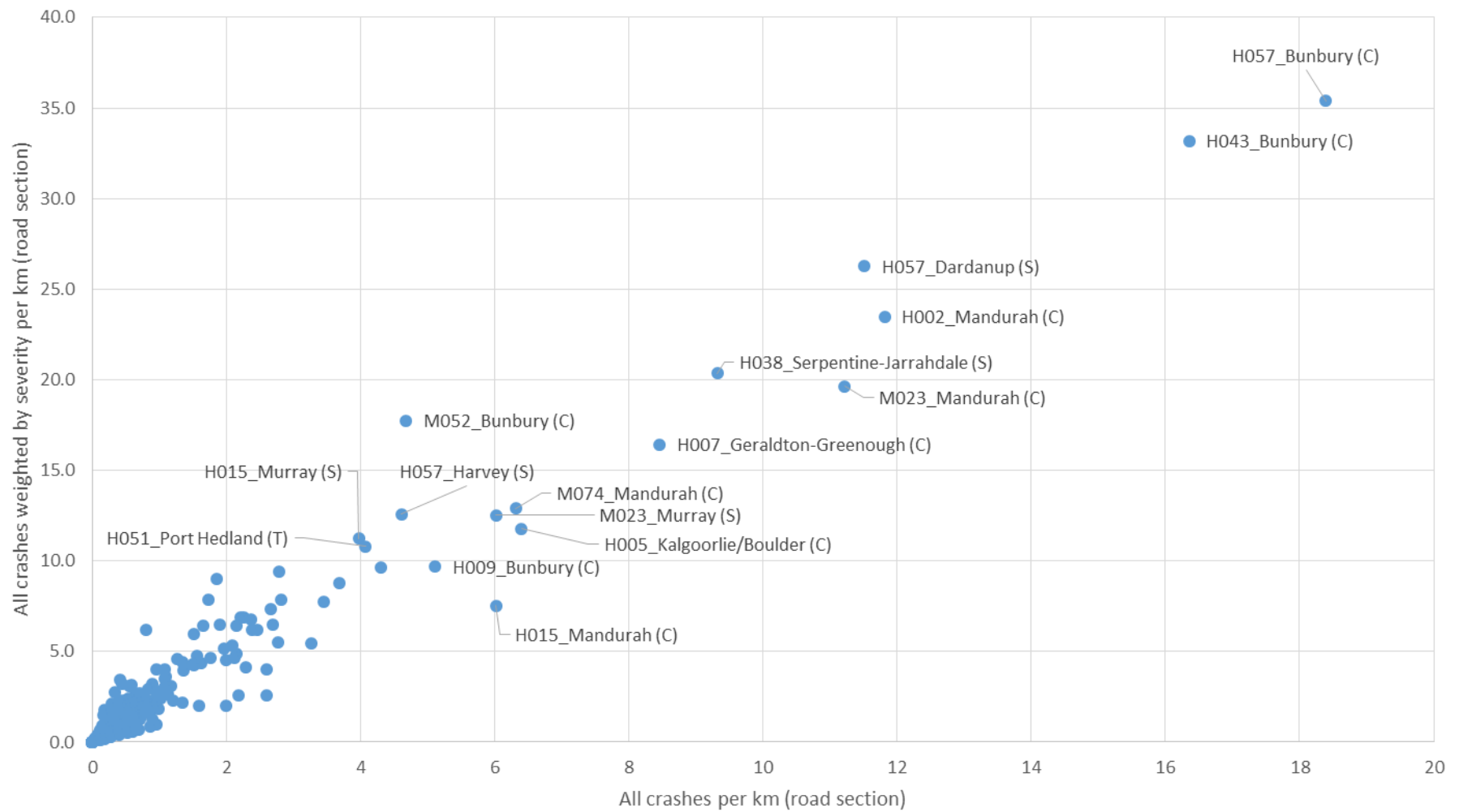


Figure 13
All crashes and weighted sum of crashes (per km); road sections non-metropolitan

3.2 CRASH DISTRIBUTION AND MOTOR-VEHICLE SPEED

3.2.1 Roads

The distribution of crashes weighted by severity for the Mitchell Freeway (H016), Kwinana Freeway (H015), and the Graham Farmer Freeway (H020) is shown in Figure 14 to Figure 16. These represent the three roads with the highest sum of weighted crashes per kilometre, and of reasonable road length. There is a downward trend in crashes for the Mitchell Freeway (H016) and the Kwinana Freeway (H015) the further the location is from Perth.

Along the Mitchell Freeway (H016), the distribution of crashes noticeably reduces around 12.5 kilometres of Perth. Similarly, along the Kwinana Freeway (H015), the top 50th percentile of the sum of weighted crashes are approximately located within 30 kilometres of Perth. A local maximum along the Kwinana Freeway occurs between SLK 10.0 and 20.0 kilometres (from Perth). This section coincides with the series of interchanges between the Kwinana Freeway and the Leach Highway, South Street, Roe Highway, Berrigan Drive, and Armadale Road.

The distribution of crashes along the Graham Farmer Freeway (H020) is relatively flat, with two local maximums occurring at SLK 1.5 kilometres and 3.5 kilometres (approximately). These markers are located along the Graham Farmer Freeway east of the Mitchell Freeway interchange, and across the Swan River bridge.

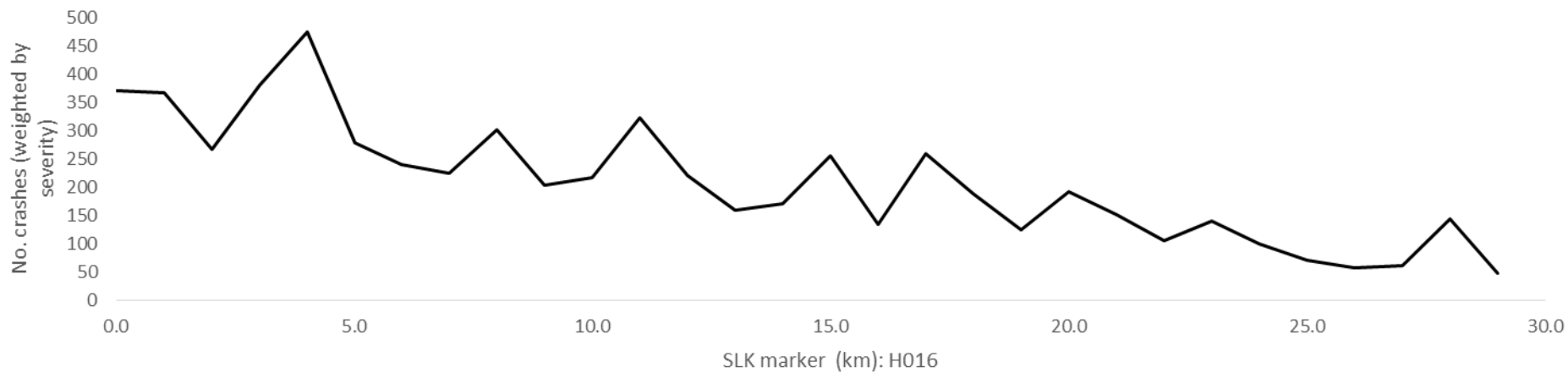


Figure 14
Distribution of sum of weighted crashes (interval 1.0km), H016

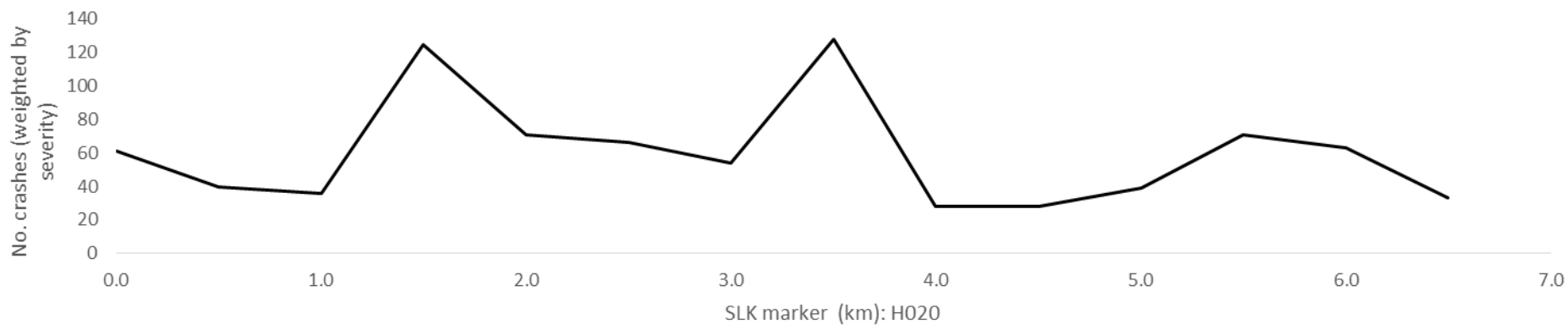


Figure 15
Distribution of sum of weighted crashes (interval 0.5km), H020

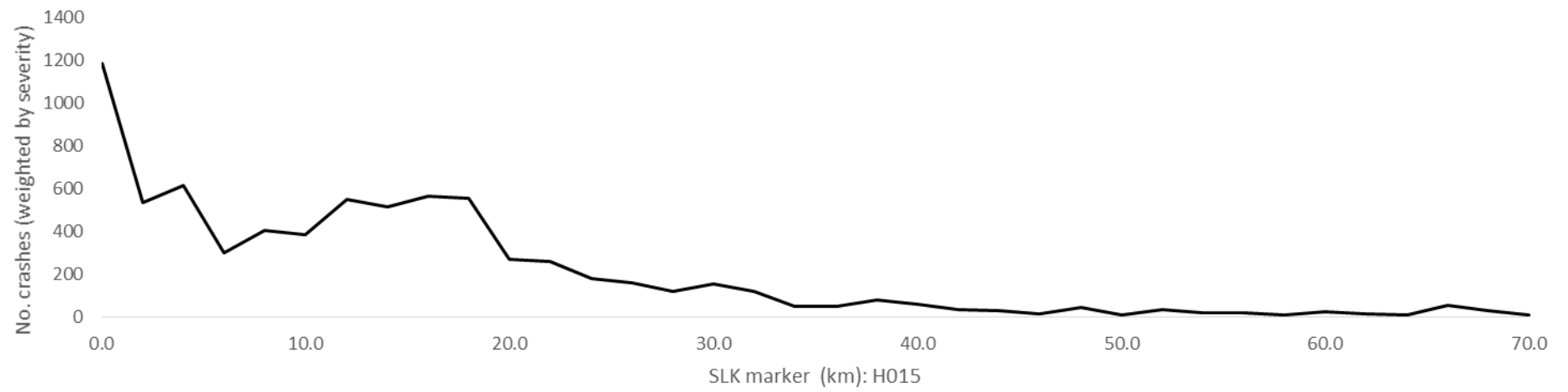


Figure 16
Distribution of sum of weighted crashes (interval 2km), H015

3.2.2 Road sections

The distribution of crashes weighted by severity for the Mitchell Freeway in Perth, Cambridge, and Stirling are shown in Figure 17, 18, and 19. The distribution of crashes weighted by severity for the Kwinana Freeway in South Perth and Melville are shown in Figure 20 and 21. The mean of the 15 minute averages speeds is also shown by direction.

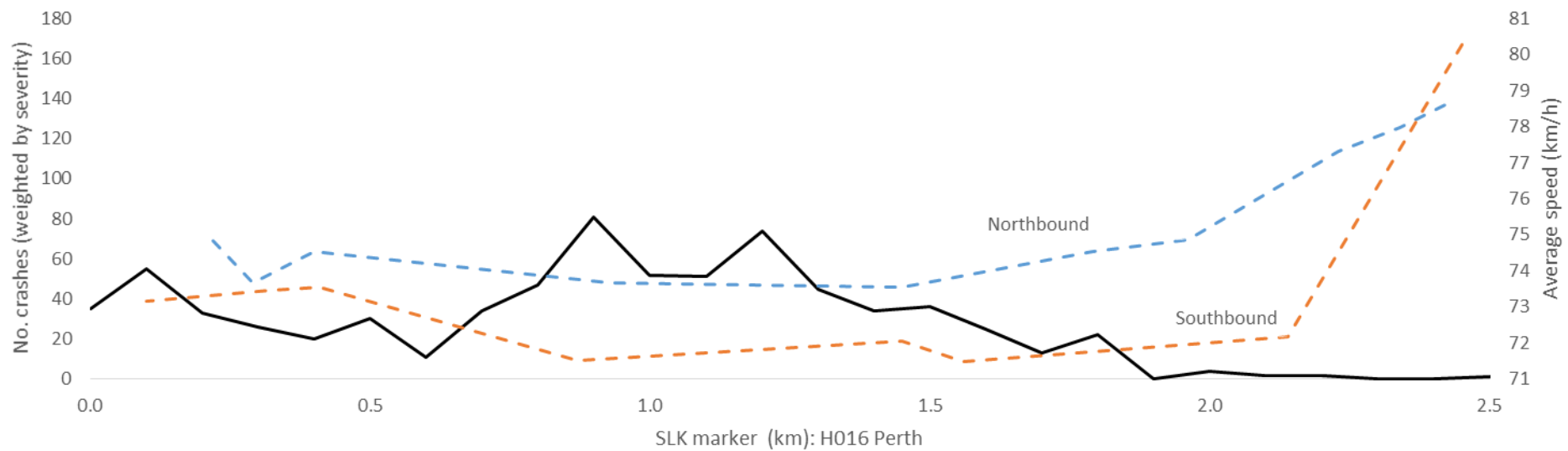


Figure 17
Distribution of sum of weighted crashes (interval 0.1km) and motor-vehicle speed, H016 Perth

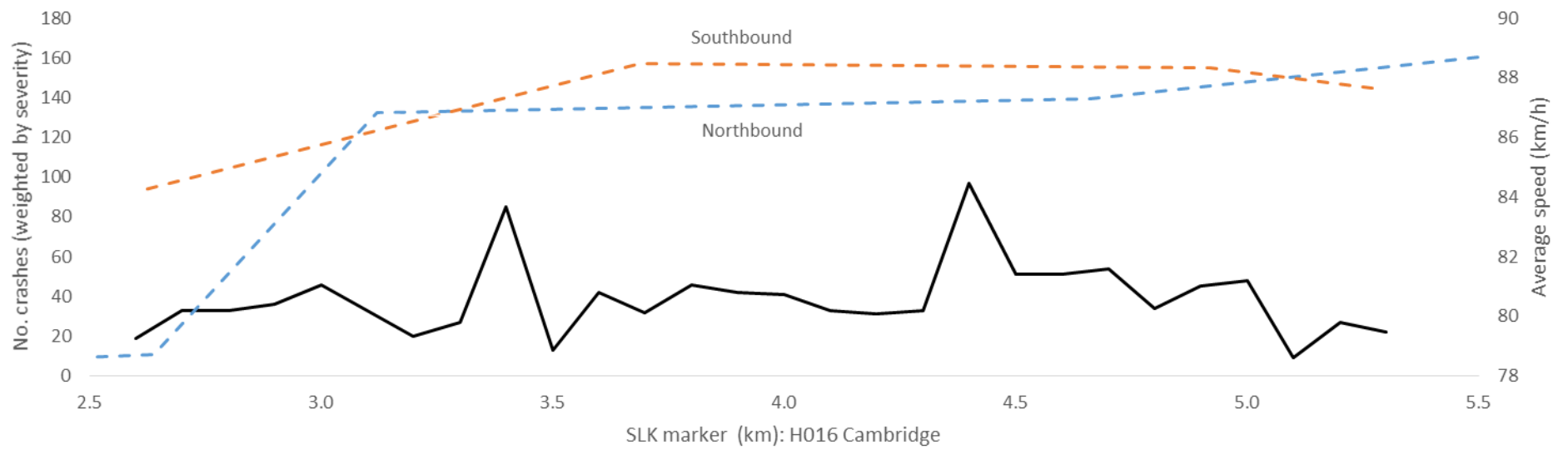


Figure 18
Distribution of sum of weighted crashes (interval 0.1km) and motor-vehicle speed, H016 Cambridge

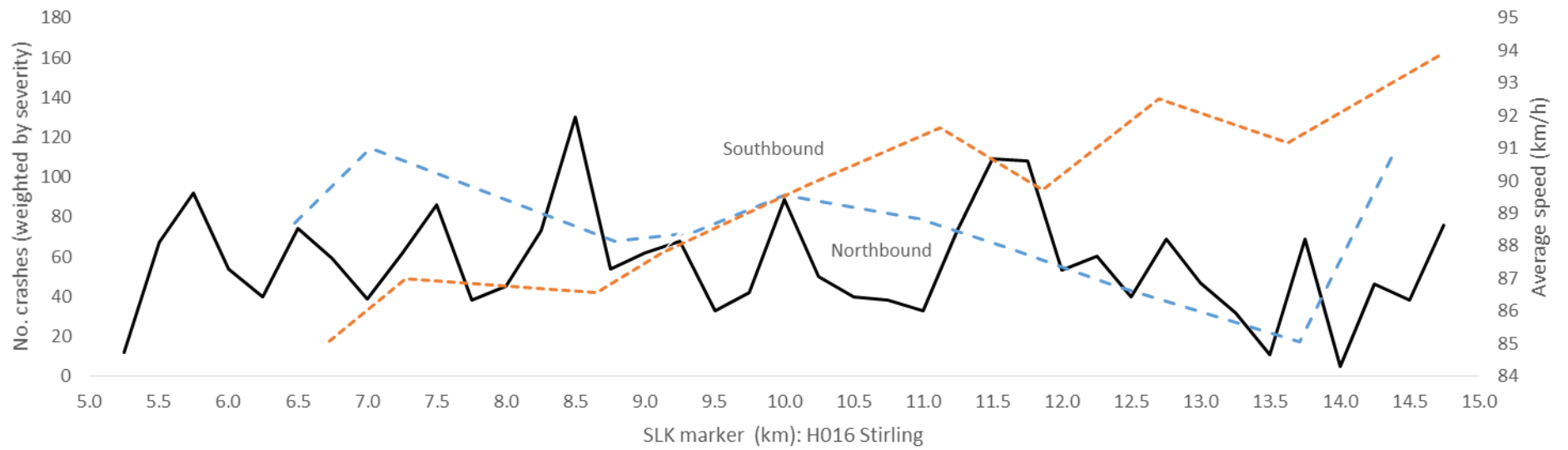


Figure 19
Distribution of sum of weighted crashes (interval 0.25km) and motor-vehicle speed, H016 Stirling

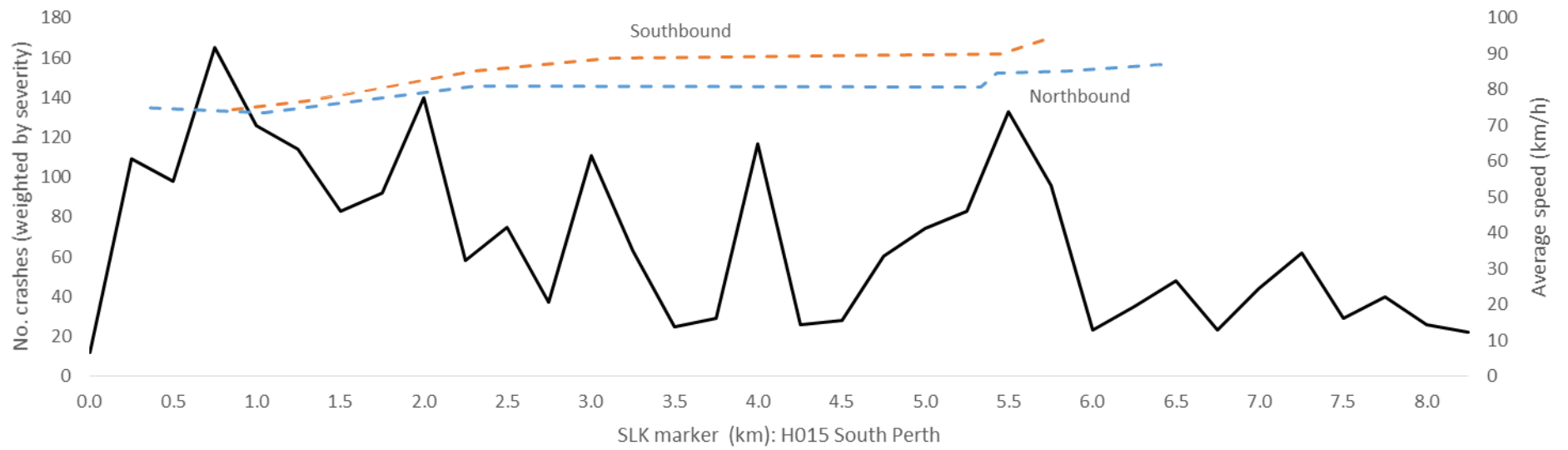


Figure 20
 Distribution of sum of weighted crashes (interval 0.25km) and motor-vehicle speed, H015 South Perth

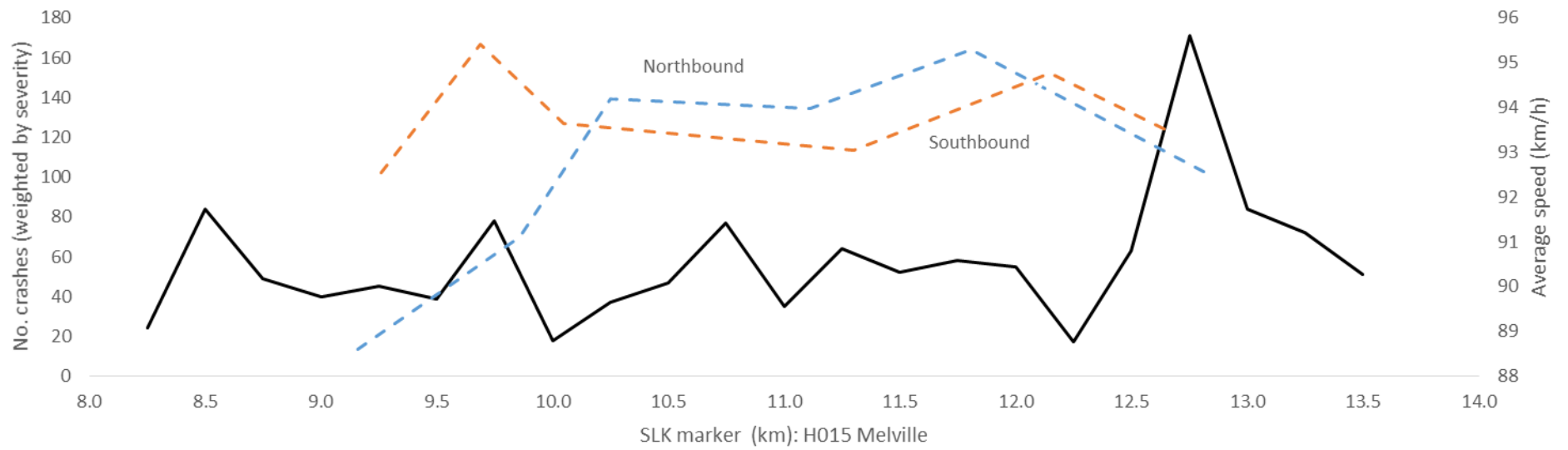


Figure 21
Distribution of sum of weighted crashes (interval 0.25km) and motor-vehicle speed, H015 Melville

4. CANDIDATE LOCATIONS

4.1 ROADS

The primary criteria against which the candidate roads were assessed is the 5 year crash history of KSI crashes per kilometre, and the sum of weighted crashes per kilometre. Against both criteria, the Mitchell Freeway, Kwinana Freeway, and the Graham Famer Freeway ranked highly. South Street also ranked highly (4th) against the KSI criteria, but not on the weighted sum of crashes criteria. This is due the balance between hospital crashes (KSI) and medical crashes (non KSI), as medical crashes represented a higher proportion of all crashes on South Street than other roads with a similar total crash history. The Kwinana Freeway also had the highest number of mid-block crashes reported (independent of length) over the 5 year crash period.

Table 1 High ranked roads

Rank	KSI (per km)	Sum of weighted crashes (per km)
1	Mitchell Freeway	Mitchell Freeway
2	Graham Farmer Freeway	Graham Farmer Freeway
3	Kwinana Freeway	Kwinana Freeway

4.2 ROAD SECTIONS

The road sections that ranked highest against the KSI crash history were different to those ranked highest against the sum of weighted crash history. Consistent between the two, was the Mitchell Freeway in Cambridge and Stirling (see Table 2). The five road sections that ranked highest on both criteria (product of ranking), were the Mitchell Freeway, Cambridge; the Mitchell Freeway, Stirling; the Kwinana Freeway, South Perth; the Kwinana Freeway, Melville; and the Kwinana Freeway, Cockburn (see Table 3).

Table 2 High ranked road sections

Rank	KSI (per km)	Sum of weighted crashes (per km)
1	Mitchell Freeway, Stirling	Mitchell Freeway, Cambridge
2	Mitchell Freeway, Cambridge	Kwinana Freeway, South Perth
3	Kwinana Freeway, South Perth	Mitchell Freeway, Perth
4	Graham Farmer Freeway, Belmont	Kwinana Freeway, Melville
5	Mitchell Freeway, Joondalup; AND Kwinana Freeway, Melville	Mitchell Freeway, Stirling

Table 3 High ranked road sections (product of ranking)

Rank	Road section and ranking
1	Mitchell Freeway, Cambridge
2	Mitchell Freeway, Stirling
3	Kwinana Freeway, South Perth
4	Kwinana Freeway, Melville ¹
5	Kwinana Freeway, Cockburn ²

1. Ranked 6th on KSI criteria
2. Ranked 7th on KSI criteria, and 6th on sum of weighted criteria

4.3 ROAD SECTIONS NON-METROPOLITAN

The road sections not located in metropolitan areas that ranked highest against the KSI crash history were largely similar to those ranked highest against the sum of weighted crash history (see Table 4). State roads around Bunbury featured most prominently, and three of the five road sections that ranked highest on both criteria (product of ranking), were the Forrest Highway, Boyanip-Picton Road, and the Bussell Highway in Bunbury (see Table 5).

Table 4 High ranked non-metropolitan road sections

Rank	KSI (per km)	Sum of weighted crashes (per km)
1	Boyanip-Picton Road, Bunbury	Forrest Highway, Bunbury
2	Forrest Highway, Bunbury	Bussell Highway, Bunbury
3	Forrest Highway, Dardanup	Forrest Highway, Dardanup
4	Bussell Highway, Bunbury	Melville-Mandurah Highway, Mandurah
5	Melville-Mandurah Highway, Mandurah	Thomas Road, Serpentine-Jarrahdale

Table 5 High ranked non-metropolitan road sections (product of ranking)

Rank	Road section and ranking
1	Forrest Highway, Bunbury
2	Boyanip-Picton Road, Bunbury ¹
3	Bussell Highway, Bunbury
4	Forrest Highway, Dardanup
5	Melville-Mandurah Highway, Mandurah

1. Ranked 7th on sum of weighted criteria

Intersections are predominantly signalised along the Forrest Highway, Bunbury; Bussell Highway, Bunbury; and the Melville-Mandurah Highway, Mandurah. There is a 5.5 kilometre length of the Forrest Highway in Dardanup that is not currently interrupted by signalised intersections.