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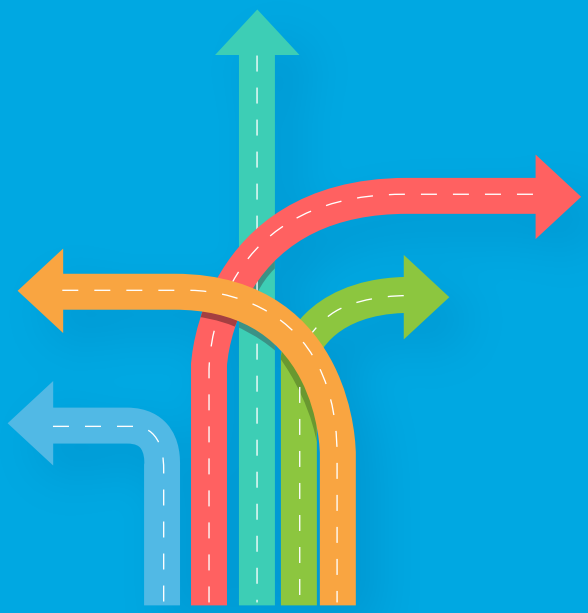

Trends In Driver Speed Behaviours On Perth Metropolitan Road Network

2000 To 2018

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Title
Trends in Driver Speed Behaviours on Perth Metropolitan Road Network 2000 to 2018

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Abstract
Thirteen annual speed surveys were conducted in the Perth metropolitan area during the period between March and August from 2000 to 2018 inclusive, to measure driver speed compliance across the network of speed limit roads ranging from 60 km/h to 100 km/h. Since 2005 the surveys have been expanded with samples of sites on the 50 km/h road network. The 2000 survey was used as the baseline year for the comparisons with all subsequent surveys from which road safety and speed performance indicators were derived as measures of driver speed behaviours over the time.

The principal objective of the surveys was to measure changes in driver speed behaviours at general locations of the road network over time and to relate those changes to the effectiveness of various speed related road safety programs implemented in the state.

In each of the twelve surveys conducted in the years 2003 to 2018 an attempt was made to survey all of the sites chosen in the stratified random sample of 118 sites in the baseline 2000 survey. In all surveys, two-day of speed data was collected at each site in the sample of roads chosen across the metropolitan network. Each of the surveys resulted in over 1 million vehicles travelling in traffic free-flowing environments.

Effectiveness of speed road safety programmes is estimated in terms of changes in: speed compliance rates, proportion of drivers exceeding 10 or more km/h above the speed limit, 85th percentile and mean speed.

The study found that under free-flowing condition over the metropolitan network of all speed limits (excluding 50 km/h and 110 km/h roads) in 2000, 53% of all vehicles travelled at or below posted speed limits.

Relative to the compliance rate in 2000 there was a significant average increase in the compliance rate over the period 2003-2015 to the compliance rate of 64.1% in 2015. Compared to 2015, the 2018 survey recorded a substantial increase in the compliance rate of 5.3% to a record high of 69.5%. This has also resulted in a decrease of 0.6% in the percentage of speeding drivers, comparable to the average annual reduction

observed since 2013. This trend since 2013 in the small percentage change in the number of vehicles travelling at excessive speeds or the speed compliance rate needs to be monitored in order to assess current or future speed management and enforcement strategies that would maintain or improve the current trend in the driver speed compliance rates.

When compared to the 2000 survey, the number of drivers travelling at high speeds, within the presumed "tolerance level" of 10 km/h above the speed limit, reduced from 12.6% to 3.4% in 2018. The number of speeding drivers (exceeding 10 km/h above the speed limit) recorded in 2018 was 73.3% less than in 2000, representing a very significant change in driver speed behaviours over the last 18 years.

Analysis of travel speeds by speed limits suggested that the poorest compliance to the speed limit was observed on 60 km/h roads, ranging from 46.1% in 2000 to 67.8% in 2018. The compliance rate on the 70 km/h and 80 km/h roads increased in 2018 to 68.9% and 75.0%, 30.4% and 25.8%, respectively, higher than in 2000.

Compared to the 2000 survey, the 2018 survey showed that the higher speed limit roads experienced a small reduction in the compliance rate.

In general, drivers are more likely to travel at excessive speed during the night hours, from 7 p.m. to 7 a.m. Hourly patterns of driver speed behaviours are similar between the survey years. On average the highest travel speeds are expected to occur between 11 p.m. and 6 a.m. In all surveys the fewer speeding drivers were recorded between 8 a.m. and 12 a.m., approximately 3% in 2018.

In 2018, the best days of the week for speed limit compliance were found to be Friday and Thursday (average 71.4%), followed by Wednesday (average 70.8%) and the worst day was Sunday, followed by Saturday (average 61.7%). The surveys from 2003 to 2018 indicated that, in general, the greatest compliance to speed limits occurs from Monday to Wednesday, followed by Thursday to Friday, on average 64% and 60%, respectively, significantly less on Saturday and Sunday with the lowest average of 57%.

The results from the analysis of the data collected in the speed surveys from 2000 to 2018 suggested that speed enforcement strategies should incorporate consideration of the differences in driver speed behaviours associated with road type, speed limit and temporal factors such as day of the week and time of day.

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Iain Cameron
Chairman, Road Safety Council

As residents in Perth, Western Australia know, much has changed in the metropolitan area over the past 18 years. The data provided in this survey also reveals significant change in driver behaviour in Perth since the year 2000.

It's pleasing that the results show a positive trend in speed limit compliance of drivers, particularly in recent years, with almost 70% of drivers and riders obeying marked speeds in the metropolitan area in 2018.

The survey reveals that Perth drivers are more likely to exceed speed limits at times when traffic is quiet. The data in this survey drills down to the exact times, days and roads when this occurs.

Even though more of us now adhere to the speed limit, we need an even greater level of compliance and a fundamental shift in the community's understanding of speed limits to achieve bold road safety targets.

As there is clear evidence to show that higher speeds increase the risk of crashes causing death and serious injuries, I commend this report.

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EXECUTIVE SUMMARY

Thirteen annual speed surveys on the Perth metropolitan road network had been conducted during the period between March and August in 2000, 2003, 2004, 2005, 2007, 2008, 2010, 2011, 2012, 2013, 2014, 2015 and 2018 inclusive, to measure driver speed compliance. The 2000 survey was used as the baseline for comparisons against all future surveys from which road safety and speed performance indicators would be derived on annual basis in order to monitor driver speed behaviours on the road network.

The principal objective of the surveys is to measure changes in driver speed behaviours at general locations of the road network over time. Changes in driver speed behaviours are used as measures of effectiveness of speed enforcement programs and other road safety initiatives undertaken from time to time in order to slow vehicle speeds and improve safety of all road users across the entire metropolitan road network.

The aims of the surveys are to monitor:

(1) driver speed behaviours at general locations on the road network; and
(2) driver speed compliance with respect to legal speed limits.

A stratified random sample chosen for the 2000 baseline survey consisted of 150 sites across the metropolitan road network, including National Highways, State Roads and Local Roads. Due to some changes in speed limits, road geometry, or road treatments over time some of the sites were excluded in the subsequent surveys and the data analysis to maintain consistency in speed limits and road environments that otherwise could have affected the reliability of the speed indices between the surveys. The sample sizes in the surveys from 2010 to 2018 varied between 108 and 157 sites, larger than the sample size in the 2008 survey mainly due to inclusion of the 50 km/h Local roads and 110 km/h State roads ranging between 21 and 46 sites, selected from the road network within the metropolitan area.

Sample sizes by the strata were based on the estimates of the vehicle-kilometres-travelled on the road types, state and local roads.

Traffic volume, speed and vehicle composition data was collected using vehicle classifiers.

Two-day metropolitan area surveys resulted in excess of two million vehicles, ranging from 2.47 million in 2003 to 4.07 million in 2018, of which over one million in each of the survey years were considered to have travelled with "free" speeds (headway >= 4 sec).

The findings of this study are based only on data obtained on vehicles travelling under the free flowing traffic conditions.

(A) Compliance to Speed Limit on the Perth Metropolitan Road Network

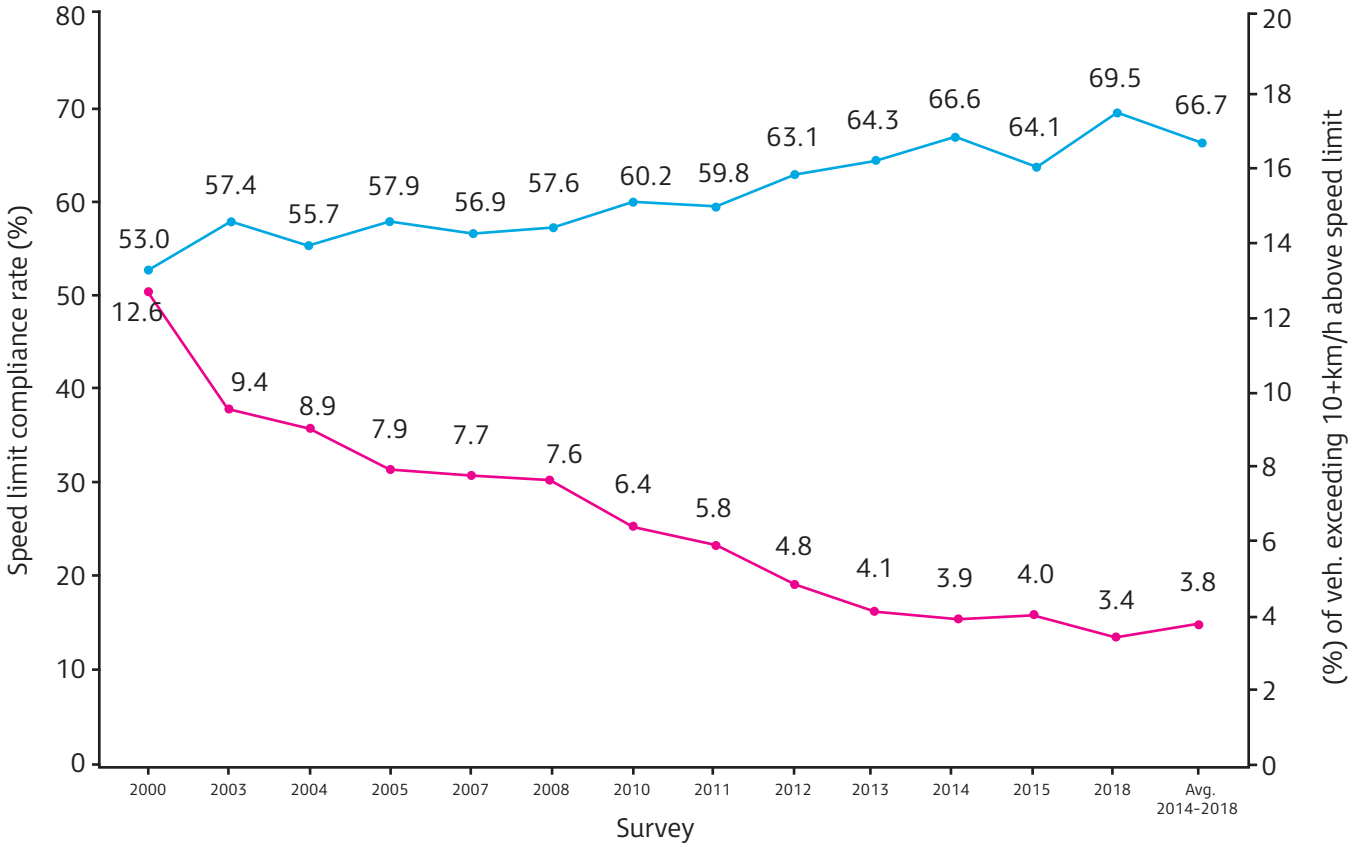
(i) Overall Network Compliance

All Types of Vehicles

Analysis of the speed data suggested that under free-flowing conditions, over the metropolitan road network of all speed limits in *2000, 53% of all vehicles travelled at or below posted speed limits*. The 2003 survey indicated that there was an increase of 4.4% in the compliance rate from 53% to 57.4%, followed by a drop to approx. 55.7% in 2004. Further slight increases in the compliance of 1% to 2% were observed in 2005, 2007 and 2008, to 57.9%, 56.9% and 57.6%, respectively, followed by an increase in the compliance rate recorded in 2010 at approx. 60.2%, 2.6% higher than in 2008 survey, and a small non-significant reduction in the compliance rate observed in the 2011 survey at approx. 59.8%, 0.4% less than in 2010 survey. However, a significant increase in the compliance rate was observed in the 2012 survey at approx. 63.1%, 3.3% higher than in 2011, and 1.2% higher in 2013 survey than in 2012, at 64.3%. *The compliance rate recorded in the 2014*

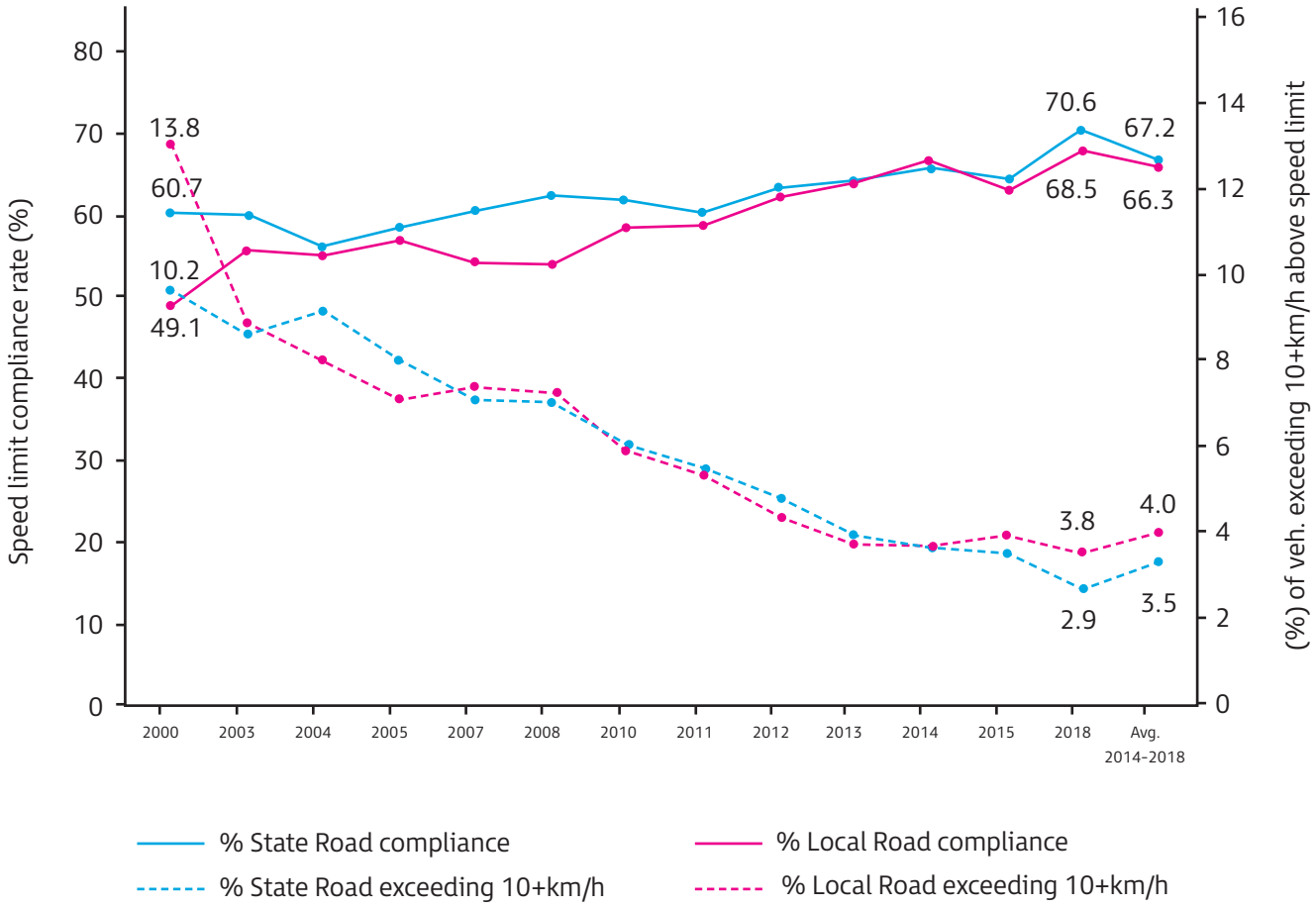
survey was at approx. 66.6%, 2.3% higher than in 2013 survey, followed by a 2.5% reduction in the compliance rate to 64.1% in the 2015 survey. Compared to the 2015 survey, the 2018 survey recorded a significant 5.3% increase in the compliance rate to the highest ever result of 69.5% , 16.5% higher than in the baseline speed survey. The average network compliance for most recent three surveys over the 5 years period 2014 to 2018 was estimated at 66.7%, 13.7% higher than in the baseline survey conducted in 2000 (ref Summary Figure 1 and Summary Table 1).

Summary Figure 1



Analysis of the speed data recorded under free-flowing conditions, over the metropolitan state and local roads network of all speed limits in 2000 showed that 60.7% of vehicles on state road and 49.1% of vehicles on local road travelled at or below posted speed limits. Despite of some variations between the surveys in the increasing trend, the highest compliance rate was recorded on state and local roads in the 2018 survey at approx. 70.6% and 68.5, 10.0% and 19.4% higher than in 2000 survey, respectively. The average network compliance for most recent three surveys over the 5 year period 2014 to 2018 on state and local roads was estimated at 67.2% and 66.3%, 6.5% and 17.2% higher than in the baseline survey conducted in 2000, respectively (ref Summary Figure 2).

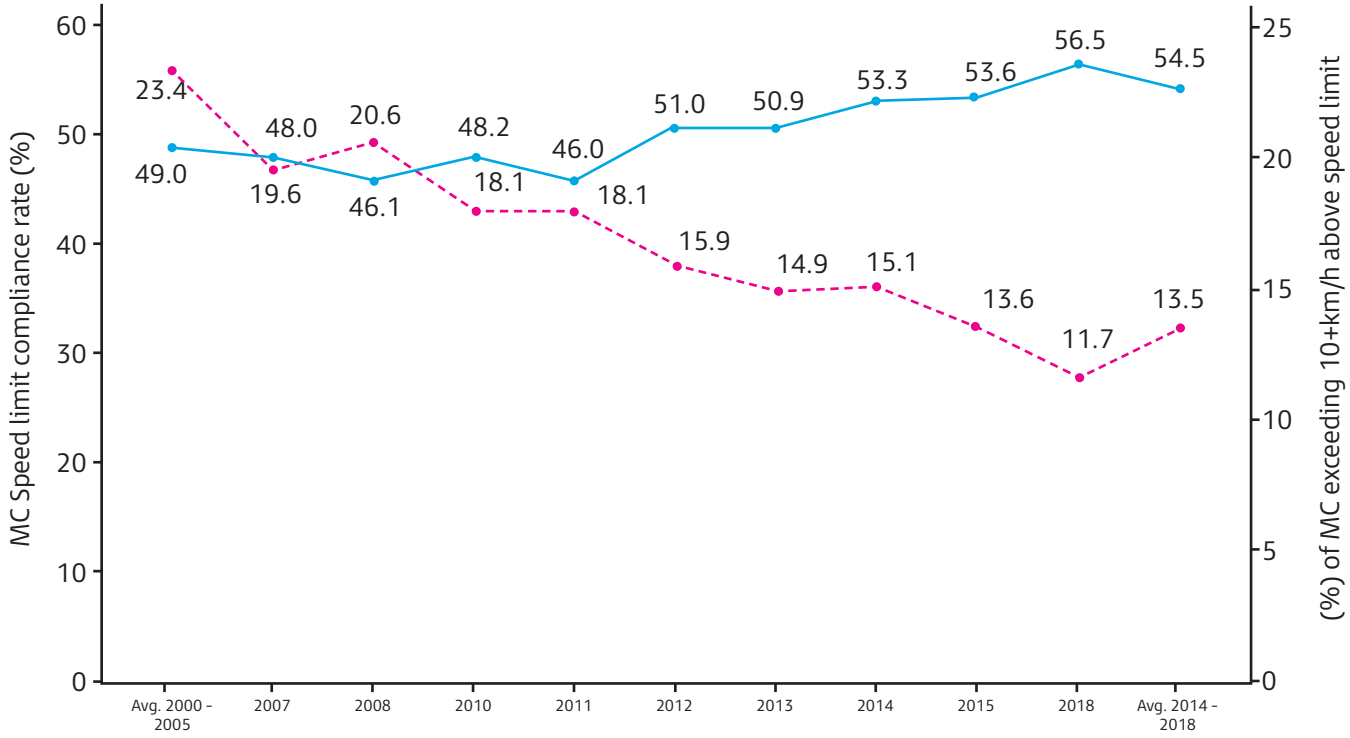
Summary Figure 2



Motorcycles

The analysis of speed data for motorcycles (not restricted to free-flowing conditions), recorded over the metropolitan road network of all speed limits over the period 2000 to 2005, showed that 49.0% of all motorcyclists travelled at or below posted speed limits. Apart from some variability between the surveys in the increasing compliance rate trend, the highest compliance rate was recorded in the 2018 survey at 56.5%, 7.5% higher than the average for the period 2000 to 2005. The average network compliance for most recent three surveys over the 5 years period 2014 to 2018 was estimated at 54.5%, 5.4% higher than the average for the period 2000 to 2005 (ref Summary Figure 3).

Summary Figure 3



(ii) Compliance by Speed Limit

The surveys from 2003 to 2018, apart from some variability between years, indicated an overall improvement in the speed compliance rates when compared to the 2000 survey.

- The poorest compliance to the speed limit was observed on 60 km/h roads ranging from 46.1% in 2000 to 67.8% in 2018, however, a significant increase of 21.7%.
- Compared to the 2000 survey, the compliance rate in 2018 on 70 km/h and 80 km/h roads increased by 16.1% and 15.4%, from 52.9% to 68.9% and 59.6% to 75.0%, respectively.
- Speed compliance on 90 km/h roads remained fairly constant over the years at approximate average of 73%, while the compliance on the 100 km/h had significantly varied from year to year, ranging from 80.4% in 2000 to 67.4% in 2018 with the average of 71.0% from 2003 to 2018 (ref. Summary Table 1).

The compliance rates by speed limit were as follows:

Speed Limit	2000 Survey	Average 2003 to 2008	2010 Survey	2011 Survey	2012 Survey	2013 Survey	2014 Survey	2015 Survey	2018 Survey
60 km/h	46.1	51.7	53.4	51.8	55.7	58.7	61.7	59.0	67.8
70 km/h	52.9	57.8	62.6	63.0	66.4	66.0	68.0	64.5	68.9
80 km/h	59.6	61.2	60.1	66.0	65.2	68.0	72.4	66.9	75.0
90 km/h	74.2	72.3	73.4	72.2	68.4	72.4	76.0	75.6	71.9
100 km/h	80.4	69.3	79.8	67.7	79.4	68.7	65.0	73.9	67.4
All Speed Limits	**53.0**	**57.0**	**60.2**	**59.8**	**63.1**	**64.3**	**66.6**	**64.1**	**69.5**

(iii) Compliance by Day of Week

The surveys from 2003 to 2018 indicated that, in general, the greatest compliance occurs from Monday to Wednesday, on average 64%, followed by Thursday to Friday, on average 60%. The week-end compliance was significantly less than the week day compliance, at average of 57% on Saturday and Sunday.

In 2018, the worst compliance was recorded on Sunday, on average 59.6%.

(B) Metropolitan Road Network – Proportions of Drivers Travelling 10+ km/h above Speed Limit

(i) Network Average Percentage of Drivers Travelling 10+ km/h above Speed Limit

All Roads and Speed Limits

In 2003, the number of drivers travelling with speeds exceeding 10 km/h above the speed limit was significantly less than in 2000. The reduction in the percentage of speeding drivers was estimated at 25%, representing an absolute reduction of 3.2%, from 12.6% to 9.4%.

Since 2003 the trend in percentage of speeding drivers has been steadily decreasing to 4.8% in 2012 and 4.0% in 2015. In the most recent 2018 survey, a small reduction of 0.6% was observed to the lowest ever level of 3.4%, 9.2% less than the baseline 2000 survey.

In 2000, the number of speeding drivers on Perth metropolitan state and local road network was recorded at 10.2% and 13.8%, respectively. However in 2018, the percentage of speeding drivers dropped to 2.9% and 3.8% on state and local roads, representing a substantial reduction of 7.3% and 10.0%, respectively. The average number of speeding drivers for most recent three surveys over the 5 year period 2014 to 2018 on state and local roads was estimated at 3.5% and 4.0%, 6.7% and 9.8% less than in the baseline survey conducted in 2000, respectively.

Motorcycles Travel Speed Behaviours

Speed data analysis was also conducted on all motorcycle travel speeds, not restricted to free-flowing conditions, over the metropolitan road network of all speed limits. Over the period 2000 to 2005, 23.4% of all motorcyclists travelled at speeds exceeding 10 km/h above the speed limit. The percentage of speeding drivers dropped to 11.7% in 2018, 11.7% less than in the period 2000 to 2005. The average percentage of speeding drivers for the most recent three surveys over the 5 years period 2014 to 2018 was estimated at 13.5%, 9.9% less than for the period 2000 to 2005.

(ii) Percentage of Drivers Travelling at High Speeds by Speed Limit

Despite some variations between the interim years between 2000 and 2018, all roads on average recorded a reduction in speeding drivers relative to the percentage recorded in the 2000 survey. The difference between 2018 and 2000 in the percentage of speeding drivers ranged from a reduction of 1.8% on 100 km/h roads (from 4.0% to 2.1%) to 12.1% on 60 km/h roads (from 14.9% to 2.9%) (ref. Summary Table 1). This translates into a percentage reduction in the proportions of speeding drivers between 46.6% on 100 km/h roads to 80.8% on 60 km/h roads.

The most significant results arising from the surveys is that the number of speeding drivers from 2000 to 2018, across all metropolitan roads, had been reduced by approximately 73.3%, from 12.6% to 3.4%, largely biased by the reduction of the number of speeding drivers on 60 km/h, 90km/h and 100 km/h speed limit roads in the most recent 2018 survey.

The percentage distribution of vehicles travelling at the high speeds (10+ km/h above the speed limit) by year of survey, from 2000 to 2018 were as follows:

Speed Limit	2000 Survey	Average 2003 to 2008	2010 Survey	2011 Survey	2012 Survey	2013 Survey	2014 Survey	2015 Survey	2018 Survey
60 km/h	14.9	9.1	7.1	6.7	5.4	4.4	4.5	4.4	2.9
70 km/h	11.8	8.6	6.5	5.9	5.0	4.5	3.9	4.5	4.5
80 km/h	11.0	7.8	5.7	4.3	4.3	3.4	3.2	3.2	3.5
90 km/h	6.7	4.9	4.6	3.9	3.9	2.8	2.4	2.3	2.2
100 km/h	4.0	5.5	3.3	4.4	3.0	3.3	4.0	2.4	2.1
All Speed Limits	**12.6**	**8.3**	**6.4**	**5.8**	**4.8**	**4.1**	**3.9**	**4.0**	**3.4**

Summary Table 1

Compliance/ Non-compliance	2000 (%)	2003 (%)	2004 (%)	2005 (%)	2007 (%)	2008 (%)	2010 (%)	2011 (%)	2012 (%)	2013 (%)	2014 (%)	2015 (%)	2018 (%)	Change in Rate 2018 vs 2015	Change in Rate 2018 vs 2000
Network Compliance to Speed Limit															
	53.0	*57.4*	*55.7*	*57.9*	*56.9*	*57.6*	*60.2*	*59.8*	*63.1*	*64.3*	*66.6*	*64.1*	*69.5*	*5.3*	*16.5*
Network % of drivers travelling 10+km/h above speed limit															
	12.6	*9.4*	*8.9*	*7.9*	*7.7*	*7.6*	*6.4*	*5.8*	*4.8*	*4.1*	*3.9*	*4.0*	*3.4*	*-0.6*	*-9.2*
Compliance to speed limit on:															
60 km/h roads	46.1	52.0	50.9	53.6	49.0	53.4	53.4	51.8	55.7	58.7	61.7	59.0	67.8	*8.8*	*21.7*
70 km/h roads	52.9	59.1	55.4	57.9	58.6	57.9	62.6	63.0	66.4	66.0	68.0	64.5	68.9	*4.5*	*16.0*
80 km/h roads	59.6	64.0	60.8	60.7	62.7	56.9	60.1	66.0	65.2	68.0	72.4	66.9	75.0	*8.1*	*15.4*
90 km/h roads	74.2	72.3	67.4	74.0	75.4	72.5	73.4	72.2	68.4	72.4	76.0	75.6	71.9	*-3.8*	*-2.3*
100 km/h roads	80.4	65.7	73.3	69.0	66.2	73.7	79.8	67.7	79.4	68.7	65.0	73.9	67.4	*-6.5*	*-13.0*
% of drivers travelling 10+km/h above speed limit on:															
60 km/h roads	14.9	10.4	9.4	8.6	8.7	8.2	7.1	6.7	5.4	4.4	4.5	4.4	2.9	*-1.6*	*-12.1*
70 km/h roads	11.8	9.4	9.4	8.1	8.0	8.1	6.5	5.9	5.0	4.5	3.9	4.5	4.5	*0.0*	*-7.3*
80 km/h roads	11.0	8.8	9.4	7.7	6.3	7.0	5.7	4.3	4.3	3.4	3.2	3.2	3.5	*0.4*	*-7.4*
90 km/h roads	6.7	4.7	6.3	4.2	4.7	4.6	4.6	3.9	3.9	2.8	2.4	2.3	2.2	*-0.1*	*-4.4*
100 km/h roads	4.0	6.7	4.7	5.5	6.2	4.2	3.3	4.4	3.0	3.3	4.0	2.4	2.1	*-0.3*	*-1.8*

(iii) Speeding by Day of Week

Over most of the surveys Sunday, followed by Saturday were found to be the days with the highest percentage of drivers exceeding 10 or more km/h above the speed limit, ranging from 2.6 % on Saturday in 2014 to 13.9% on Sunday in 2000, however significantly less in 2014, at 3.9%.

Across all surveys, the average week day percentage of drivers travelling at high speeds was estimated at 6.3%, compared to the average week-end percentage of 8.0%.

In the most recent 2018 survey, the average percentage of speeding drivers on week days was estimated at 3.0%, compared to the higher week-end average of 7.6%, being 2.6% higher than the average week-end percentage for the most recent three surveys over the 5 years period 2014 to 2018 estimated at 5.0%.

(iv) Speeding by Time of Day

All 13 surveys indicated that drivers were more likely to travel at excessive speeds(10+ km/h above speed limits) during night hours, from 7 p.m. to 7 a.m., than during other times of the day. These driver speed behaviours are fairly consistent from year to year. No significant differences in the patterns were found, although the percentage magnitude varied in line with the overall driver speed behaviours in a particular year.

On average, the highest travel speeds are expected to occur between 11 p.m. and 6 a.m. The percentage of speeding drivers during this period in 2018 ranged from 4% to 8%. In all surveys the least number of speeding drivers was recorded between 8 a.m. and 12 p.m., approximately 3% in 2018.

The reduction in the percentage of vehicles travelling 10+ km/h above the speed limit across all hours of the day in 2018 compared to 2000 ranged between 67% and 79%.

(C) Mean Travel Speeds in the Perth Metropolitan Area

Mean Speed by Speed Limit

The speed surveys consistently showed that drivers on the metropolitan 60 km/h, 70 km/h and 80 km/h roads have travelled at higher average speeds, relative to the speed limits, than drivers on the other speed limit roads, such as 90 km/h and 100 km/h roads. The estimates of the mean speeds across all surveys were as follows:

Speed Limit	Mean Estimate (km/h)
60 km/h	58.4
70 km/h	67.6
80 km/h	76.6
90 km/h	84.5
100 km/h	94.4

The mean travel speeds recorded in the 2018 survey, compared to the mean speeds in 2000, were significantly less on some roads and slightly higher on the others. The highest reductions were observed on:

- *60 km/h -4.8 km/h*
- *70 km/h -2.9 km/h*
- *80 km/h -4.2 km/h, and*

Some increase in the mean speed was observed on:

- *90 km/h +2.7 km/h*
- *100 km/h +5.0 km/h*

Mean distribution by survey and percentage change in the mean speed in 2018 relative to 2000 are presented in the Summary Table 2, below.

Summary Table 2

Mean Speed for Roads	2000 (km/h)	2003 (km/h)	2004 (km/h)	2005 (km/h)	2007 (km/h)	2008 (km/h)	2010 (km/h)	2011 (km/h)	2012 (km/h)	2013 (km/h)	2014 (km/h)	2015 (km/h)	2018 (km/h)	*2018 vs 2015*	*2018 Change*	*vs 2000 % Change*
60 km/h	60.6	59.4	59.3	58.4	59.6	57.7	58.4	59.1	58.2	57.6	57.3	57.9	55.9	-2.0	*-4.8*	*-7.8*
70 km/h	69.4	68.1	69.1	68.3	68.2	67.9	67.0	67.2	66.4	66.2	66.0	67.3	66.5	-0.8	*-2.9*	*-4.1*
80 km/h	77.2	76.9	78.1	78.4	77.3	78.4	77.9	77.6	76.6	75.6	73.6	76.2	73.0	-3.3	*-4.2*	*-5.4*
90 km/h	82.6	85.8	86.5	83.9	83.1	84.7	83.9	85.0	85.7	85.0	82.8	84.2	85.3	1.1	*2.7*	*3.3*
100 km/h	91.2	95.9	94.3	95.7	96.1	95.1	88.6	95.6	89.4	95.4	96.2	92.6	96.2	3.6	*5.0*	*5.5*

(D) Speed Compliance and Mean Speeds on 50 km/h and 110 km/h Roads in the Metropolitan Area

(i) 50 km/h Roads

The speed indices derived from the survey conducted on samples of the 50 km/h roads within the Perth metropolitan area over the period 2004 to 2018 showed significant positive changes in driver speed behaviours measured by the indices such as compliance to the speed limit (at 2.0% increase per survey year) and the mean travel speed (a reduction of 0.5 km/h per survey year) (ref. Summary Table 3, below).

The compliance rate on the 50 km/h roads increased from 29.5% in 2004 to 51.9% in 2018 and the percentage of drivers travelling 10 or more km/h above the speed limit decreased from 19.8% in 2004 to 8.9% in 2018.

Likewise, the mean speed in 2018 compared to the mean speed recorded in 2004 decreased from 53.9 km/h to 48.9 km/h.

(ii) 110 km/h Roads

For a small sample of 110 km/h roads in the Perth metropolitan area surveyed in 2007, 2010, 2011, 2012, 2013, 2014, 2015 and 2018, the percentage of drivers travelling within the speed limit was estimated at 76.4%, 76.2%, 84.5%, 77.2%, 76.3%, 83.4%, 78.7% and 84.6%, and the percentage of drivers travelling 10 or more km/h above the speed limit was estimated at 3.4%, 3.9%, 2.0%, 2.2%, 2.7%, 1.9%, 2.2% and 1.2%, respectively (ref. Summary Table 3).

The mean speed on the 110 km/h metropolitan roads was estimated at approximately 100.6 km/h, 101.5 km/h, 99.4 km/h, 101.2 km/h, 100.9 km/h, 99.1 km/h, 101.3 km/h and 99.9 km/h in 2007, 2010, 2011, 2012, 2013, 2014, 2015 and 2018, respectively.

No speed data was collected on these roads in 2008.

Driver speed behaviour on Perth metropolitan 110 km/h roads was more compliant than the driver speed behaviour on the non-metropolitan 110 km/h roads as shown by the speed surveys conducted over the period 2000 to 2015.

Summary Table 3

Compliance/ Non-Compliance	2004 (%)	2005 (%)	2007 (%)	2008 (%)	2010 (%)	2011 (%)	2012 (%)	2013 (%)	2014 (%)	2015 (%)	2018 (%)	2005vs 2004	2007vs 2005	2008 vs 2007	2010vs 2008	2011vs 2010	2012vs 2011	2013vs 2012	2014vs 2013	2015vs 2014	2018vs 2015
Compliance - 50k roads	29.5	34.2	29.5	38.7	35.5	40.9	39.9	40.9	50.2	49.1	51.9	4.7	-4.6	9.2	-3.2	5.4	-1.0	1.0	9.3	-1.0	2.7
Compliance - 110k roads	-	-	76.4	-	76.2	84.5	77.2	76.3	83.4	78.7	84.6	-	-	-	-	8.3	-7.3	-0.9	7.1	-4.7	5.9
% of drivers travelling 10+ km/h above speed limit - 50k roads	19.8	20.0	19.6	18.2	17.5	14.4	13.9	13.4	8.3	10.9	8.9	0.3	-0.5	-1.4	-0.7	-3.1	-0.6	-0.4	-5.1	2.5	-2.0
% of drivers travelling 10+ km/h above speed limit - 110k roads	-	-	-	3.4	3.9	2.0	2.2	2.7	1.9	2.2	1.2	-	-	-	-	-1.9	0.2	0.5	-0.8	0.3	-1.0
Mean Speed	**2004 (km/h)**	**2005 (km/h)**	**2007 (km/h)**	**2008 (km/h)**	**2010 (km/h)**	**2011 (km/h)**	**2012 (km/h)**	**2013 (km/h)**	**2014 (km/h)**	**2015 (km/h)**	**2018 (km/h)**	**2005vs 2004**	**2007vs 2005**	**2008 vs 2007**	**2010vs 2008**	**2011vs 2010**	**2012vs 2011**	**2013vs 2012**	**2014vs 2013**	**2015vs 2014**	**2018vs 2015**
50km/h roads	53.9	52.2	53.7	51.4	52.1	50.6	51.1	50.9	49.3	49.8	48.9	-1.7	1.4	-2.3	0.7	-1.5	0.5	-0.2	-1.6	0.5	-0.9
110km/h roads	-	-	100.6	-	101.5	99.4	101.2	100.9	99.1	101.3	99.9	-	-	-	-	-2.1	1.8	-0.3	-1.8	2.2	-1.4

Summary of Speed Surveys Results

In conclusion, the in-depth analysis of speed data collected over 12 surveys since 2000 suggests that driver speed behaviours do differ depending on:

- Speed limit on the road;
- Day of the week; and
- Time of day.

The speed surveys conducted over the period 2000 to 2018 suggest that driver compliance on the Perth metropolitan road network have significantly improved since 2000. The number of speeding drivers (10 or more km/h above the speed limit) on the Perth metropolitan road network in 2018 was approximately 73.3% less than was the case in 2000.

Compared to 2015, the 2018 survey recorded *a* substantial increase in the compliance rate of 5.3% to 69.5%, which resulted in a small decrease of 0.6% in the percentage of speeding drivers. However, the trend since 2013 in the small annual percentage change in the number of vehicles travelling at excessive speeds or the speed compliance rate needs to be monitored in order to assess current or future speed management and enforcement strategies that would maintain or improve the recently observed trend in the driver speed compliance rates.

It is recommended that findings of this study on driver speed behaviours related to the road type and temporal factors be used as components in formulation of speed enforcement or other road safety strategies aimed at reduction of travel speeds on the Perth metropolitan roads network. In addition, the findings of past and future similar studies on driver speed behaviours should be utilised as the indicators against which effectiveness of the speed enforcement programs or other implementations of speed reduction strategies would be assessed.

Acknowledgements

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Introduction

1

Within the domain of road safety it has been well recognised that speed is one of the most important core elements of road safety problem that affects not only the risk of being involved in a crash but more importantly the severity of the crash outcomes which could result in fatality or serious injury. The annual speed survey study design was originally intended to support and evaluate the first phase of the Coordinated Action Program: Speed Project (CAP: Speed), implemented by the WA Police Force in 1998. The main objective of CAP: Speed was to reduce speed-related crashes through the increased use of speed and red light cameras. Subsequently, the annual speed surveys have been used to support a range of speed interventions as part of the WA's state road safety strategy, Towards Zero 2008 -2020 (Office of Road Safety, 2009), including further expansions to the automated traffic enforcement network.

Cameron (1999) proposed that the CAP: Speed program should be evaluated with respect to driver speed behaviours at general locations of the WA network rather than using travel speed behaviours recorded at speed camera sites which would be more likely biased towards lower speeds than expected on other similar non-camera road environments. For this reason it was suggested than annual speed surveys should be conducted at general locations covering most speed limit and road types, metro and rural regions. The principal objective of the surveys was to measure changes in driver speed behaviours at general locations across the entire WA road network and use the derived speed indices in the assessment of effectiveness of enforcement strategies on road safety outcomes. It was envisaged that results of the survey would also provide substantial grounds upon which future road safety and enforcement strategies could be addressed and formulated.

In the past, no systematic approach was used in acquiring a reasonable representative sample of speed data across the WA road network. The most reliable speed data that has been recorded in a systematic way comes from several CULWAY sites located on National and State roads. Although this data provides good information on trends in speeds on major highways commonly used by heavy vehicles, the data cannot be used as a substitute for a representative speed survey covering the entire road network, including National, State and Local roads, within the rural regions and the Perth metropolitan area. A representative sample of road locations was needed in order to conduct annual or other selected speed survey periods. The data collected during the surveys could be used to monitor changes in driver speed behaviours over time and evaluation of the effects of traffic safety and enforcement programs on such behaviours on general road locations across the entire road network.

The principal objective of the surveys was to measure changes in driver speed behaviours at general locations of the metropolitan road network over a period of time. Changes in driver speed behaviours may be used as one of the significant measures in the assessment of effectiveness of speed interventions, and to a lesser extent as a measure of the impacts of other safety awareness non-enforcement programs on driver traffic behaviours.

Other objectives of the survey implied in the driver speed behaviour areas are to:

1. Monitor general driver compliance to legal speed limits;
2. Measure road/site specific speed compliance rate; and
3. Assess the need for a review of speed limits for the network of road types or specific road sections, or roads within selected areas.

The aims of the surveys are to:

1. Monitor driver speed behaviour at the metropolitan network level;
2. Achieve a high level of representativeness of speed behaviours for:

a) the metropolitan network of roads;
b) types of roads;
c) legal speed limits;
d) various traffic volumes;
e) traffic composition; and
f) built up/non-built up areas.

3. Monitor speed behaviours at each of the levels stated above;

4. Monitor speed compliance rate by the categories listed above;

5. Monitor effects of traffic safety interventions or enforcement on speed behaviours;

6. Provide a baseline speed data for the development of performance indicators for Western Australia; and

7. Provide the baseline data for the assessment of the effects of change in speed behaviours on the occurrence of speed related crashes and other types of crashes not necessarily identified as speed related crashes.

SURVEY METHODOLOGY

2

Given that the Perth metropolitan road network covers a vast area, ranging from roads in the dense built-up area, arterial local and state roads to open State and National Highways, substantial care was taken in the design of the survey such that the data collected would be representative of the state's driver population and their behaviours on these types of roads.

The survey is conducted over the most trafficked roads across the WA metropolitan road network covering most common speed limits and road types. The design of the study sample was based on the selection criteria that would satisfy representativeness of the network in terms of:

1. Amount of traffic on various types of roads;
2. The sample size in each of the strata of the road types;
3. Speed limits; and
4. Traffic composition.

The sample of approximately 150 sites would be sufficient in size to provide reliable representativeness of driver speed behaviour at the general road locations of the Perth metropolitan road network.

2.1 Determination of Sample Size by Strata

In order to determine the sample sizes for each of the principal factors to be investigated and monitored in future surveys three methods were investigated:

1. Exposure measured in million vehicle kilometres travelled (MVKT);
2. Estimated speed related crashes; and
3. Estimated number of speed related serious injury crashes, during the period 1994 - 1998.

The most reliable method in estimating the number of survey sites by the primary survey stratum, region, was proposed to be used in determining sample sizes for other strata in the proposed speed survey.

2.2 Determination of Sample Size by Region

Three approaches were considered in determining distribution of sample sizes by region, chosen as the principal stratum for the survey:

1 Amount of exposure measured in terms of million vehicle kilometres travelled (MVKT) estimates by region;
2. Average number of speed related serious injury crashes; and
3. Average number of speed related all severity types' crashes.

Comparison of the three methods showed no significant differences in sample sizes calculated by the region (see Table 1). The analysis suggested a strong correlation between exposure and number of speed related serious injury and all types of speed related crashes. It appears that speed related crashes were equally likely to occur in any of the regions. Occurrence of a serious crash appeared to be dependent on traffic exposure rather than state regional area. Based on the data, it was inferred that the current likelihood of drivers speeding and being involved in serious injury or other severity type crashes was very similar across the entire regional road network.

Since there was no identifiable difference in the distribution of number of sites by region between the three sample size determination methods, MVKT was thought to be a more stable denominator to be used for this purpose. The number of speed related crashes as the determinant of the sample sizes was considered to be unstable as it may change over time due to traffic safety programs implementation or speed enforcement. Therefore, in order to preserve representativeness of the state traffic speed data, the sample size for each of the two main strata, region and road type, was based on the principal determinant taken as the amount of exposure measured in terms of MVKT.

	Parameter								
	MVKT			Number of Speed Related (94-98)			Number of Speed Related Serious Inj. Crashes (94-98)		
Region	**MVKT 1996**	**% Total**	**N of Sites**	**N**	**% Total**	**No. of Sites**	**N**	**% Total**	**N of Sites**
Great Southern	581.5	3	6	230	3	6	33	2	5
South West	1682.6	9	18	767	9	18	153	11	22
Gascoyne	211.6	1	2	45	1	1	13	1	2
Mid West	609.83	3	6	234	3	6	61	4	9
Goldfields-Esp.	716.74	4	8	297	4	7	70	5	10
Kimberley	226.37	1	2	107	1	3	35	3	5
Metropolitan	**12750**	**68**	**136**	**6019**	**73**	**145**	**854**	**62**	**124**
Wheatbelt South	514.26	3	5	166	2	4	43	3	6
Wheatbelt North	905.06	5	10	292	4	7	80	6	12
Pilbara	600.16	3	6	143	2	3	36	3	5
Total	**18798**	**100**	**200**	**8300**	**100**	**200**	**1378**	**100**	**200**

Table 1. Determination of sample size based on MVKT and number of speed related crashes

2.3 Determination of Sample Size by Road Type

The survey is confined to the top four types of road environment, namely, National Highways, State Highways, Main Roads and Local Roads. Since there is no readily available MVKT split between State Highways and Main Roads, estimates of sample size by road type were based on the three road types: National Highways, State Roads (comprised of State Highways and Main Roads) and Local Roads. Estimates of MVKT by road type were obtained from a MRWA model. The estimated number of survey sites by regional road types are presented in Table 2.

	National			State			Local		
Region	**MVKT**	**% Total**	**N of Sites**	**MVKT**	**% Total**	**N of Sites**	**MVKT**	**% Total**	**N of Sites**
Great Southern	0	0	0	429	0.04	4.4	177	0.02	1.8
South West	0	0	0	1452	0.15	14.9	591	0.07	6.1
Gascoyne	0	0	0	183	0.02	1.9	45	0.01	0.5
Mid West	71	0.05	0.7	437	0.04	4.5	162	0.02	1.7
Goldfields-Esp.	257	0.18	2.6	271	0.03	2.8	192	0.02	2
Kimberley	156	0.11	1.6	149	0.02	1.5	38	0	0.4
Metropolitan	**442**	**0.3**	**4.5**	**6027**	**0.61**	**61.8**	**6395**	**0.79**	**65.7**
Wheatbelt South	0	0	0	357	0.04	3.7	130	0.02	1.3
Wheatbelt North	412	0.28	4.2	406	0.04	4.2	208	0.03	2.1
Pilbara	124	0.08	1.3	230	0.02	2.4	136	0.02	1.4
Total	**1461**	**0.08**	**15**	**9943**	**0.51**	**102.1**	**8074**	**0.41**	**82.9**

Table 2. Estimates of number of survey sites by road type based on MVKT

Based on the sample size estimate for the entire state, the metropolitan region and the rural regions, of 200 sites, the proportional number of sites for the Perth metropolitan area, was also proportionally distributed with respect to the exposure by road type and wherever it was possible, by speed limit. The distribution of the estimated number of survey sites by road type and the schematic representation of the distribution of speed limits by road type is presented in Figure 1.

For the purpose of comparability of data, the sample sizes by the initial stratification categories remain fairly constant unless there are justified reasons for change. In addition, the choice of survey locations and the speed data collection are conducted according to the criteria described in the following sections within this report.

In the process of the survey design, careful consideration is given to the representativeness of the exposure and the road environment whilst maintaining a high degree of randomness in the selection of road sections and road geometry.

Although driver behaviour with respect to speed may vary between road sections and types of roads, depending on the road geometry, general road and traffic environments, a speed survey at any location can be considered as a random sample of vehicle speeds, representing the population driver speed behaviours for the location.

Since driver speed behaviours may depend on type of road, speed limits and the general road environment, substantial care has been taken in choosing survey sites within the available number of sites allocated for each road type within the region surveyed. This has been achieved through sampling stratification with respect to: traffic volume, speed limit, divided/undivided road, and number of lanes.

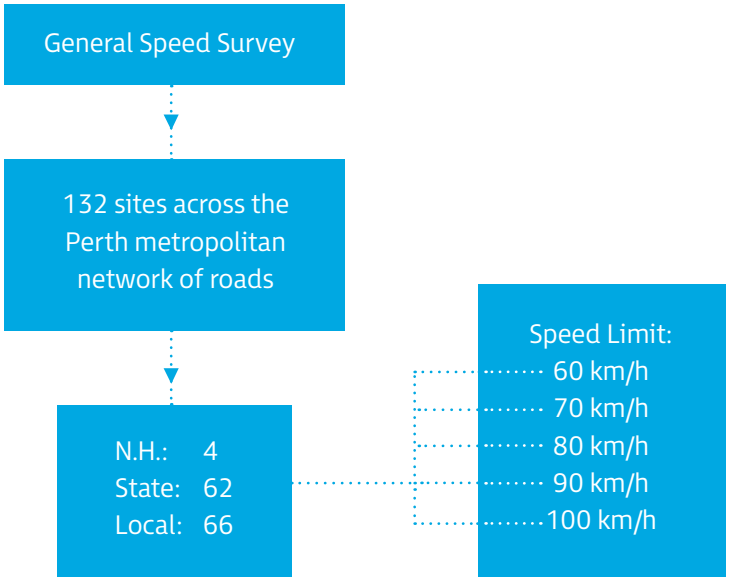


Figure 1. Distribution of survey sites and Road Administrative Classification and Accountability based on 98/99 MVKT in Perth Metropolitan Area

2.4 Sampling Stratification within Road Type

Traffic Volume

The minimum number of vehicles surveyed per day per location should not be less than 1000, unless a suitable site could not be found on a particular road type. Due to the equipment storage limitation, the highest volume at a site should not exceed 20000 vehicles per day.

Speed Limit

Survey sites are randomly distributed within each of the common legal speed limits within the constraints determined by the number of road types and the number of sites surveyed. The survey is intended to cover road sections with posted speed limits of 60, 70, 80, 90, 100 km/h. In addition, the surveys from 2010 to 2018 included the sample between 20 and 46 on 50 km/h local roads and two 110 km/h state road in order to expand the future surveys to cover all most commonly used speed limits in the Perth metropolitan area.

Divided and Undivided Roads

Based on road design, it is expected that drivers are more likely to experience free speed flows on divided multiple lane roads rather than on single carriageway-two lane roads. Undivided roads are more prone to slower speeds due to free flow interruptions by turning vehicles exiting or entering traffic streams. Estimates of number of survey sites on divided roads were determined on basis of traffic exposure, as a proportion of the total exposure for the road type.

Number of Lanes

The number of lanes on divided or undivided roads play a significant role in the provision of opportunities for drivers to experience free unimpeded speeds. This may be true for all types of roads and road environments. Therefore, the number of lanes has been considered as an important factor in the survey sampling within the stratification parameters such as the road type, divided and undivided roads, and speed limits.

Traffic Composition

Traffic volume classifiers are utilised in the survey for the purpose of collecting traffic volume, vehicle speed and traffic composition data. The nature of stratified random sampling is expected to result in a population representative of traffic composition data, and consequently providing sufficient information on driver speed behaviours by AUSTROADS vehicle class.

General Survey Criteria

The series of annual speed surveys is undertaken for the purpose of evaluating whether driver population speed has been influenced by traffic safety intervention programs, it is necessary to measure changes in speed population parameters (e.g. mean, 85th percentile, standard deviations, and others). Precautions should be taken in order to control extraneous factors that may have an effect on driver speed behaviours at the survey sites.

Survey Period

One of the factors that is considered is the period or months of the year the survey is conducted. For the purpose of survey reliability, the data collection is ideally taken during expected stable weather periods, namely, between March and May or between September and November each year, thus avoiding winter months.

Site Data Collection Time Period

The minimum data collection period per site should not be less than 2 days in the metropolitan area, and approximately the same number of survey sites be represented by every day of the week, distributed across all speed limit roads in order to control for variability in speed behaviours between the days of the week and behaviours on various speed limit roads. Also, the data should be continuously collected over consecutive hours in order to control for the differences between times of day.

For detailed distribution of number of sites by region and road type, refer to Figure 2.

For detailed survey criteria and data collection guidelines, refer to Appendix A.

2.5 Speed Survey Site Selection Methodology

It is proposed that selection of a physical location on a road be determined by the following six criteria:

1. Traffic volume exceeding 1000 vehicles/day and not more than 20000 vehicles per day per lane, unless sampling frame allows for smaller volumes;

2. Speed limit 50 km/h or greater;

3. Must approximately satisfy distribution of number of sites as presented in Figure 1.

4. Locations should provide opportunities for uninterrupted traffic flow (e.g. avoiding spots in vicinity of major intersections, changes in posted speed limits, entries to petrol stations, shopping centres etc.);

5. Sufficient representation of dual carriageway and multi-lane roads; and

6. Sufficient coverage of area within region.

In the site selection procedure, it was anticipated that each of the criteria would be considered in order to achieve satisfactory representation of the population with respect to the factors such as road type, speed limit, number of carriageways and number of lanes. Selection of locations would be determined by inspection rather than employing an algorithmic computerised procedures.

2.6 Minimum Sample Size Requirement

Research literature suggests that the risk of vehicle involvement in a crash increases with the increase in speed above the speed limit, or average speed (Kloeden et al., 1997). This is more pronounced for speeds in

excess of 25 km/h above the limit (West and Dunn, 1971). Research has shown that a sample size of 50000 would be needed to detect a 20% reduction in the proportion of drivers exceeding speed limits by 30 km/h (Cowley, 1987). Similarly, studies involving surveys of this sample size have proved to be sensitive in detecting changes in the 95th percentile speed as low as 2 km/h between two consecutive years (Cameron & Vulcan, 1998).

Based on the research studies, it is proposed that the minimum sample size by road type would not be less than 50000 vehicles. A sample size of this magnitude, when stratified by road type and speed zone is thought to be sufficient to detect significant changes in speed percentiles and average speed.

The sample size for the comparison of two sample means of the proposed annual surveys may be estimated by the equation:

$$N = 2 [(Z_{alpha} - Z_{beta})S/D]^2$$

where

- N = required sample size
- Z_{alpha} = normal deviate corresponding to the desired confidence level
- Z_{beta} = normal deviate corresponding to the desired power
- D = population difference of interest

A sample of speeds taken on four locations selected from the Perth metropolitan road network covering a range of speed limits suggests that the minimum sample size of approximately 1000 to 16000 vehicles is required to detect changes of 1 km/h in mean speed, depending on road type and speed limit (see Table 3).

							Min.Sample Size	
Region	**Road Type**	**Speed Zone**	**N**	**Mean**	**Std Dev**	**Std Err**	**Diff. In Means***	**95th Percent.**
Perth Metro	Local	60	47765	58.46	8.393	0.038	1856	903
	National	80	36058	80	9.614	0.051	2436	1185
	Hwy State	70	112603	72.24	6.673	0.02	1173	571
	State	110	49495	100.25	13.269	0.06	4640	2257

* 95% confidence level, 95% test power and difference=1 km/h

Table 3. Minimum sample size requirement estimates

Since spot speed populations' approximate normal distributions, the minimum sample size estimates for percentiles are derived using the equation (Oppenlander et al., 1961):

$$N = v^2S^2 (1+u^2)/2d^2$$

where

- N = minimum sample size
- v = normal deviate corresponding to the desired confidence level
- S = standard deviation of the sample
- u = normal deviate corresponding to the percentile being estimated, and
- d = permitted error in the estimate.

The required minimum sample sizes for the 95th percentiles with the 99% confidence level and error of 1 km/h are presented in Table 3. Assuming that the speed variances of the two surveys are the same, then the estimated sample size required detecting the change in the 95th percentile of 1 km/h would be approximately 2N. Therefore, the sample sizes for the strata are 16000 for State Roads with 110 km zones. Selection of locations for spot speed surveys are based on the derived sample size criteria with respect to road type and speed zone.

2.7 Selection of Speed Survey Locations

In order to arrive at a target sample size for the metropolitan road network, according to the proposed distribution by region and road types (presented in

Figure 1), all known section traffic volumes, by legal speed limits, were extracted from MRWA Integrated Road Information System. In total, it was estimated that approximately 132 sites will be surveyed across the metropolitan road network, consisting of approximately 4 locations on National Highways, 62 on State Roads and 66 on Local Roads.

In order to cover all commonly used speed limits, an additional 24 50 km/h local roads and 2 110 km/h state roads selected within the metropolitan areas were included in the 2015 survey. Prior to 2008, the 50 km/h and 60 km/h roads were separately surveyed from the General Speed Survey which excluded the 50 km/h roads. For practical reasons it was decided that a separate survey for the local 50 km/h and 60 km/h would not be justified, and that an adequate number of 50 km/h roads added to the existing sample would provide sufficient information to estimate indices on driver speed behaviours for these roads, and therefore for the entire road network in the area.

In the process of selecting estimated number of sites for the baseline 2000 survey across entire network, care was taken to achieve the most feasible representation of all driver speed behaviours over all road types. For this reason, an attempt was made to survey sites on all major roads of the network at the locations that were expected to be most representative for the road. The initial estimate of 132 sites distributed over the metropolitan area and road types (as shown in Figure 1) was a guide in determining the final set of locations for the survey.

A summary of the proposed number of survey sites and minimum survey period required by road type within metropolitan areas is outlined in Figure 2.

From the list of road segments satisfying regional and road type distribution criteria, 132 traffic "free" flow sections were proposed for possible inclusion in the survey sample. Most of the proposed sections are characterised by representative speed limits for the road type.

Since one of the aims of the survey was to investigate driver speed compliance on various speed zones over all road types, some non-typical speed zone sections for a road type satisfying the selection criteria were included in the survey sample. For example, in addition to the typical 110 km/h legal speed limit sections on metropolitan State Roads and National Highways, in some cases, short sections, not less than 2 km, with lower speed limits were chosen in the sample. It is anticipated that the data obtained on the various speed limit sections will provide an insight into driver speed behaviours within and between various speed zones, as well as the effects of alternate speed zones on driver speed compliance when travelling from higher to lower zones.

Likewise, in order to achieve a satisfactory representation of all speed zones, a number of sections on Local Roads with speed zones higher than the typical 60 km zones were selected in the sample. The scope of the surveys from 2010 to 2018 were extended to include the 50 km/h and 110 km/h zones. Distribution of selected survey sites for 2000 baseline survey and 2018 survey by road type and various speed zones is presented in Appendix B and Appendix C, respectively.

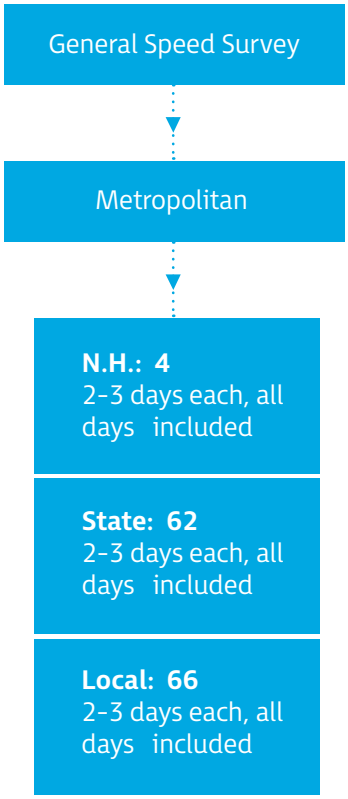


Figure 2. Proposed distribution of number of survey sites by road type and duration of the site surveys in the Perth metropolitan area

2.8 Speed Surveys Data Analysis

Data from each annual survey is processed and analysed according to the set objectives and aims outlined in Section 2 of this study. The principal objective of the surveys is to monitor change in driver speed behaviours over the network of roads. Speed behaviour measures are estimated using only vehicle travel speeds with the vehicle headways greater or equal to 4 seconds. Vehicles with lower headway values are excluded from the analysis.

Traffic classifiers used in the surveys generally provide necessary information regarding speed, headway, vehicle type and time of day. Each of these parameters is summarised by day of week and time of day, as required. The data has been arranged in a form most suitable for general and specific analyses of speed data by categories in the design of the survey.

The change in speed behaviours has been investigated across all factors considered in the survey, as outlined in the following sections. Driver speed behaviours within each of the strata or combination of strata are assessed in terms of change in traditionally used indices like mean, 85th percentile and proportions of vehicles travelling at various speeds. In assessing the significance of changes at each level of interest, care is taken to control for any confounding factors that may be represented in the survey design. Four areas of interest in speed analysis of annual surveys are changes in:

a) Speed compliance rates,

b) The proportion of drivers exceeding 10+ km/h above posted speed limits;

c) Various speed percentiles and speed groups; and

d) Mean speeds.

The change in the proportion of drivers exceeding a speed limit by 10+ km/h (10 km/h above the speed limit often considered by drivers as the enforcement speed tolerance level), could be a good measure of the speed enforcements effect on driver speed behaviours. Any speed enforcement effect that could be observed among speeding drivers may not necessarily have effect on overall speed compliance rate or average speed; however, it may have an effect on magnitude of speeds that drivers may choose to travel. Of course, enforcement effects may vary between regions, road types, legal speed limits and specific locations.

Before the first survey in 2000,no network representative speed data had ever been collected. Speed data collected in 2000 would be used as the baseline data for all subsequent surveys for evaluation purposes of the safety measures supporting the safe speeds cornerstone of the Towards Zero 2008 – 2020 road safety strategy . In broad terms, each of the surveys provides population estimates with respect the following:

1. General descriptive statistics (mean, 85th percentile, standard deviation);

2. Distribution of compliance rates by road type, days of the week and speed limit, if sufficient data is available;

3. Distribution of proportion of drivers travelling 10+ km/h above posted speed limits, ranging from 60 km/h to 100 km/h, and the default speed limit of 50 km/h;

4. Association between speed compliance, speeding and speed related crashes, particularly speed related serious injury crashes, depending on availability of the data.

Since the surveys are generally conducted annually, it is expected that this would result in a sufficient number of indices for analysis of trends and changes in speed behaviours over time. The data could be used to assess:

1. Changes in mean speeds relative to earlier surveys and baseline surveys;

2. Changes in compliance rates relative to earlier and baseline surveys;

3. Changes in the 85th percentiles;

4. Trend analysis of speed behaviour indices;

5. Changes in proportion of drivers exceeding 10+ km/h above the speed limit (or presumed speed tolerance level);

6. Differences between factor levels (road type, days of the week, speed limit, and factor interaction);

7. Effects speed enforcement programs on driver speed behaviour;

8. Needs for review of site specific, road or area specific speed limits; and the

9. Effects of speed behaviour changes on speed related crashes.

2.9 Survey Samples

The baseline speed survey was taken over the period April to June 2000 covering various road sections on National Highways, State Roads and Local roads with posted speed limits ranging from 60 km/h to 100 km/h. The 60 km/h roads initially included in the proposed sample and subsequently changed to the default speed limit of 50 km/h were excluded from the survey samples and the speed data analysis presented in the following sections. Similarly, the road sections that have changed speed limits over the time were also excluded from the current and subsequent surveys. As a result of the speed limit changes over time and absence of surveys of some sites in the metropolitan area, the sample size varied between the surveys.

Speed data was collected at each of the proposed locations in this baseline survey sample, which was to be used in all subsequent surveys. At the time of the 2003 survey, it was found that some of the road sections in the 2000 surveys were subsequently changed to different speed limits. Some 60 km/h roads became the 50 km/h roads while some of the higher speed road sections changed to higher or lower speed limits when compared to the speed limits that existed at the time of the baseline survey. After all associated exclusions, the proposed sample size of approximately 150 road sections was reduced to the final 2000 survey sample size of 132 that could be used as the baseline sample and the sample for future surveys. The sample distribution by road type is presented in Figure 2.

At the completion of the baseline survey the data was obtained for 118 road sections out of the proposed sample of 132 sites throughout the Perth metropolitan area. The metropolitan area sample was represented by 3 locations on National Highways, 31 on State Roads and 84 on Local roads (49 on Distributor A roads, 14 on Distributor B roads and 21 on Local Distributor roads).

Due to some difficulties in arranging data collection, the 2003 survey sample in the metropolitan area was reduced to 109 sites of roads or road sections. For similar reasons the number of sites surveyed in 2004 and 2005 was less than the number of sites surveyed in the 2000 survey, 112 and 106 sites, respectively. On the other hand, in 2007 the data collection was successfully completed by counting 118 sites in the metropolitan area. The sample size in 2008, 2010 and 2011 was reduced to 98, 113 and 108, respectively and 2012, 2013, 2014, 2015 and 2018 was increased to 123, 115, 130, 149 and 157 sites, respectively.

The sample size in the Perth metropolitan speed surveys conducted in 2008, 2010, 2011, 2012, 2013, 2014, 2015 and 2018 included 16, 20, 22, 25, 23, 24, 42 and 42 sites on the 50 km/h local roads network, respectively. Over the same period up to 4 sites on 110 km/h could have been surveyed due to short sections of the network within the metropolitan area and practicality to conduct the survey at the time of the survey program.

For the purpose of consistency in the speed data analysis and comparisons between the surveys all sites surveyed in the 2000 or any other subsequent survey that were identified as the roads that changed the speed limit, such as some of the 60 km/h roads, to the default speed limit of 50 km/h, were excluded from the speed data analysis and derivation of the speed indices. It is acknowledged that the exclusion of these types of roads from the sample, compared to the baseline survey, would result in biased estimates of the speed indices towards higher rather than lower values due to specific characteristics of the roads which the lower speed limit was warranted for at the time of the introduction of the default 50 km/h speed limit on the local road network. However, separate speed indices were determined for the samples of 50 km/h and 110 km/h roads that have been included in the surveys since 2008.

The distribution of road sections by speed limit surveyed in 2000, and the two most recent surveys conducted in 2015 and 2018 is presented in Table 4, below.

		2000							2015								2018							
Region		**60**	**70**	**80**	**90**	**100**	**110**	**Total**	**50**	**60**	**70**	**80**	**90**	**100**	**110**	**Total**	**50**	**60**	**70**	**80**	**90**	**100**	**110**	**Total**
Metropolitan	Local	60	17	7	-	-	-	84	42	35	27	2	2	0	1	109	42	39	24	3	2	0	2	112
	State	4	11	7	7	5	-	34	0	8	10	10	7	3	2	40	0	8	11	11	7	6	2	45
	Total	64	28	14	7	5	-	118	42	43	37	12	9	3	3	149	42	47	35	14	9	6	4	157

Table 4. Distribution of samples by road and speed limit in the 2000, 2015 and 2018 surveys

DATA ANALYSIS AND DISCUSSION

3

Comparison between the thirteen surveys conducted between 2000 and 2018 on driver speed behaviour indices is based on the samples of road sections, distributed by speed limits. The driver behaviour indices measured in the surveys are based on vehicle speeds with headway greater or equal to four seconds. All other speeds that do not satisfy this criterion are excluded from derivation of the speed indices estimates used in this study.

The metropolitan driver speed behaviour indices are determined from the vehicle speed data collected over two days on each of the locations in the sample in each of the surveys. All additional data that could have been collected in excess of consecutive 48 hours in the metropolitan sample locations were discarded due to possible variation in driver speed behaviours between days of the week and times of day. The various speed limit sites in the sample were randomly surveyed over the seven days for a period of at least two days.

3.1 Overall Network Comparison between Surveys

The surveys in the metropolitan area recorded 1.90 million vehicles in the 2000, 2.47 million in the 2003, 2.79 million in the 2004, 2.81 million in the 2005, 3.03 million in the 2007, 2.30 million in the 2008, 2.88 million in the 2010, 2.80 million in the 2011, 3.12 million in the 2012, 3.16 million in the 2013, 3.60 million in the 2014, 3.44 million in the 2015 and 4.07 million in the 2018 survey.

The number of vehicles represented by bicycles in the surveys was estimated at 0.24%, 0.13%, 0.13%, 0.85%, 0.46%, 0.23%, 0.18%, 0.27%, 0.23%, 0.27%, 0.35%, 0.29% and 0.41%, respectively. After excluding bicycles and all other vehicles with the headways less than 4 seconds, vehicles that did not travel under free-flowing condition (Standards Australia, 1999), the sample of vehicles used in the analysis was reduced to 1.15 million in 2000, 1.28 million in 2003, 1.37 million in 2004, 1.25 million in 2005, 1.51 million in 2007, 1.24 million in the 2008, 1.56 million in the 2010, 1.45 million in the 2011, 1.63 million in the 2012, 1.57 million in the 2013, 1.80 million in the 2014, 1.74 million in the 2015 and 2.0 million in the 2018 survey.

The number of vehicles represented by motorcycles in the surveys was estimated at 0.51%, 0.63%, 0.43%, 1.01%, 0.66%, 0.71%, 0.74%, 0.60%, 0.55%, 0.79%, 0.67%, 0.69% and 0.64%, respectively.

If it was assumed that each vehicle was recorded at only one road section in the survey during the survey period and passed the survey spot twice a day, once in each direction of travel, then the estimate of number of different drivers recorded in the metropolitan area would be in the range of 280000 drivers in the year 2000, 310000 drivers in the year 2003, 340000 in 2004, 310000 in 2005, 370000 in 2007, 310000 in 2008, 390000 in 2010, 360000 in 2011, 400000 in 2012, 390000 in 2013, 450000 in 2014, 430000 in 2015 and 500000 in 2018 survey travelling in the traffic free-flowing environments on the sample of metropolitan roads. Each of the drivers is assumed to be associated with unique and independent speed behaviour.

3.1.1 Driver Compliance to Speed Limits

All Types of Vehicles

An analysis of the speed data suggests that under free-flowing conditions over the Perth metropolitan network of all speed limits compliance rate varied from year to year, ranging from 53.0% to 69.5%. The compliance rates by year are presented in Table 5, below.

Year	Compliance Rate (%)
2000	53.0
2003	57.4
2004	55.7
2005	57.9
2007	56.9
2008	57.6
2010	60.2
2011	59.8
2012	63.1
2013	64.3
2014	66.6
2015	64.1
2018	69.5

Table 5. Driver compliance to speed limits by survey year

The compliance rate in 2003 increased by 4.4% to 57.4% from the compliance recorded in 2000. This compliance rate had been fairly consistent until 2008, ranging between 55.7% in 2004 being the lowest and 57.9% in 2005 being the highest, followed by a substantial increase to 60.2% in 2010, a slight decrease to 59.8% in 2011 and a significant increase to 63.1%, 64.3%, 66.6%, 64.1% and ever best 69.5% in 2012, 2013, 2014, 2015 and 2018 survey, respectively (see graph in Figure 3).

From 2000 to 2018 the percentage of drivers travelling at speeds within the speed limit has increased by 16.5%, from 53.0% to 69.5%. The average network compliance for the most recent three surveys over the 5 years period 2014 to 2018 was estimated at 66.7%, 13.7% higher than in the baseline survey conducted in 2000 (ref. Figure 3).

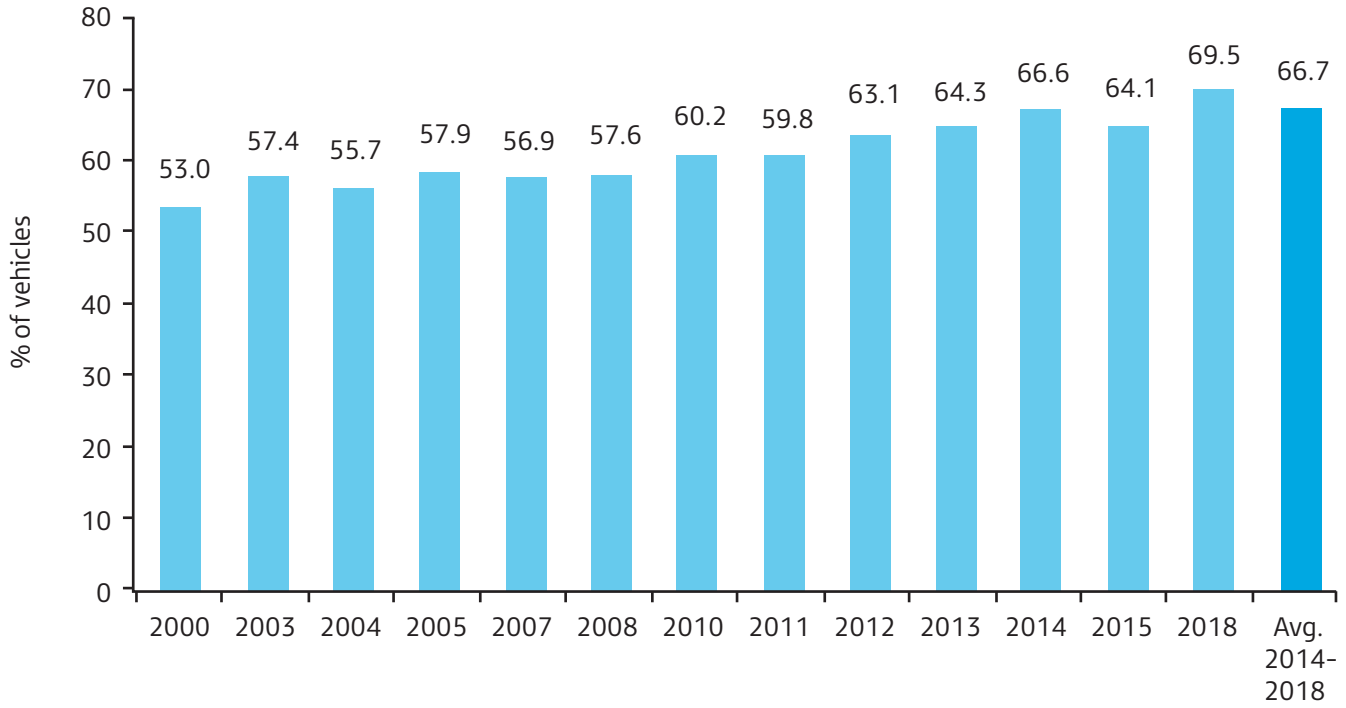


Figure 3. Driver speed compliance to speed limits across the metropolitan road network 2000 to 2018

The compliance rate (percentage of vehicles travelled at or below posted speed limits) on state and local road network of all speed limits in 2000 was 60.7% on state roads and 49.1% on local roads. The compliance rate varied from 2003 to 2015, ranging from 59.1% to 66.1% on state roads and 54.3% to 66.9% on local roads. The highest compliance rate was recorded on state road and local road in the 2018 survey at approx. 70.6% and 68.5, 10.0% and 19.4% higher than in 2000 survey, respectively.

The average network compliance for the most recent three surveys over the 5 years period 2014 to 2018 on state road and local road were estimated at 67.2% and 66.3%, 6.5% and 17.2% higher than in the baseline survey conducted in 2000, respectively (ref Figure 4).

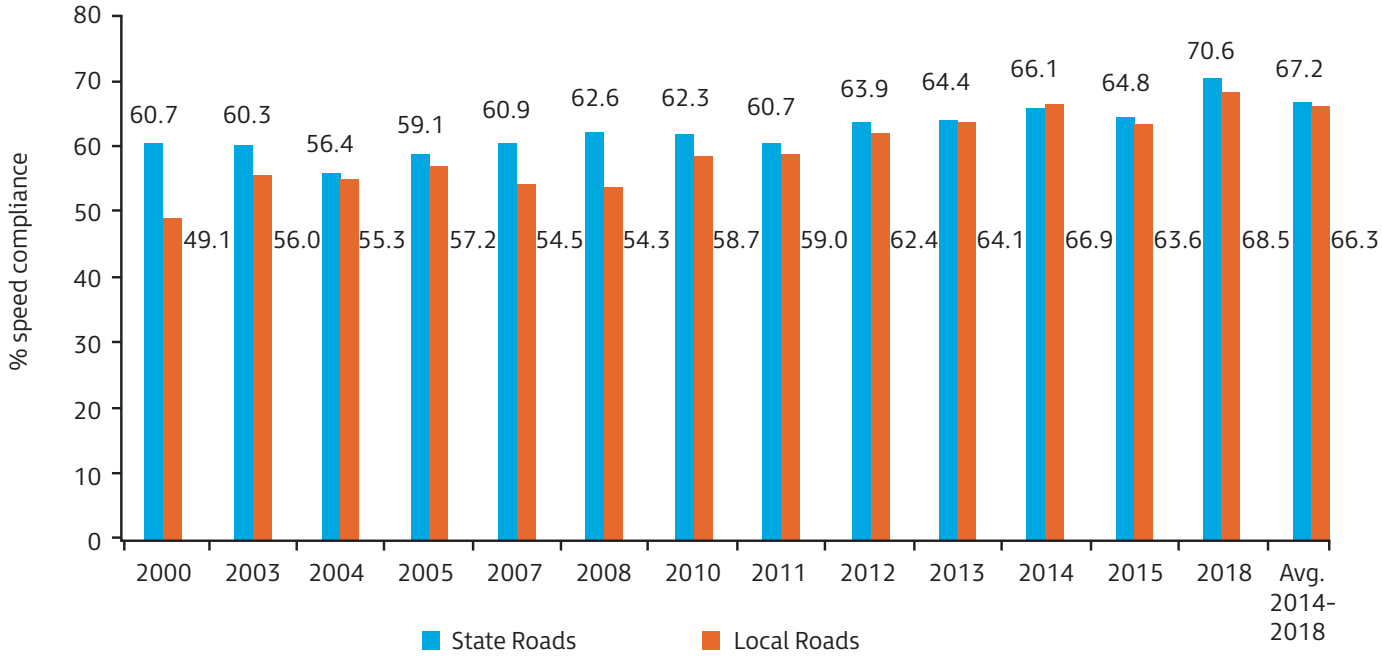


Figure 4. Driver speed compliance to speed limits across the metropolitan state and local roads network 2000 to 2018

Motorcycles Compliance Rates

The speed compliance for motorcycles not restricted to free-flowing conditions over the period 2000 to 2005 was 49.0%. The compliance rate varied from 2007 to 2015, ranging from 46.0% to 53.6%. The compliance rate was recorded in the 2018 survey at 56.5%, 7.5% higher than the period 2000 to 2005. The average network compliance for the most recent three surveys over the 5 years period 2014 to 2018 was estimated at 54.5%, 5.4% higher than the period 2000 to 2005 (ref Figure 5).

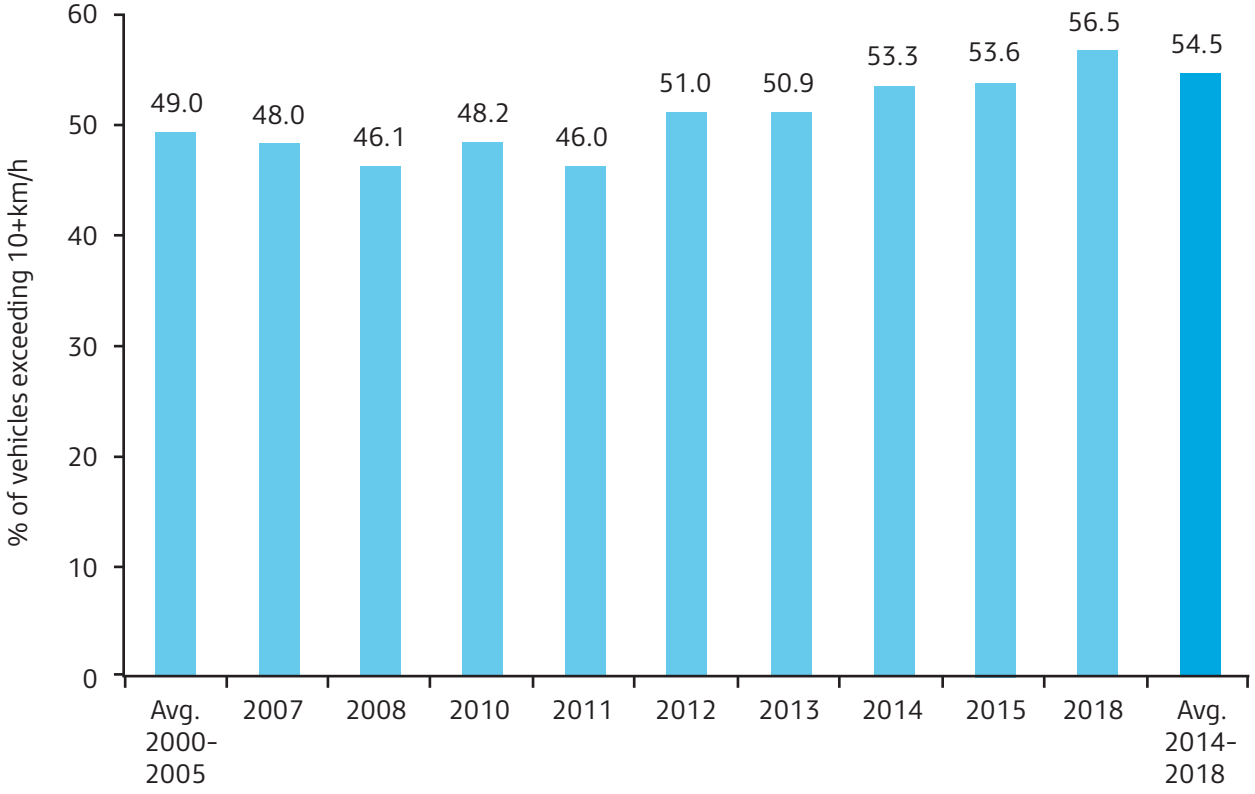


Figure 5. Motorcyclist speed compliance to speed limits across the metropolitan road network 2000 to 2018

Vehicle Excessive Travel Speeds – 10 km/h Above Speed Limit

Similar to the increase in the general speed limit compliance rate, in 2003 more drivers were inclined to maintain speeds within presumed tolerance level of 10 km/h above the speed limit than in 2000, such that there was 25% reduction in the proportion of drivers exceeding this "tolerance level", from 12.6% of all drivers observed in free-flowing traffic environments in 2000 to 9.4% in 2003 (ref. Figure 6).

The significant decrease in number of speeding drivers in 2003 was followed by further decreases in 2004 and 2005 to 8.9% and 7.9%, respectively. The number of speeding drivers decreased to 7.7% in 2007, remained at the similar level of 7.6% in 2008 and a further decrease of 1.2% and 0.6% to 6.4% and 5.8% in 2010 and 2011, respectively, followed by a substantial decrease of 1.0% to 4.8% and 0.7% to 4.1% in 2012 and 2013, respectively and a further decrease of 0.2% to 3.9% in 2014 and a minor increase of 0.1% to 4.0% in 2015 followed by a small decrease of 0.6% to ever lowest 3.4% in 2018 approximately 73.3% less than what was observed in 2000.

Apart from some variability in the interim period between 2000 and 2018, overall driver speed behaviours have significantly improved. The number of speeding drivers has significantly declined over the last 13 years.

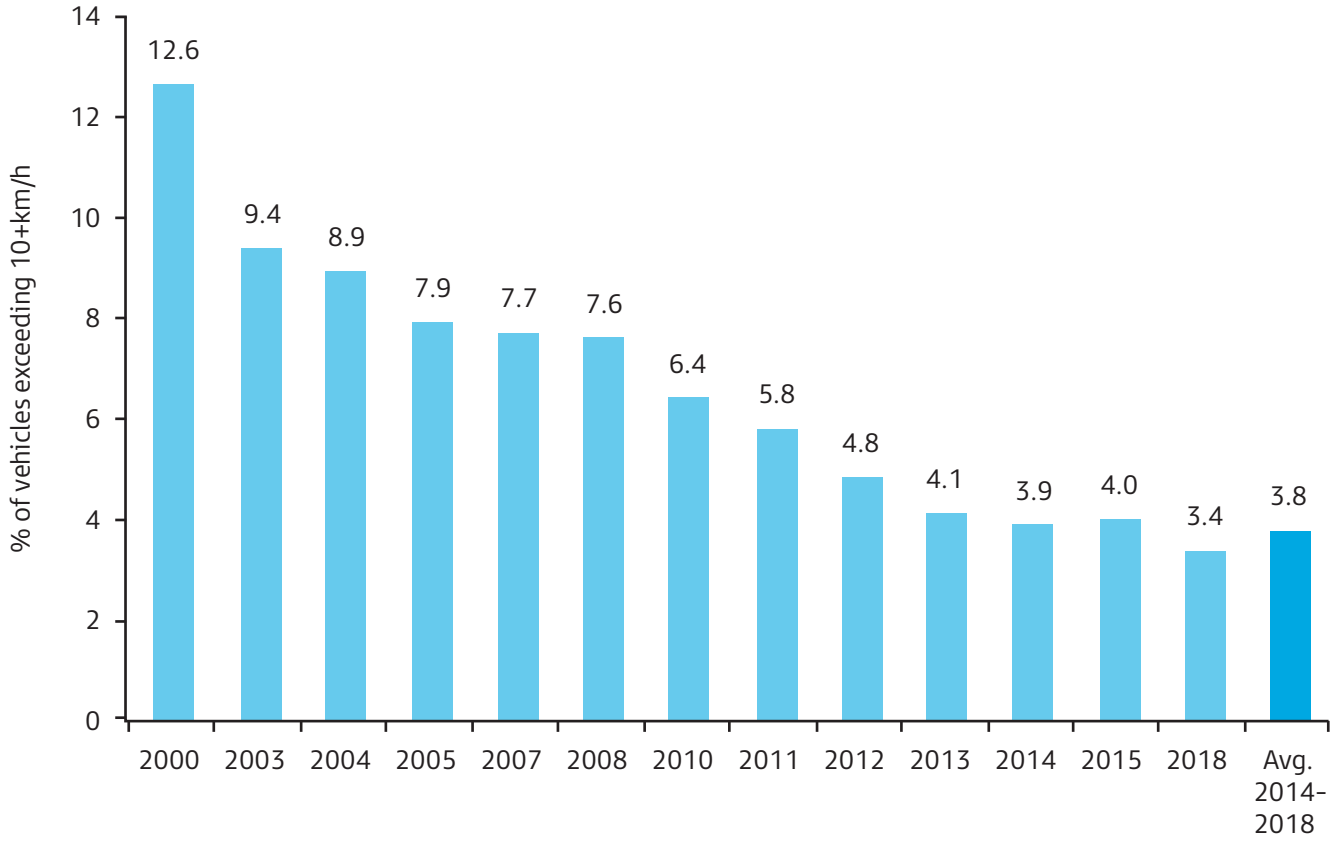


Figure 6. Percentage of drivers travelling 10+ km/h above the speed limit 2000 to 2018

Since 2000 the number of speeding drivers on the metropolitan network has substantially reduced, ranging from 26% in 2003 to 73.3% in 2018 (see Figure 7 below). The reductions in the number of speeding drivers were correlated to the overall speed compliance to the speed limit.

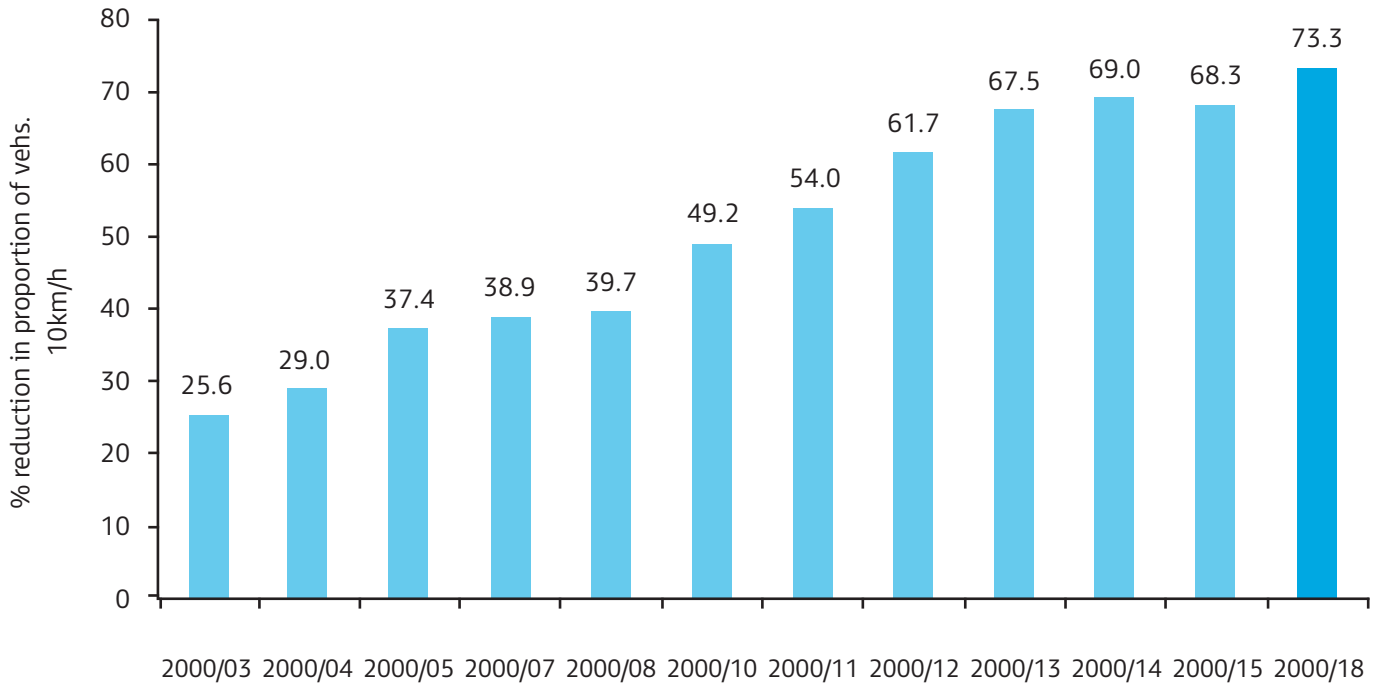


Figure 7. Percentage reduction in proportion of vehicles travelling 10+ km/h above the speed limit between 2003 and 2018 compared to 2000, Perth metropolitan area

From 2000 to 2003 the percentage of speeding drivers decreased to 9.4%, representing a percentage decrease of 26% in the proportion of speeding drivers recorded in the base year, 2000. Since 2003 relative to the base year the percentage of speeding drivers, travelling in excess of 10 km/h above the speed limit have significantly reduced, up to 73.3% as recorded in 2018.

Differences between State and Local Roads in Excessive Travel Speeds

In 2000, the number of speeding drivers on Perth metropolitan state and local roads network was recorded at 10.2% and 13.8%, respectively. The percentage of speeding drivers varied from 2003 to 2015, ranging from 3.8% to 9.1% on state roads and 3.9% to 9.5% on local roads. However, since then the percentage of speeding drivers dropped to 2.9% and 3.8% on state and local roads, respectively in the most recent 2018 survey, a substantial reduction of 7.3% and 10.0%, respectively when compared to the baseline 2000 survey. The average number of speeding drivers for most recent three surveys over the 5 year period 2014 to 2018 on state and local roads were estimated at 3.5% and 4.0%, 6.7% and 9.8% less than in the baseline survey conducted in 2000, respectively (see Figure 8 below).

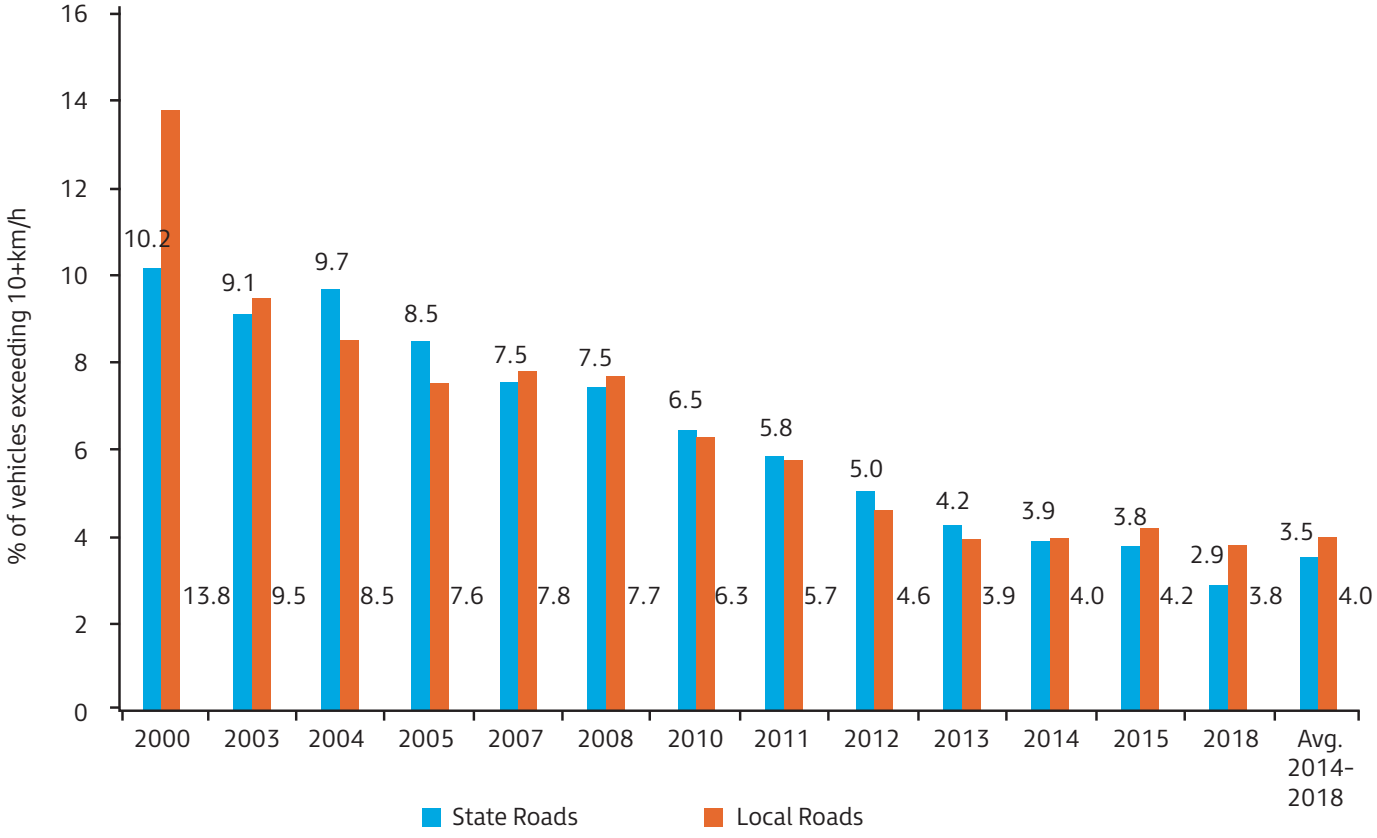


Figure 8. Percentage of drivers travelling 10+ km/h above the speed limit across the metropolitan state and local roads network 2000 to 2018

Motorcycle Excessive Travel Speeds

The percentage of motorcycles speeding is not restricted to free-flowing conditions, over the metropolitan road network of all speed limits over the period 2000 to 2005, 23.4% of all motorcyclists travelled with speeds exceeding 10 km/h above the speed limit. The percentage of speeding motorcyclists varied from 2003 to 2015, ranging from 13.6% to 20.6% across all speed limit roads. *The percentage of speeding drivers dropped to 11.7% in **2018**, 11.7% less than the period 2000 to 2005.* The average percentage of speeding drivers for the most recent three surveys over the 5 years period 2014 to 2018 was estimated at 13.5%, 9.9% less than the period 2000 to 2005.

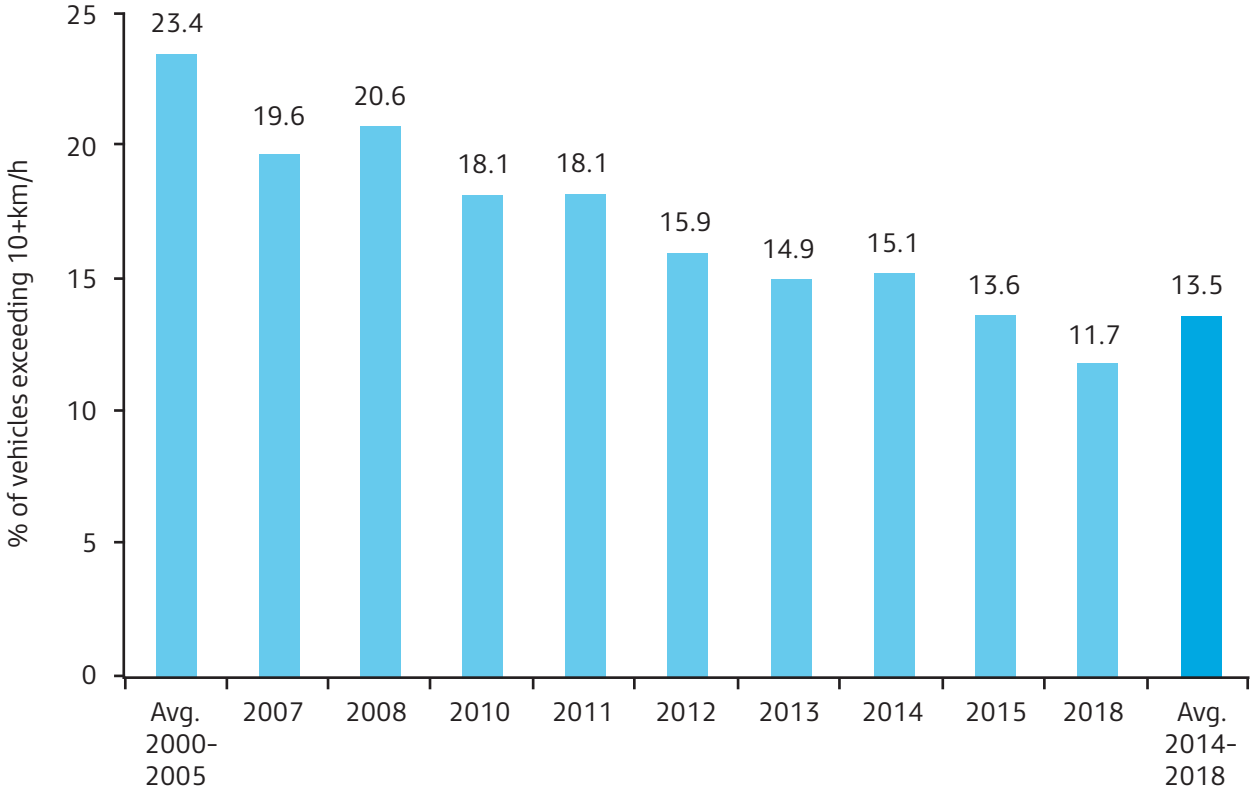


Figure 9. Percentage of motorcyclists travelling 10+ km/h above the speed limit 2000 to 2018

Further analyses indicated that driver speed behaviours measured in terms of percentage of vehicles exceeding the speed limit and presumed speed tolerance level of 10+ km/h above the speed limit varied between the speed limits, days of the week and time of the day.

Compliance by Speed Limits

The poorest compliance to the speed limit was observed on 60 km/h roads ranging from 46.1% in 2000 to 67.8% in 2018, nevertheless an increase of 21.7%.

From 2000 to 2018, the compliance rate on the 70 km/h and 80 km/h has on average increased by 16.1% and 15.4%, from 52.9% to 68.9% and from 59.6% to 75.0%, respectively (ref. Figure 10).

Since 2000, the higher speed limit roads such as 90 km/h and 100 km/h roads experienced a substantial variability in the compliance rates from survey to survey. Overall, the trend for the 90 km/h roads remained constant over the period, whereas the trend for the 100 km/h seems to be negative showing the reduction in the compliance rate. Compared to the 2000 survey the 2018 survey recorded a substantial reduction in compliance rate of 2.3% on 90 km/h roads and 13.0% on 100 km/h roads.

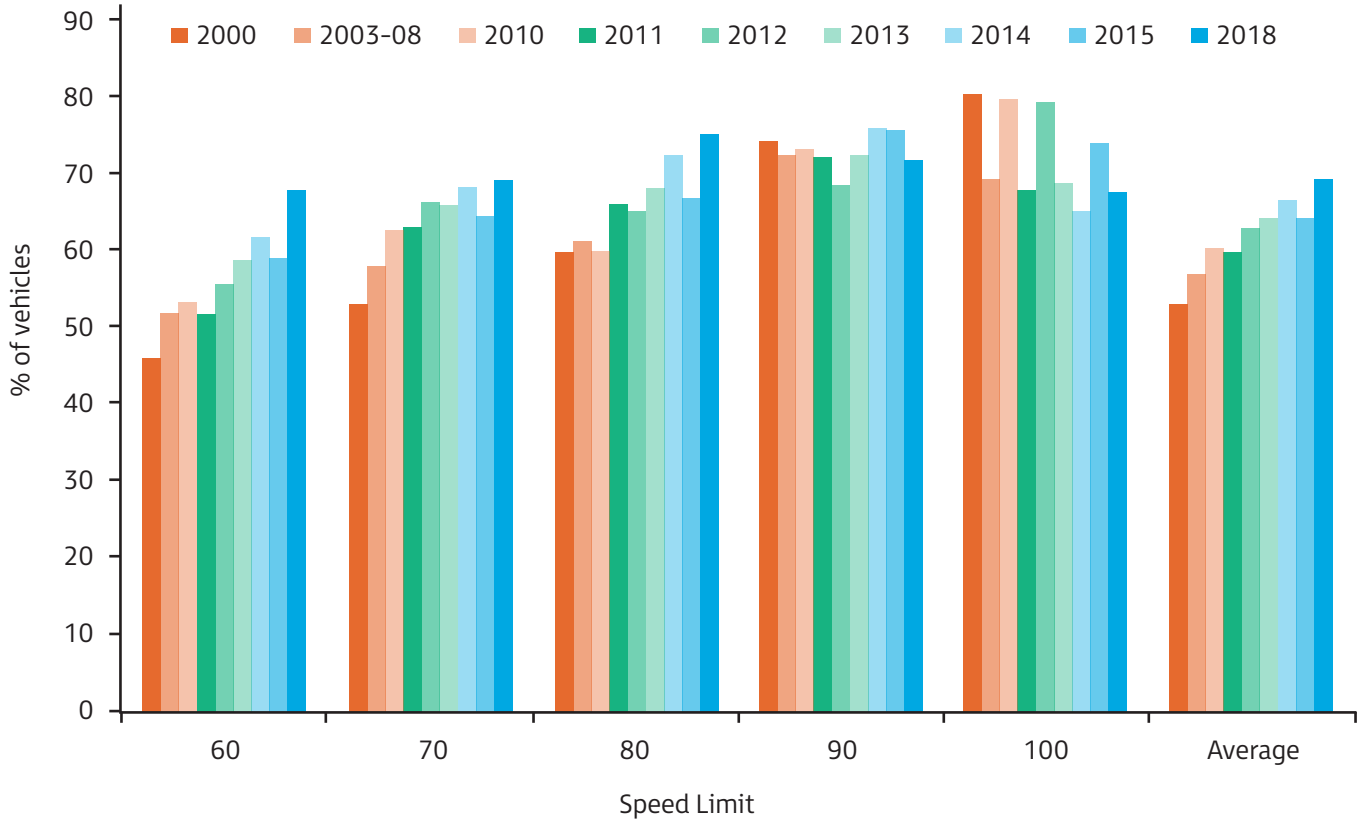


Figure 10. Compliance rate by speed limit across the metropolitan road network

The most positive findings arising from the surveys is that despite the variability in the compliance rates over the last eighteen years the network compliance rate increased to a significantly higher level than what it was in 2000.

Compared to the 2000 survey, over the period 2003 to 2008 the overall average compliance rate increased by 4.0%, followed by a further increase of 3.2% in 2010, a slight reduction of 0.4% in 2011, a substantial increase of 3.3% and 1.2% in 2012 and 2013, respectively and a further increase of 2.3% to the highest 66.6% in 2014, followed by a small reduction of 2.5% to the compliance of 64.1% in 2015 and a further substantial increase of 5.3% to the compliance of ever best 69.5% in the most recent 2018 survey, 16.5% higher than in the 2000 baseline survey.

3.1.2 Vehicles Travelling at Excessive Speeds - 10+ km/h above Speed Limit

Since 2000 all speed limit roads showed substantial reductions in the proportions of drivers travelling at high speeds, 10 or more km/h above the speed limit. Despite some variations between the interim years between 2000 and 2018, all roads, on average, recorded a reduction in the number of speeding drivers relative to the percentage recorded in the 2000 survey.

The reduction in the number of vehicles travelling 10+ km/h above the speed limit in 2003-2008 period compared to 2000 ranged from 39% on 60 km/h and 29% on 80 km/h roads to the minimum of 27% on 70 km/h and 26% on 90 km/h roads except an increase of 39% estimated for 100 km/h roads over the same period (see Figure 11).

In 2000, the percentage of drivers travelling 10+ km/h above the speed limit of 12.6% reduced to the average of 8.3% over the period 2003-2008, down to ever lowest 3.4% in 2018. Compared to the averages by speed limit for the period 2003-2008, the 2018 survey has shown further reductions in the percentage of vehicles travelling at the excessive speeds ranging from 68% on 60 km/h, 61% on 100 km/h, 54% on 80 km/h and 90 km/h roads, respectively to the minimum of 47% on 70 km/h roads (see Figure 11).

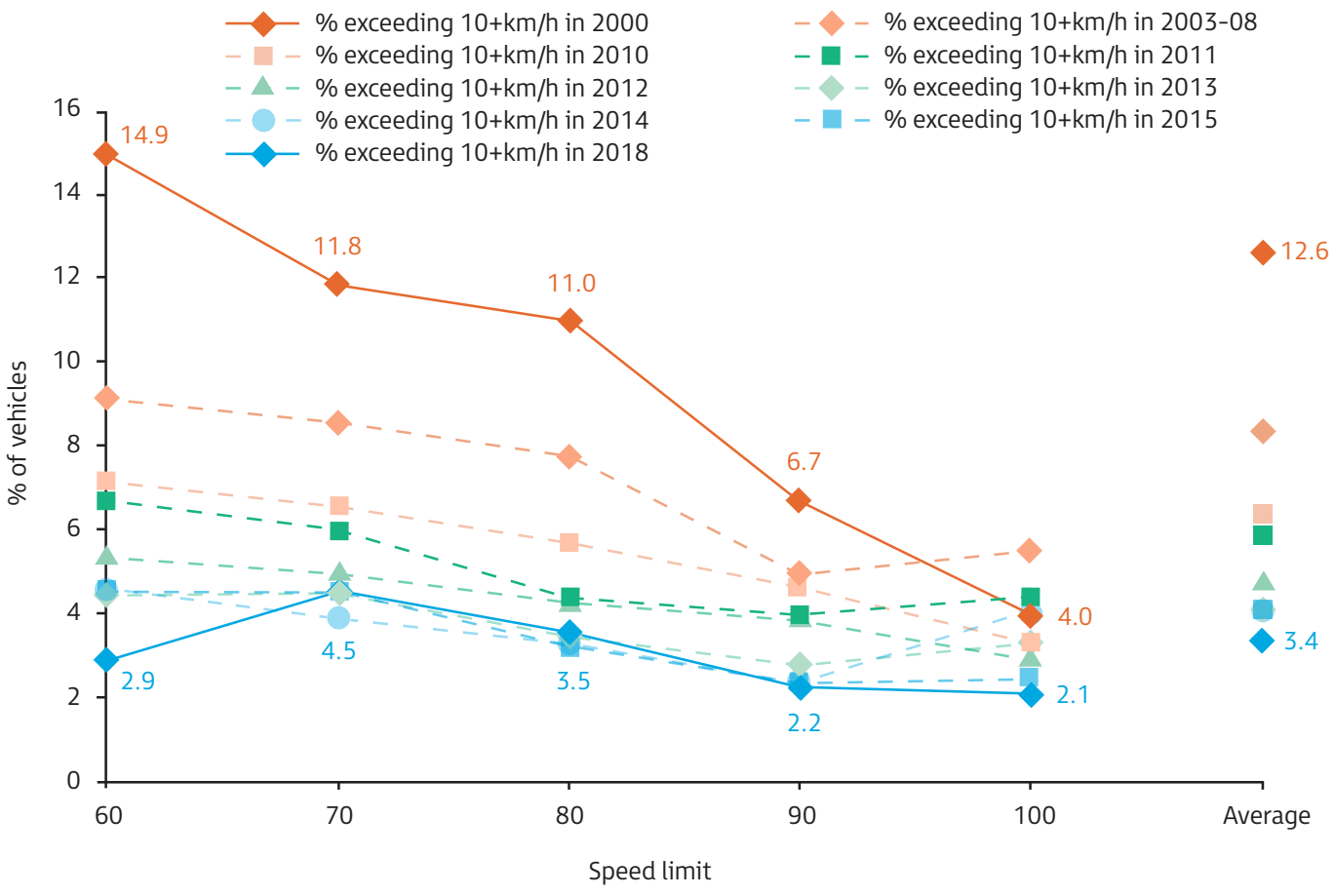


Figure 11. Percentage of vehicles travelling 10+ km/h above speed limit by survey and posted speed limit, Perth metropolitan area

The average percentage of speeding drivers over the 2003 to 2018 period ranged between 3.9% on 90 km/h roads to 6.7% on 60 km/h roads.

The steady reductions in the percentage of vehicles travelling 10+ km/h above the speed limit over the 2003 to 2015 period, at the average of 6.4%, followed by a reduction to 3.4% in 2018 survey.

The reduction in the number of speeding drivers in 2018 compared to the number recorded in 2000 ranged between 46% on 100 km/h roads, 61% on 70 km/h roads, 66% on 90 km/h roads and 67% on 80 km/h roads to 80% on 60 km/h roads.

Figure 11 above indicates that the magnitude of the differences in proportions of speeding drivers between lower and higher speed limit roads has significantly reduced over the period 2000 to 2018. The statistics presented in the figure demonstrate that over the period speed reduction strategies have had significantly larger effects on travel speed reductions on the lower spectrum of speed limit roads than on the higher speed limit roads.

3.1.3 Compliance to 10+ km/h above Speed Limit by Hour

As shown in Figure 12, drivers are more likely to travel at excessive speeds, 10+ km/h above speed limits during night hours, from 7 p.m. to 7 a.m. As expected, the patterns of driver speed behaviours are similar between the survey years. Apart from differences in magnitudes of proportions of drivers travelling 10+ km/h above the speed limit no significant changes in the pattern was observed in neither of the surveys.

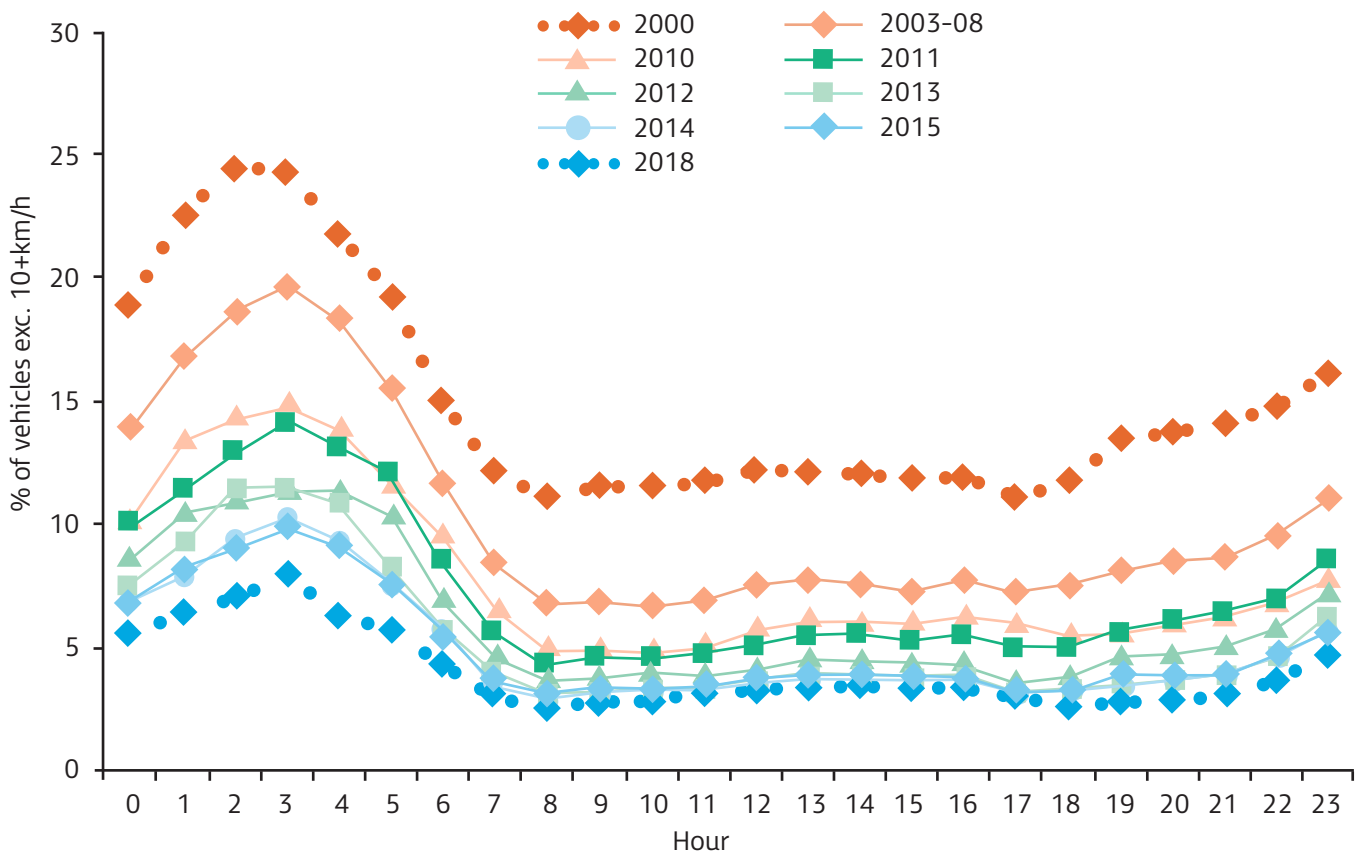


Figure 12. Percentage of vehicles travelling 10+ km/h above speed limit by hour of the day, Perth metropolitan area

The percentage change in number of drivers travelling at excessive speeds from 2003 to 2018 has been fairly consistent across all hours of the day when compared to the percentage of drivers travelling at those speeds in 2000.

On average, the highest travel speeds are expected to occur between 11 p.m. and 6 a.m. The percentage of speeding drivers during this period in 2018 ranged from 4% to 8%. In all survey the least number of speeding drivers were recorded between 8 a.m. and 12 a.m., approximately 3% in 2018.

The best driver speed behaviours across all hours of the day were recorded in 2018. When compared to the 2000 baseline survey, the reduction in the percentage of vehicles travelling 10+ km/h above the speed limit across all hours of the day in 2018 ranged from 67% to 79%.

3.1.4 Compliance by Day of Week

Compliance to Speed Limit

The surveys from 2003 to 2018 indicated that, in general, the highest compliance to speed limits occurs from Monday to Wednesday, followed by Thursday to Friday, on average 64% and 60%, respectively, significantly less on Saturday and Sunday, average of 57%.

The distribution of speed limit compliance rates by day of week is presented in Figure 9, below.

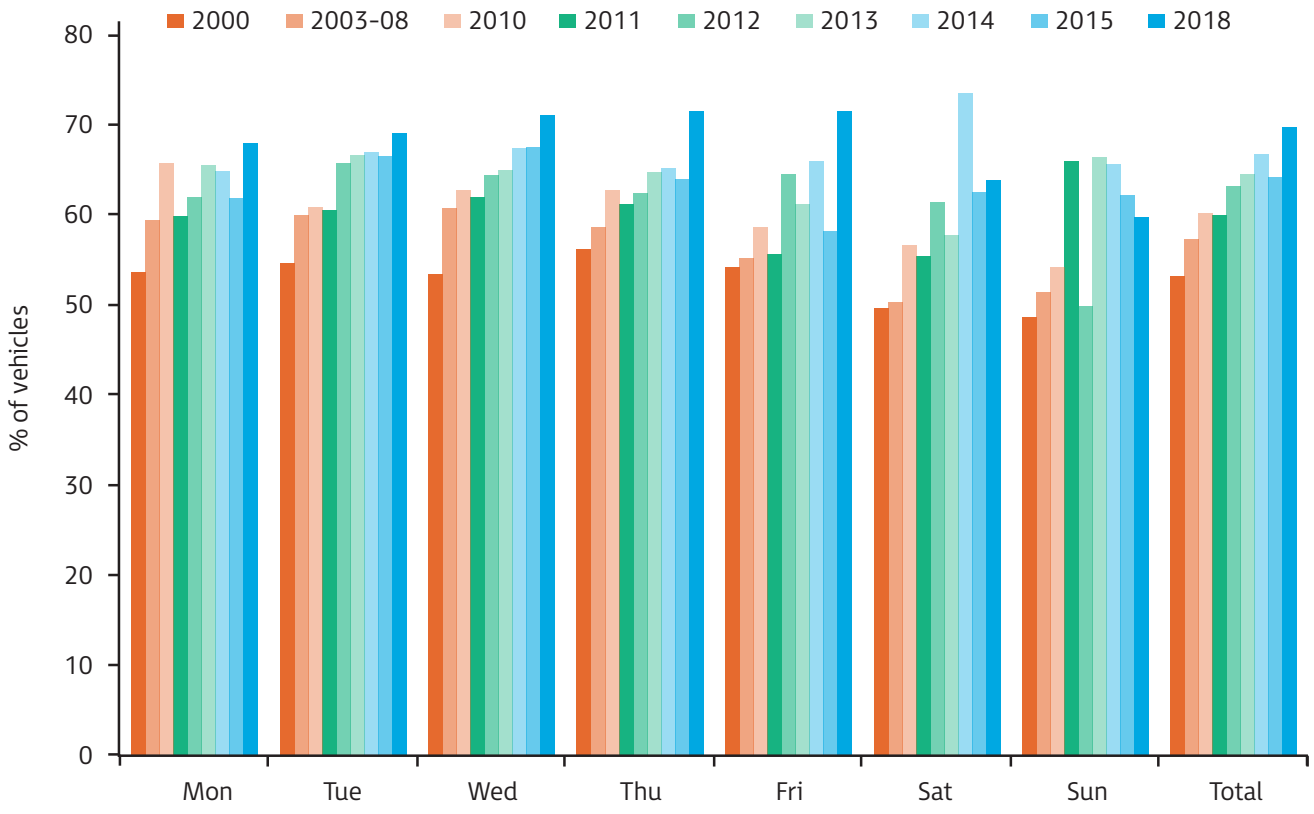


Figure 13. Compliance rate by day of the week in the Perth metropolitan area

Excessive Travel Speeds 10 + km/h above Speed Limit

In general, excessive travel speeds are inversely related to overall compliance to speed limits. The highest compliance to the speed limit is associated with the lowest percentage of vehicles travelling with speeds 10 or more km/h above the speed limit.

Over most of the surveys Sunday, followed by Saturday were found to be the days with the highest percentage of drivers exceeding 10 or more km/h above the speed limit, ranging from 2.6 % on Saturday in 2014 to 13.9% on Sunday in 2000, significantly less in 2014, at 3.9% (see Figure 14).

Across all surveys, the average weekday percentage of drivers travelling at high speeds was estimated at 6.3%, compared to the average week-end percentage of 8.0%.

In the most recent 2018 survey, the average percentage of speeding drivers on weekdays was estimated at 3.0%, compared to the significantly higher weekend average of 7.6% that is, 3.9% higher than the average weekend percentage for the most recent two surveys 2014 and 2015, estimated at 3.7%.

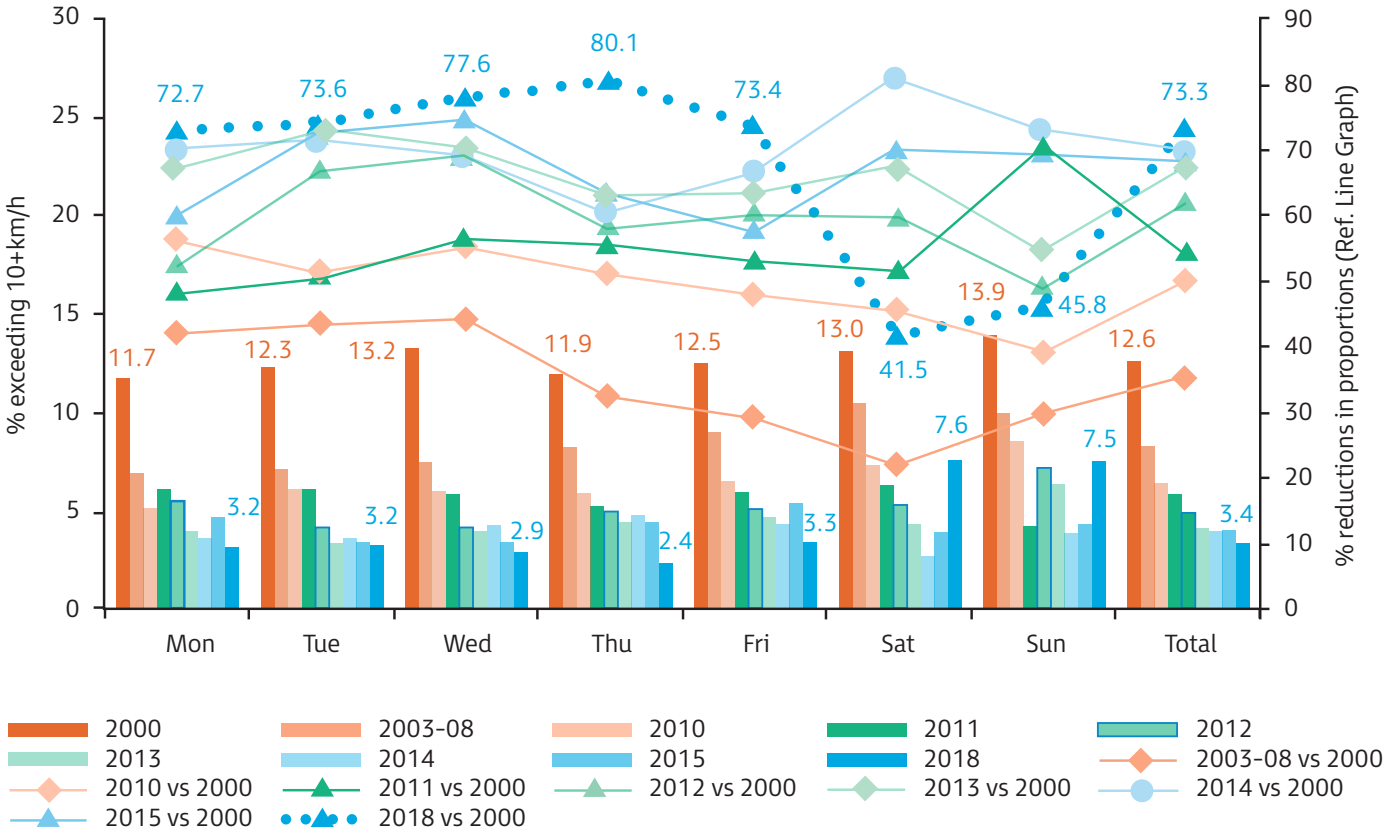


Figure 14. Percentage of vehicles exceeding 10+ km/h above speed limit by day of the week, Perth metropolitan area

The best performing days in 2018 were Thursday and Wednesday at 2.6% followed by Monday, Tuesday and Friday at 3.2% and the worst days of the week were Sunday and Saturday with 7.6% of vehicles exceeding 10 km/h above the speed limit.

The estimated average weekday and weekend percentage of drivers travelling 10 or more km/h above the speed limit by survey year is shown in Table 6, below.

Survey	Weekday %	Weekend %
2000	12.3	13.5
2003	8.8	9.9
2004	7.7	12.2
2005	6.6	11.4
2007	6.9	9.5
2008	8.0	8.5
2010	5.9	7.8
2011	5.8	5.2
2012	4.7	6.2
2013	4.1	5.3
2014	4.1	**3.2**
2015	4.2	4.1
2018	**3.0**	7.6

Table 6. Average weekday and weekend percentage of drivers travelling 10 or more km/h above the speed limit by survey year

In general, across all survey years, the highest percentage of speeding drivers, travelling 10 or more kilometres above the speed limit was recorded on week-ends except in 2011, 2014 and 2015 when the average percentage of the drivers travelling at the excessive speeds was slightly lower than the average for the weekdays.

The highest reduction in the percentage of speeding drivers in 2018 compared to 2000 was achieved on Thursday (80%) and the least on Saturday (42%).

3.2 Differences in Mean Speeds and 85th Percentiles

In addition to the differences in the speed limit compliance and the percentage of speeding drivers between the survey years the study also examined the differences in other speed indices such as mean speeds and the 85th percentiles.

3.2.1 Differences in Mean Speeds

Differences in Mean Speeds between the Surveys - Metropolitan Area

An analysis of the mean speeds between the survey years and the speed limits showed that, in general, the mean vehicle travel speed has reduced over the period 2000 to 2018.

As indicated in Figure 15, all speed limits, apart from 90 km/h and 100 km/h (with some large variability between the years), demonstrated a downward trend in the mean speed distributions by survey years.

Figure 15. Mean speed by speed limit and survey year, Perth metropolitan area

60 km/h Roads

In the 2003-2008 period, the mean speed on 60 km/h metropolitan roads was reduced by 1.7 km/h in comparison to the mean recorded in the 2000 survey of 60.6 km/h. From 2003-2008 period there was a minor decrease in the mean speed to the value of 58.4 km/h in 2010, followed by a slight increase in the mean speed to the value of 59.1 km/h in 2011, a minor decrease in the mean speed to the value of 58.2 km/h in 2012, a further decrease to 57.6 km/h in 2013, a minor decrease to 57.3 km/h in 2014, a slight increase to 57.9 km/h in 2015 and a substantial decrease to 55.9 km/h in 2018 which was 4.1 km/h less than the corresponding speed limit of 60 km/h, and 4.8 km/h less than the mean speed in 2000.

70 km/h and 80 km/h Roads

Average mean speeds across all surveys on the 70 km/h and 80 km/h roads were 2 to 3 km/h less than the corresponding speed limits. Drivers on these roads have seemed to travel at slower speeds relative to the speed limit than drivers on the 60 km/h roads with the average mean speeds 1.6 km/h less than the corresponding speed limits (see the means by year in Table 7). In 2018, the mean speed on 70 km/h roads was estimated at 3.5 km/h below the speed limit, and on 80 km/h roads 7 km/h below the speed limit.

90 km/h and 100 km/h Roads

Mean travel speeds on 90 km/h and 100 km/h roads remained fairly constant over the survey years at approximately 84 km/h and 94 km/h, respectively. Compared to 2000, the surveys conducted between 2003 and 2018 showed that the mean speeds on the 90 km/h and 100 km/h varied in magnitudes, with recorded increases in 2018 of 2.7 km/h and 5.0 km/h, respectively.

The changes in mean speeds by speed limit and survey year are presented in Figures 16 and Table 7 below.

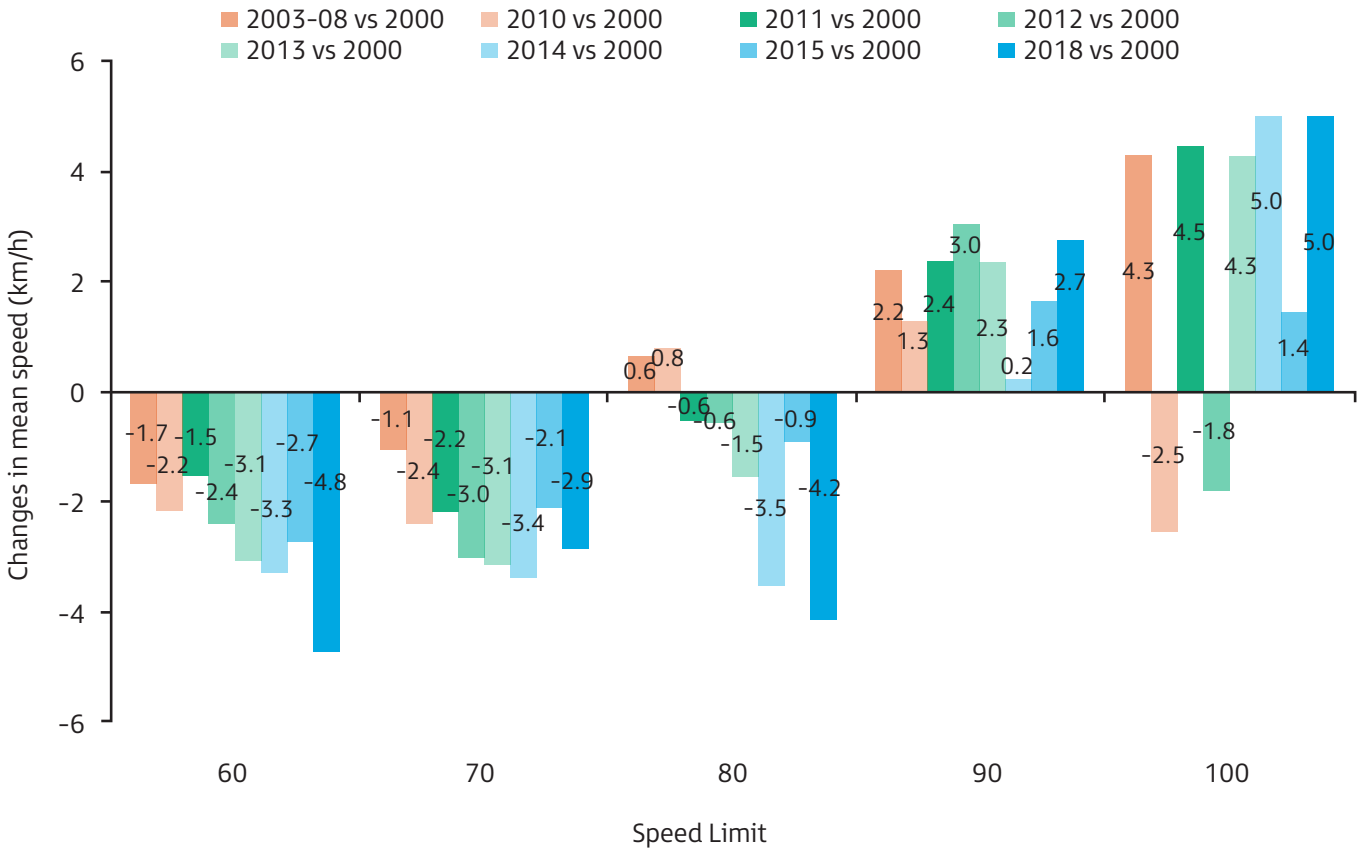


Figure 16. Differences in mean speeds between survey years on various speed limit roads, Perth metropolitan area

Survey Year	Distribution characteristic	Speed limit				
		60	70	80	90	100
2000	No. of vehicle surveyed	597895	272628	138736	85775	51222
	Mean speed	60.6	69.4	77.1	82.6	91.2
	Std. Dev.	10.6	10.1	11.7	12.7	11.6
	85th percentile	69.9	78.4	87.9	94.1	101.7
	% of vehicles exceeding speed limit	53.9	47.2	40.4	25.9	19.6
	% of vehicles exceeding enforcement speed limit	14.9	11.8	11.0	6.7	4.0
	Total no.exceeding 10 km/h above the speed limits			**144443 (12.6%)**		
	Total no.exceeding speed limit - all speed limits			**538884 (47.0%)**		
2003-2008	No. of vehicles surveyed	2998155	2013277	877551	452185	322732
	Mean speed	58.9	68.3	77.8	84.8	95.4
	Std. Dev.	9.9	9.7	9.9	10.3	10.3
	85th percentile	67.3	76.7	86.0	93.6	104.2
	% of vehicles exceeding speed limit	48.3	42.2	38.8	27.7	30.7
	% of vehicles exceeding 10+ km/h above speed limit	9.1	8.6	7.8	4.9	5.5
	Total no.exceeding 10 km/h above the speed limits			**552948(8.3%)**		
	Total no.exceeding speed limit - all speed limits			**2862711(43.0%)**		
2010	No. of vehicles surveyed	664414	521596	171508	127326	80151
	Mean speed	58.4	67.0	77.9	83.9	88.6
	Std. Dev.	9.4	9.9	8.6	11.1	14.2
	85th percentile	66.5	75.5	85.3	93.5	101.8
	% of vehicles exceeding speed limit	46.6	37.4	39.9	26.6	20.2
	% of vehicles exceeding 10+ km/h above speed limit	7.1	6.5	5.7	4.6	3.3
	Total no.exceeding 10 km/h above the speed limits			**99490(6.4%)**		
	Total no.exceeding speed limit - all speed limits			**623159(39.8%)**		
2011	No. of vehicles surveyed	568024	500905	221209	71805	83756
	Mean speed	59.1	67.2	76.6	85.0	95.6
	Std. Dev.	8.8	9.2	9.0	10.1	11.1
	85th percentile	66.3	75.2	84.2	93.3	104.0
	% of vehicles exceeding speed limit	48.2	37.0	34.0	27.9	32.3
	% of vehicles exceeding 10+ km/h above speed limit	6.7	5.9	4.3	3.9	4.4
	Total no.exceeding 10 km/h above the speed limits			**83616(5.8%)**		
	Total no.exceeding speed limit - all speed limits			**581569(40.2%)**		
2012	No. of vehicles surveyed	604359	581560	227171	133960	81767
	Mean speed	58.2	66.4	76.6	85.7	89.4
	Std. Dev.	8.9	9.4	9.7	10.2	14.0
	85th percentile	65.6	74.5	84.3	93.7	101.8
	% of vehicles exceeding speed limit	44.3	33.7	34.8	31.6	20.6
	% of vehicles exceeding 10+ km/h above speed limit	5.4	5.0	4.3	3.9	3.0
	Total no.exceeding 10 km/h above the speed limits			**78566(4.8%)**		
	Total no.exceeding speed limit - all speed limits			**601460(36.9%)**		
2013	No. of vehicles surveyed	579603	523878	261507	121684	87079
	Mean speed	57.6	66.2	75.6	85.0	95.4
	Std. Dev.	9.1	10.0	9.9	9.4	10.2
	85th percentile	64.9	74.3	83.6	92.7	103.5
	% of vehicles exceeding speed limit	41.3	34.1	32.0	27.6	31.3
	% of vehicles exceeding 10+ km/h above speed limit	4.4	4.5	3.4	2.8	3.3
	Total no.exceeding 10 km/h above the speed limits			**64069(4.1%)**		
	Total no.exceeding speed limit - all speed limits			**562164(35.7%)**		
2014	No. of vehicles surveyed	737508	565142	279483	135915	86609
	Mean speed	57.3	66.0	73.6	82.8	96.2
	Std. Dev.	8.7	9.4	12.0	12.3	9.5
	85th percentile	64.7	73.9	83.1	92.1	104.4
	% of vehicles exceeding speed limit	38.3	32.0	27.6	24.0	35.0
	% of vehicles exceeding 10+ km/h above speed limit	4.5	3.9	3.2	2.4	4.0
	Total no.exceeding 10 km/h above the speed limits			**71011(3.9%)**		
	Total no.exceeding speed limit - all speed limits			**603713(33.5%)**		
2015	No. of vehicles surveyed	652356	604600	254135	139034	88238
	Mean speed	57.9	67.3	76.2	84.2	92.6
	Std. Dev.	8.4	8.4	9.3	9.9	12.8
	85th percentile	64.9	74.4	83.6	92.1	102.7
	% of vehicles exceeding speed limit	41.0	35.5	33.1	24.4	26.1
	% of vehicles exceeding 10+ km/h above speed limit	4.4	4.5	3.2	2.3	2.4
	Total no.exceeding 10 km/h above the speed limits			**69544(4.0%)**		
	Total no.exceeding speed limit - all speed limits			**623419(35.9%)**		
2018	No. of vehicles surveyed	781522	617914	286504	155092	160394
	Mean speed	55.9	66.5	73.0	85.3	96.2
	Std. Dev.	9.1	8.9	11.8	9.2	8.4
	85th percentile	63.4	73.8	82.7	92.6	103.3
	% of vehicles exceeding speed limit	32.2	31.1	25.0	28.1	32.6
	% of vehicles exceeding 10+ km/h above speed limit	2.9	4.5	3.5	2.2	2.1
	Total no.exceeding 10 km/h above the speed limits			**67410(3.4%)**		
	Total no.exceeding speed limit - all speed limits			**610982(30.5%)**		

Table 7. Vehicle speed characteristics by speed limit, Perth metropolitan area

3.2.2 The 85th Percentiles

The speed distributions by speed limits indicate that, on all types of speed limit roads in the metropolitan area, the 85th percentiles are significantly higher than the posted speed limits. In 2000, the differences ranged from 1.7 km/h on 100 km/h roads to approximately 9.9 km/h on 60 km/h roads. The differences between the 85th percentiles follow irregular pattern across the speed limits (see Figure 17, below).

The differences between the 85th percentiles and posted speed limits were smaller in the period 2003 to 2018 than in 2000, except a slight increase on the 100 km/h roads, indicating greater compliance to speed limits over the period than in the 2000 survey. The relative pattern of the differences remained fairly constant over the observation periods, supporting the hypothesis of similar effects of various road safety initiatives on driver speed behaviours across all the speed limits.

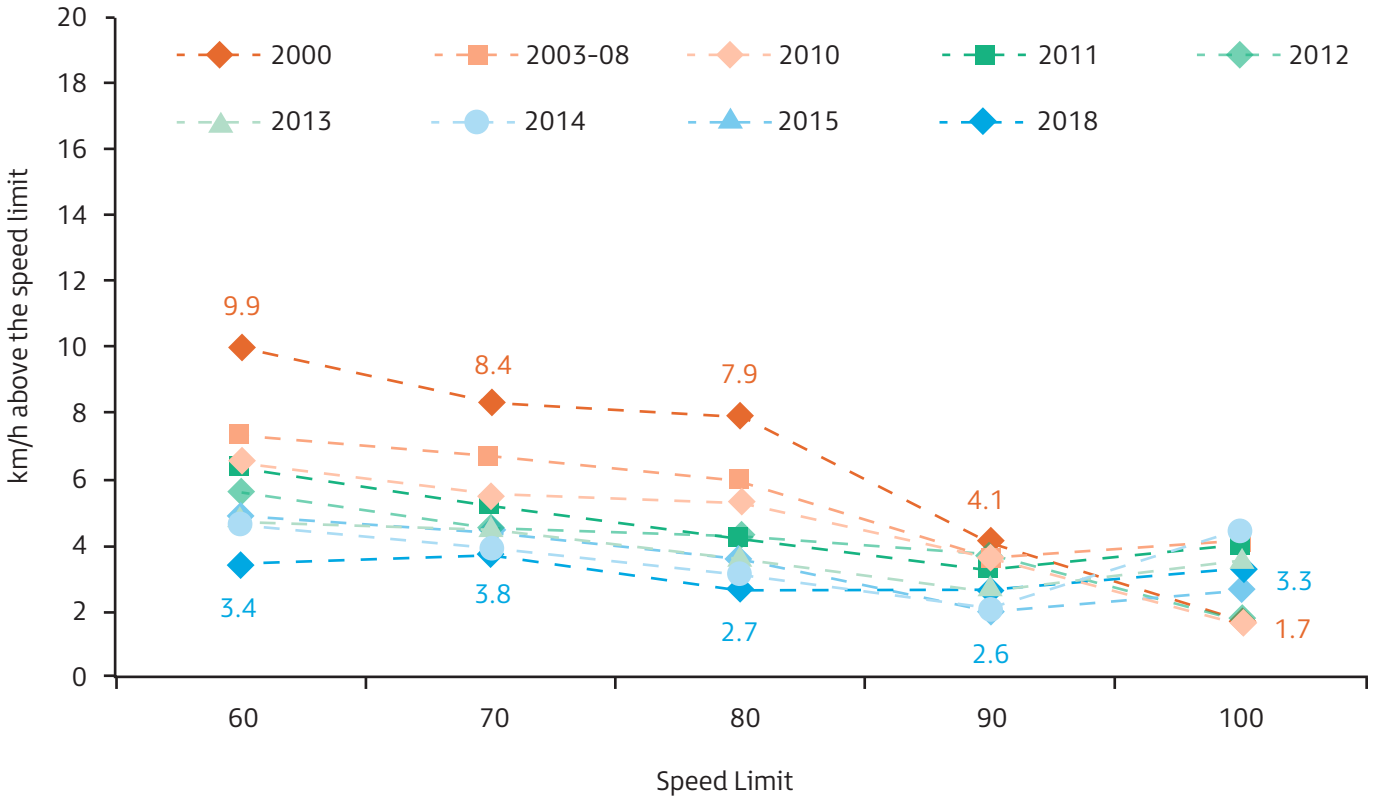


Figure 17. Differences between 85th percentiles and posted speed limits, Perth metropolitan area

The distribution of the 85th percentiles by survey year and speed limit shows that there were some fluctuations in the percentile between the surveys (ref Figure 18), ranging from a negligible change to reductions over 3 km/h. In the most recent 2018 survey the lowest percentile, relative to the speed limit, was recorded on the 90 km/h and 80 km/h roads, approx. 2.6 km/h and 2.7 km/h, respectively above the speed limit, whereas the highest 85th percentile was recorded on the 70 km/h roads, at 73.8 km/h.

Examination of the 85th percentiles by speed limits and survey years for the metropolitan area indicated that drivers since 2000 have changed their travel speeds resulting in marginal and on some roads significant reductions in the 85th percentiles. The reductions in the 2018 survey compared to the 2000 survey ranged between 1.5 km/h on 90 km/h roads to 6.5 km/h on the 60 km/h roads. The reductions in the percentiles between the survey years and the baseline survey are represented in Figure 19.

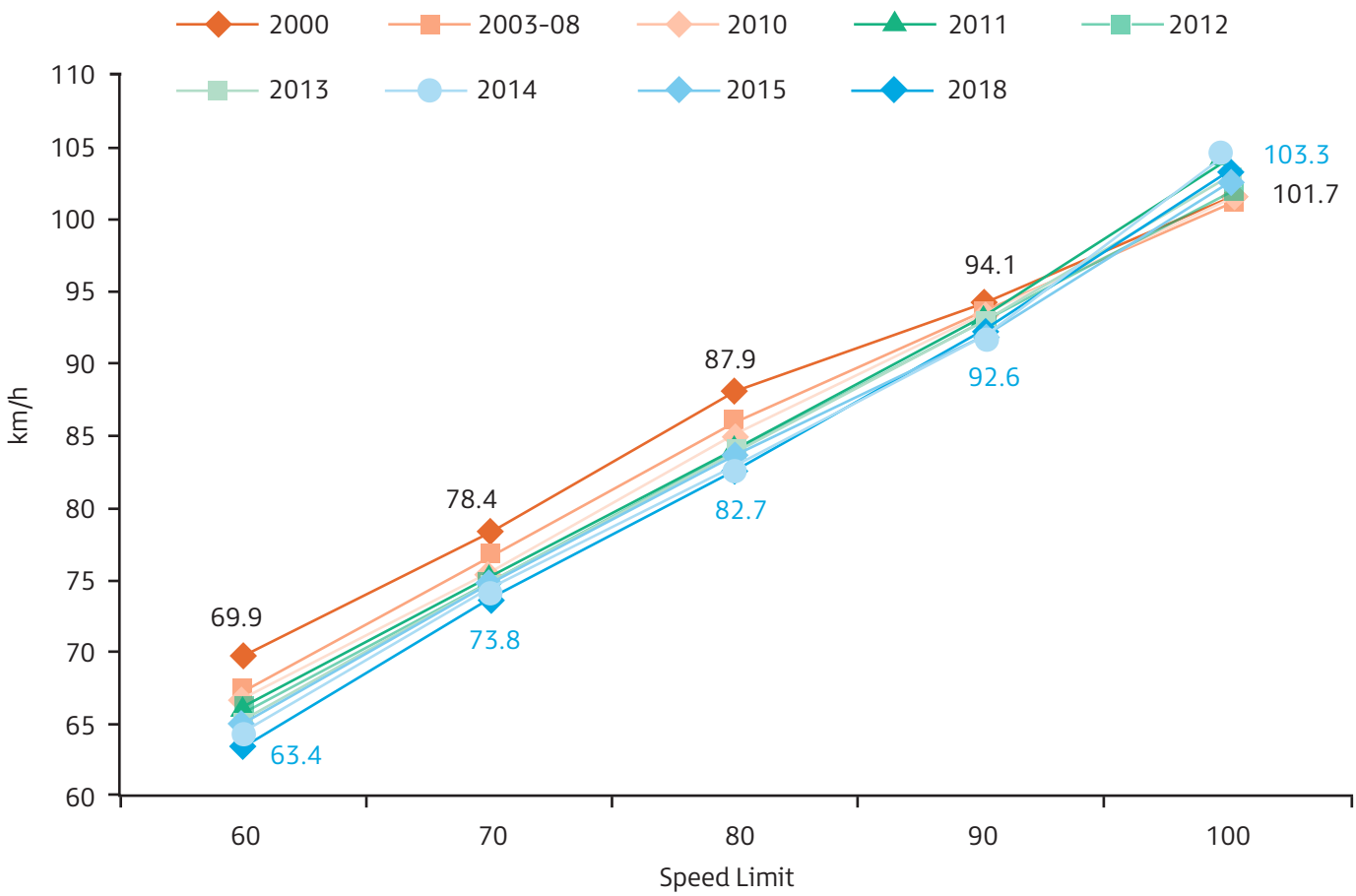


Figure 18. 85th percentiles by speed limit and survey, Perth metropolitan area

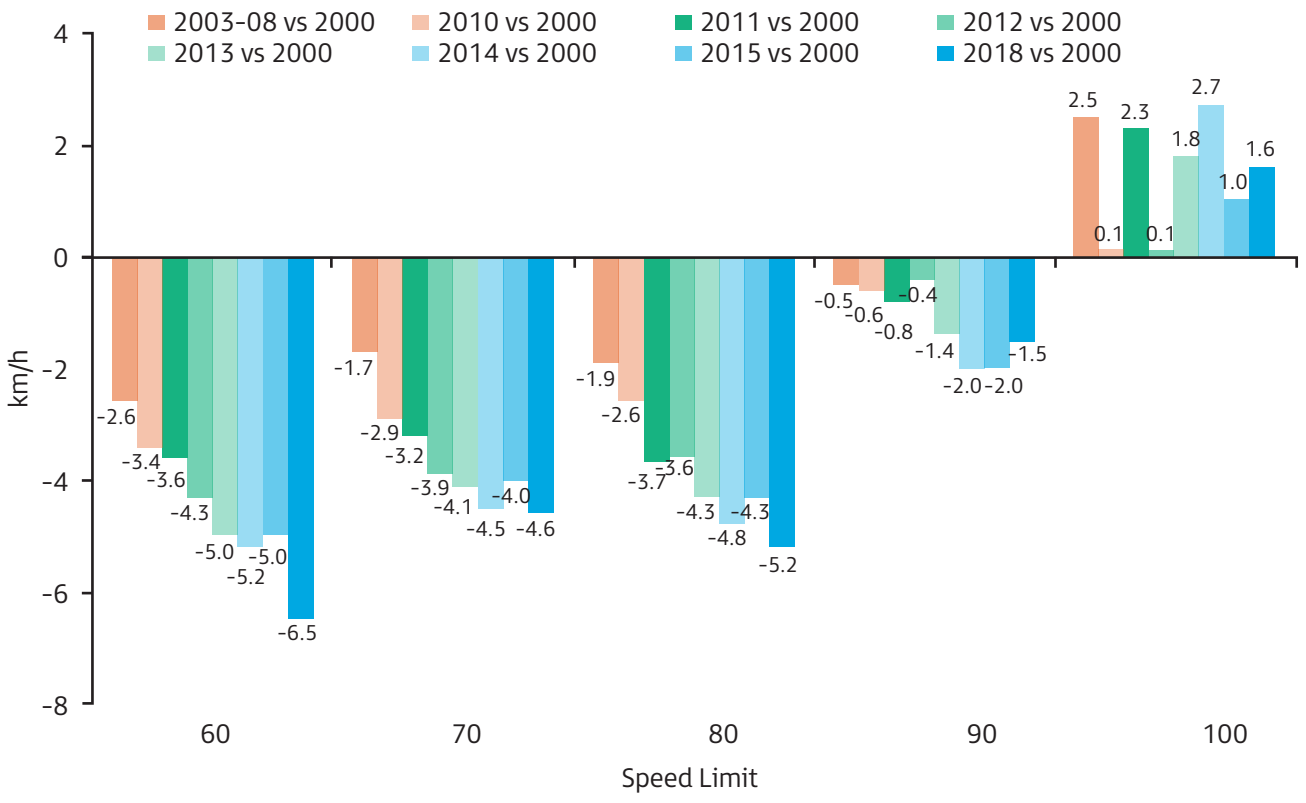
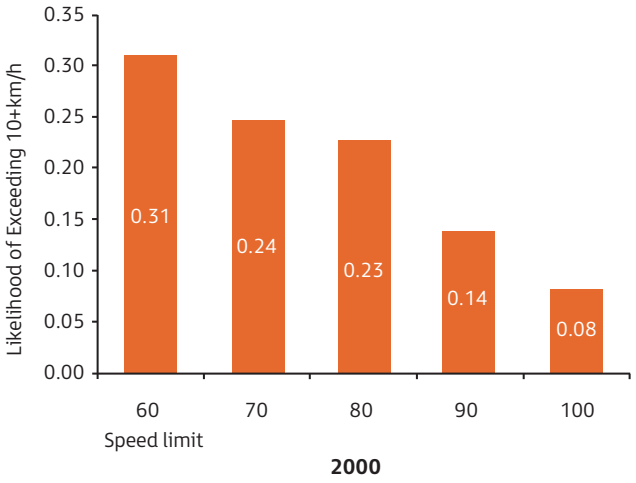


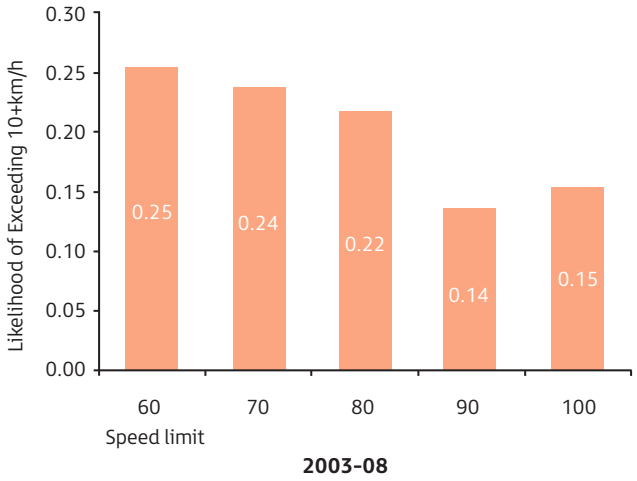
Figure 19. Differences in the 85th percentiles between the surveys, Perth metropolitan area

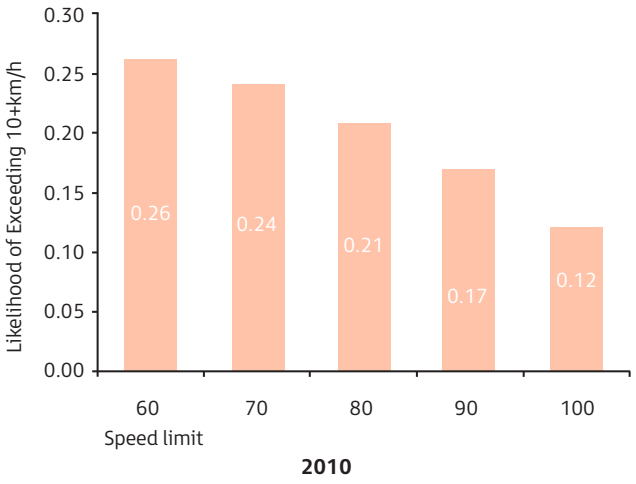
3.2.3 Likelihood of Exceeding 10+ km/h above Speed limit – Metropolitan Area

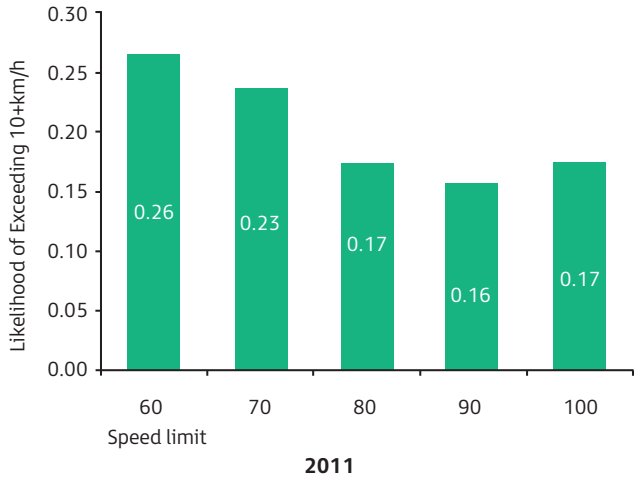
Metropolitan areas drivers are more likely to travel at excessive speeds at the lower speed limit spectrum, such as 60 km/h, 70 km/h and 80 km/h roads than on the higher speed limit roads (see Figure 20).

Although the percentage of speeding vehicles significantly reduced from 12.6% in 2000 to 3.4% in 2018, with some relative increases in the interim period between 2003 and 2018, the pattern of likelihoods of travel at excessive speeds on the various speed limits did not significantly change over the survey years. In comparison to other speed limit roads, drivers on 90 km/h and 100 km/h roads are less likely to travel at excessive speeds than on other speed limit roads.









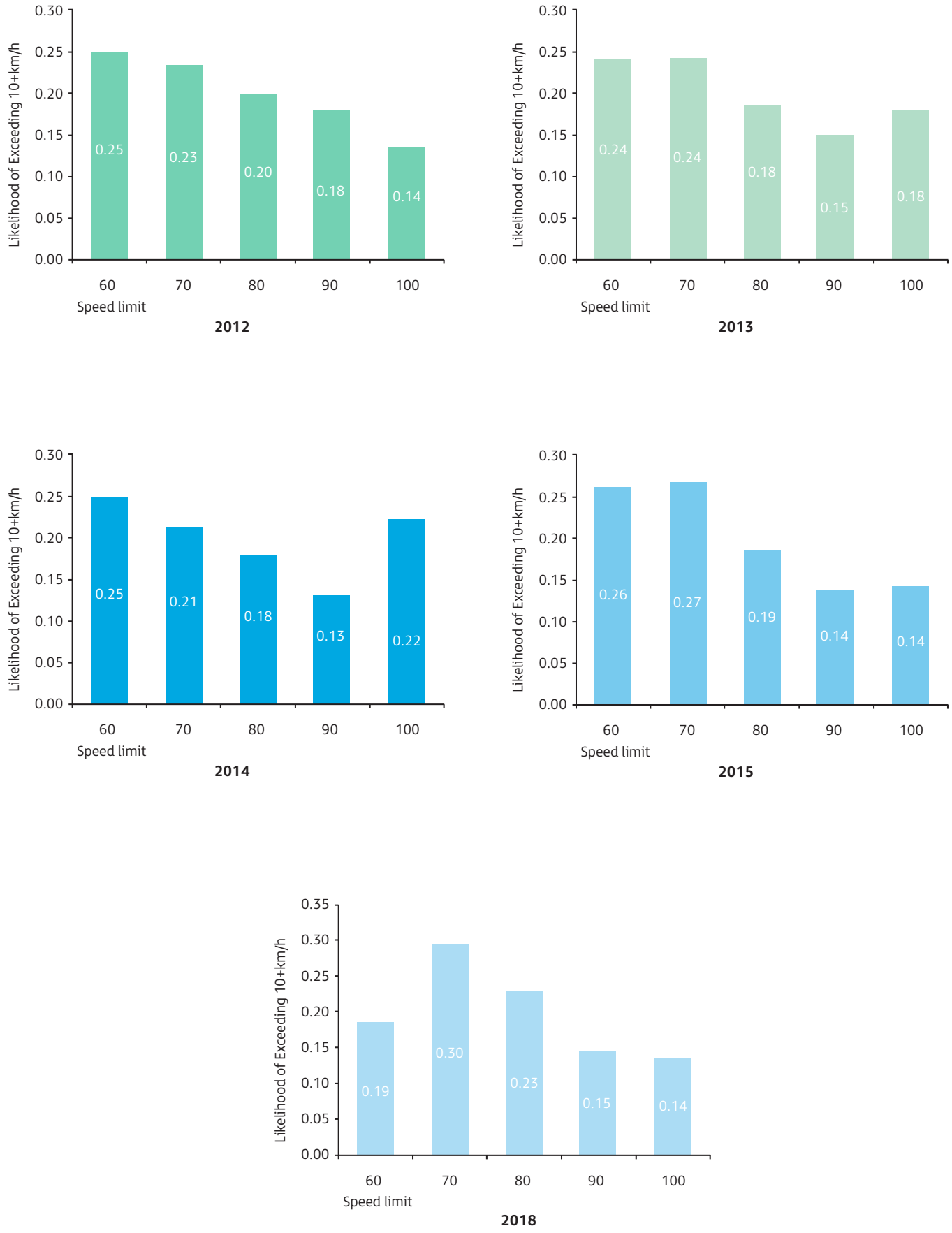


Figure 20. Relative likelihood of exceeding 10+ km/h, Perth metropolitan area

In all surveys, drivers on 60 km/h roads with an exception in 2018 and to a lesser extent on 70 km/h and 80 km/h roads were found to be more likely to travel at excessive speeds than on other speed limits roads such as 90 km/h and 100 km/h roads.

For example in 2018, drivers on the 70 km/h roads were approximately two times more likely to exceed the speed limit by at least 10 km/h than on the 90 km/h and 100 km/h roads; it was highly likely that for the same amount of traffic on the roads two times more drivers would have been found to speed on the 70 km/h roads than on the 90 km/h and 100 km/h roads.

3.2.4 Speed Limit Compliance and Excessive Speeding by Austroads Class – Metropolitan Area

Speed Limit Compliance

Percentage distributions by Austroads vehicle class (ref. Appendix D) in the 2011, 2012, 2013, 2014, 2015 and 2018 survey are presented in Figure 21. It shows that approx. 90% of the vehicles in the samples were cars, followed by 5% of 2-axle trucks, 1.4% car-towing and the rest represented by other various configuration classes.

The percentages of vehicles exceeding posted speed limit in 2011, 2012, 2013, 2014, 2015 and 2018 survey by the Austroads class were estimated at 42%, 38%, 37%, 34%, 37% and 31% for cars, respectively and approx. 7% to 15% for long vehicles and road trains (see Figure 21).

Exceeding Speed Limits by 10 km/h

On average across the surveys, the highest percentage of drivers exceeding 10+km/h above the speed limit were car drivers (in 2011, 2012, 2013, 2014, 2015 and 2018 survey at 6.1%, 5.1%, 4.3%, 4.1%, 4.2% and 3.3%, respectively), followed by 2-axle truck or bus (Class 3) (at 4.1%, 3.7%, 3.2%, 4.2%, 3.8% and 5.9%), 3-axle articulated vehicles (Class 6) (at 3.8%, 2.5%, 1.9%, 2.8%, 3.0% and 4.1%) and car- towing (at 3.3%, 2.4%, 2.4%, 2.1%, 2.3% and 2.0%, respectively). Less than 2% of other heavy vehicle drivers were found to travel at the excessive speeds. Road train drivers are unlikely to exceed the speed limit by more than 9 km/h above the speed limit with an exception of the most recent 2018 survey when 3.3% of the vehicles were recorded travelling at speeds greater than 10 km/h above the speed limit. Due to small sample sizes for road trains the indices derived from the data should be interpreted with caution (see Figure 21).

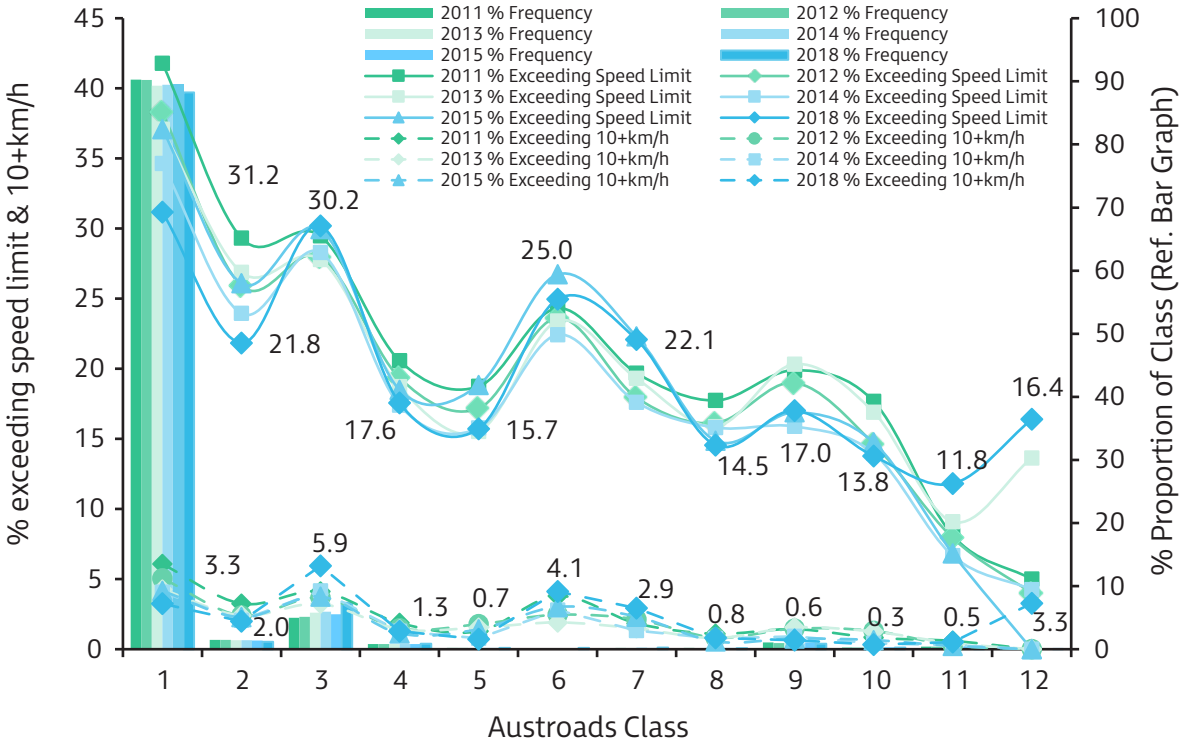


Figure 21. Austroads vehicle class distribution and percentage of vehicles exceeding posted speed limit and 10+km/h above the speed limit from 2011 to 2018, Perth metropolitan area

3.2.5 Likelihood of Exceeding 10+ km/h above Speed limit vs. Class 1 – Metropolitan Area

Figure 22 represents the likelihoods of cars travelling 10 or more km/h above the speed limit compared to other vehicle classes. The samples of vehicle speeds surveyed in 2011, 2012, 2013, 2014, 2015 and 2018 shows that Class 1 (cars) were more likely to travel at excessive speeds than any other vehicle class. For example, cars in each of the years were found more likely to travel at the high speeds than double road train; 10 times, 19 times, 10 times, 14 times, 18 times and 6 times, respectively, however, with similar likelihood to 2-axle trucks or buses.

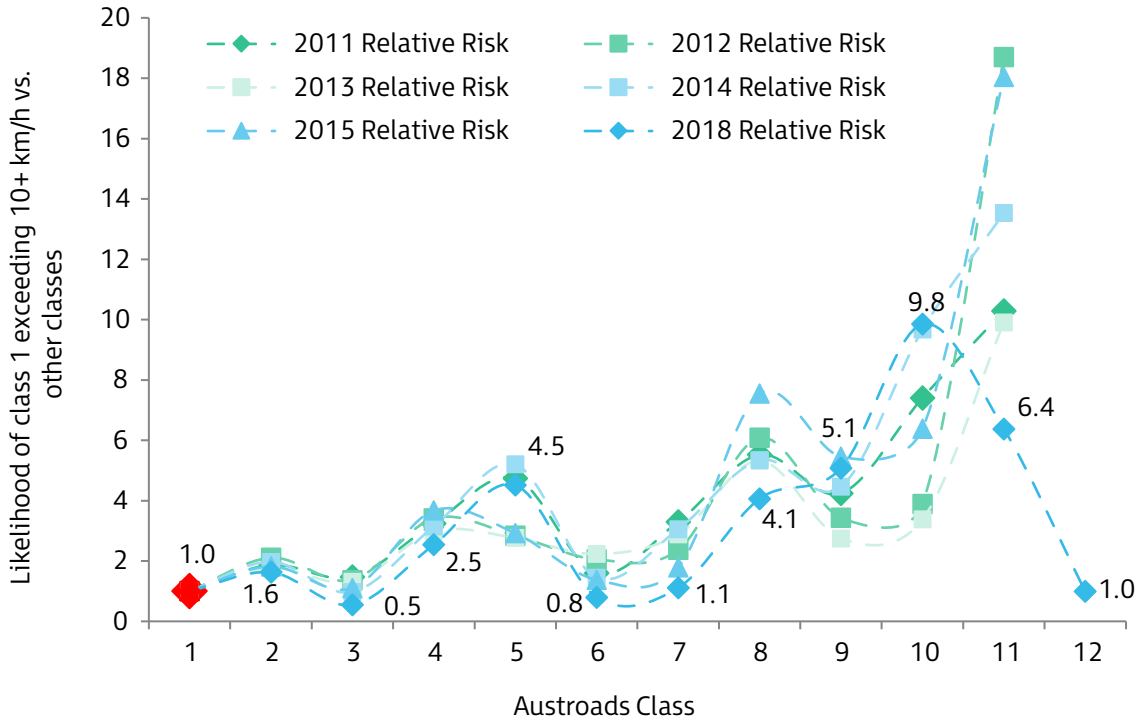


Figure 22. Relative Risk of class 1 (cars) exceeding 10+km/h above the speed limit vs. other classes, Perth metropolitan area

3.3 Analysis of Speed Data for 50 km/h and 110 km/h Speed Limit Roads in Perth Metropolitan Area

Prior to 2004 speed surveys on the residential 50 km/h and 60 km/h roads were conducted separately from the general speed surveys that started in 2000 incorporating speed limit roads from 60 km/h to 100 km/h. Due to lack of resources it was decided to cease with such separate surveys but include a sample of 50 km/h roads into the general speed survey starting from 2004, and present the findings separately from the findings related to the sample of 60 to 100 km/h speed zoned roads.

There were two reasons to conduct the analysis of the 50 km/h speed data separately from the analysis of the general speed survey data:

(1) to preserve reliability and consistency in representation of the speed indices trends derived from the general speed surveys; and

(2) to acknowledge the differences between the two types of roads, speed zoned and those with the default speed limit, which may be associated with different driver speed behaviours from those behaviours observed on the speed limit zoned road network due to lack

information on the legal speed limit on a particular road or lack of knowledge about the default speed limit on the local road network.

Since the 110 km/h network within the Perth metropolitan area is relatively small compared to the rest of the road network only a few sites could have been selected for the survey purposes, in which case the indices derived from the survey were expected to be unstable with substantial errors due to small sample size. Having this in mind with the assumption that the locations of the 110 km/h sections are situated in the semi-rural/rural areas even if the sample was larger it was expected the driver speed behaviour indices would not be significantly different from the indices derived in the rural area speed survey. In any case, when the data was available, the analysis is conducted and presented separately from the rest of the main survey data analysis.

In 2007 survey, there were 19 sites in the sample of the 50 km/h speed limit roads selected in the Perth metropolitan area. In 2004 and 2005 survey samples, there were 4 sites and 12 sites on the roads, respectively. The Perth metropolitan area speed survey samples on the 50 km/h speed limit roads consisted of 16 sites, 20 sites, 22 sites, 25 sites, 23 sites, 24 sites, 42 sites and 42 sites in 2008, 2010, 2011, 2012, 2013, 2014, 2015 and 2018, respectively. Since 2001 some of the roads in the baseline sample have changed the speed limit from 60 km/h to 50 km/h, in which case these roads were included into the 50 km/h sample of roads in future surveys.

Similarly, in the 2007 survey, speed data was also collected at 4 sites on the 110 km/h roads within the Perth metropolitan area. Although the sites are at open metropolitan road sections at the outskirts of the metropolitan area it is considered that the sample would be useful in assessment of driver speed behaviours at the high speed limit road environment. In 2008, no data was collected on 110 km/h roads in the metropolitan area, and the survey conducted in 2010 and 2011 included only one site and 2012, 2013 and 2014 included two sites, 2015 included three sites and 2018 included four sites on these roads, respectively. Therefore due to small sample sizes on the 110 km/h roads the indices derived from the data should be interpreted with caution.

50 km/h Roads

Compliance to Speed Limit

An analysis of speed data for the 50 km/h Perth metropolitan roads showed that 29.5% in 2004, 34.2% in 2005, 29.5% in 2007, 38.7% in 2008, 35.5% in 2010, 40.9% in 2011, 39.9% in 2012, 40.9% in 2013, 50.2% in 2014, 49.1% in 2015 and 51.9% in 2018 of drivers were travelling within the speed limit. Likewise, 19.8% in 2004, 20.0% in 2005, 19.6% in 2007, 18.2% in 2008, 17.5% in 2010, 14.4% in 2011, 13.9% in 2012, 13.4% in 2013, 8.3% in 2014, 10.9% in 2015 and 8.9% in 2018 of drivers were travelling 10 or more km/h above the speed limit (see Table 8, below).

Compliance/ Non-compliance	2004 (%)	2005 (%)	2007 (%)	2008 (%)	2010 (%)	2011 (%)	2012 (%)	2013 (%)	2014 (%)	2015 (%)	2018 (%)	2005 vs 2004	2007 vs 2005	2008 vs 2007	2010 vs 2008	2011 vs 2010	2012 vs 2011	2013 vs 2012	2014 vs 2013	2015 vs 2014	2018 vs 2015
Compliance - 50k roads	29.5	34.2	29.5	38.7	35.5	40.9	39.9	40.9	50.2	49.1	51.9	4.7	-4.6	9.2	-3.2	5.4	-1.0	1.0	9.3	-1.0	2.7
Compliance - 110k roads	-	-	76.4	-	76.2	84.5	77.2	76.3	83.4	78.7	84.6	-	-	-	-	8.3	-7.3	-0.9	7.1	-4.7	5.9
% of drivers travelling 10+km/h above speed limit - 50k roads	19.8	20.0	19.6	18.2	17.5	14.4	13.9	13.4	8.3	10.9	8.9	0.3	-0.5	-1.4	-0.7	-3.1	-0.6	-0.4	-5.1	2.5	-2.0
% of drivers travelling 10+km/h above speed limit - 110k roads -	-	3.4	-	3.9	2.0	2.2	2.7	1.9	2.2	1.2	-	-	-	-	-1.9	0.2	0.5	-0.8	0.3	-1.0	

Compliance/ Non-compliance	2004 (km/h)	2005 (km/h)	2007 (km/h)	2008 (km/h)	2010 (km/h)	2011 (km/h)	2012 (km/h)	2013 (km/h)	2014 (km/h)	2015 (km/h)	2018 (km/h)	2005 vs 2004	2007 vs 2005	2008 vs 2007	2010 vs 2008	2011 vs 2010	2012 vs 2011	2013 vs 2012	2014 vs 2013	2015 vs 2014	2018 vs 2015
50km/h roads	53.9	52.2	53.7	51.4	52.1	50.6	51.1	50.9	49.3	49.8	48.9	-1.7	1.4	-2.3	0.7	-1.5	0.5	-0.2	-1.6	0.5	-0.9
110km/h roads	-	-	100.6	-	101.5	99.4	101.2	100.9	99.1	101.3	99.9	-	-	-	-	-2.1	1.8	-0.3	-1.8	2.2	-1.4

Table 8. Vehicle speed characteristics and mean speeds on 50 km/h and 110 km/h roads, Perth metropolitan area

The data shows quite noticeable positive changes in driver speed behaviours, represented by the increased compliance rate and the reduction in the number of drivers travelling at excessive speeds (see Figure 23). Since 2004 the compliance to the speed limit increased by approximately 22%, from 30% to 52%. Similarly, over the same period, the number of drivers travelling more than 10 km/h above the speed limit decreased by approximately 10.9%, from 19.8% to 8.9%.

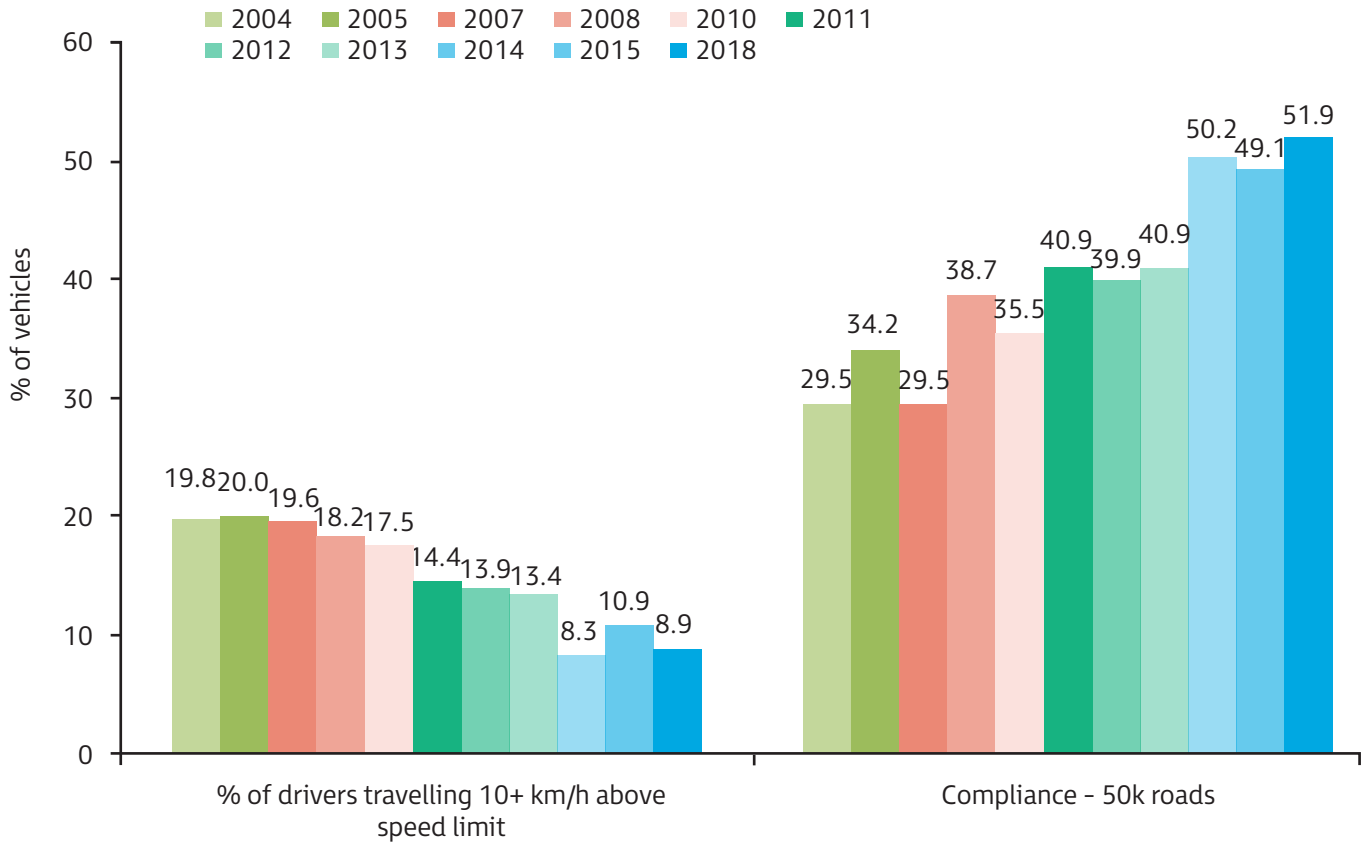


Figure 23. Percentage of drivers travelling 10+ km/h above the speed limit and speed compliance to speed limit on Perth metropolitan 50 km/h roads 2004 to 2018

Mean Speed

In all survey years from 2004 to 2013 the mean speed for the 50 km/h roads was higher than the posted speed limit, ranging from 53.9 km/h to 50.9 km/h. In 2014 the mean reduced to 49.3 km/h and a slight increase to 49.8 km/h in 2015 followed by a small decrease to 48.9 km/h in the most recent 2018 survey, representing a significant drop since 2004 of 5.0 km/h. The average annual reduction in the mean speed over the period 2004 to 2018 was estimated at 0.46 km/h (see Figure 24).

Figure 24. Mean speeds for the sample of Perth metropolitan 50 km/h and 110 km/h roads recorded in the surveys from 2004to 2018

110 km/h roads

Compliance to Speed Limit

The percentage of drivers travelling within speed limit on 110 km/h roads in the Perth metropolitan area was estimated at 76.4% in 2007, 76.2% in 2010, 84.5% in 2011, 77.2% in 2012, 76.3% in 2013, 83.4% in 2014, 78.7% in 2015 and 84.6% in 2018 (see Figure 25).

Similarly, for the same years, the percentage of drivers travelling 10 or more km/h above the speed limit was estimated at 3.4%, 3.9%, 2.0, 2.2%, 2.7%, 1.9%, 2.2% and 1.2%, respectively, significantly less than the corresponding network averages for other speed limit roads (60 to 100 km/h) in the metropolitan area of 7.7%, 6.4%, 5.8%, 4.8%, 4.1%, 3.9%, 4.0% and 3.4%, respectively.

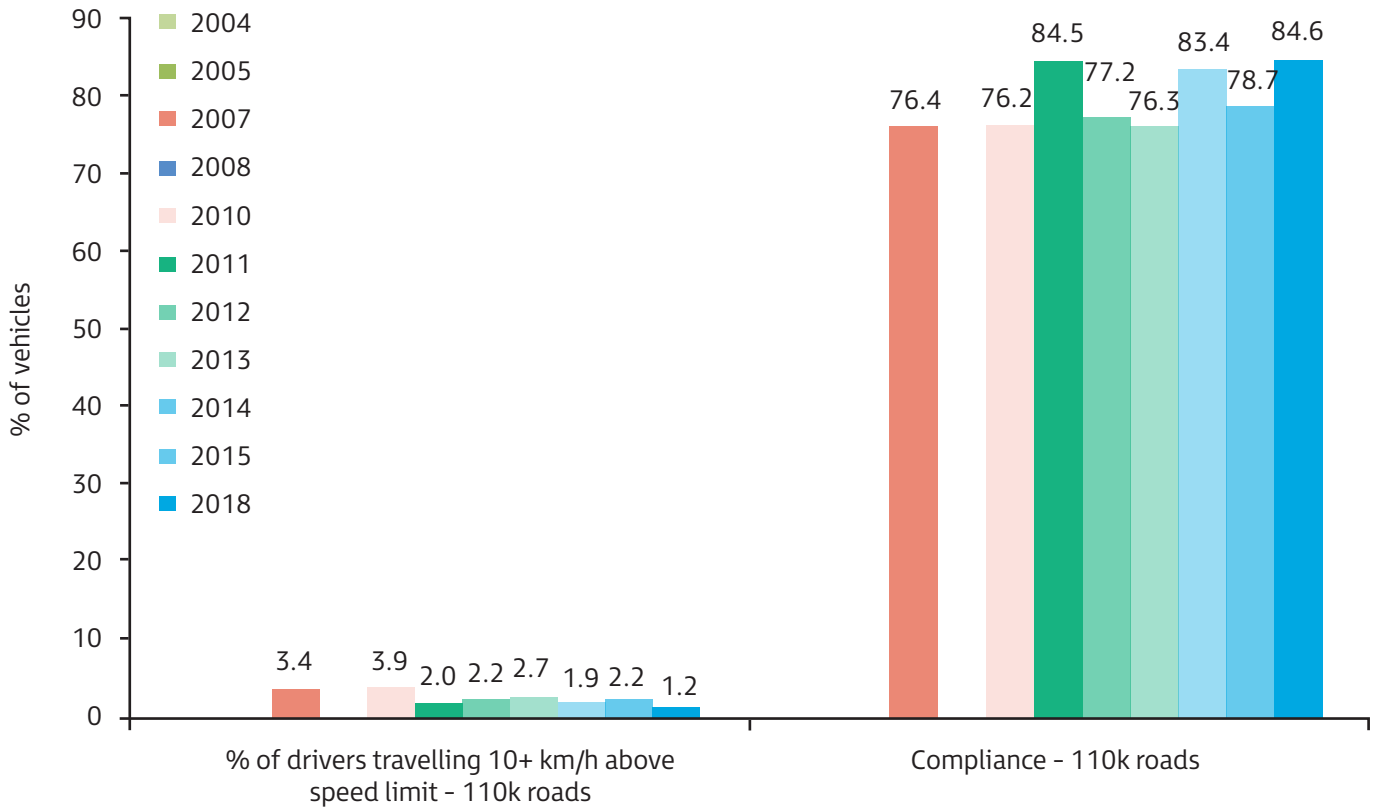


Figure 25. Percentage of drivers travelling 10+ km/h above the speed limit and speed compliance to speed limit on Perth metropolitan 110 km/h roads 2004 to 2018

Mean Speed

The mean speed on 110 km/h metropolitan roads was estimated at approximately 100.6 km/h in 2007, 101.5 km/h in 2010, 99.4 km/h in 2011, 101.2 km/h in 2012, 100.9 km/h in 2013, 99.1 km/h in 2014, 101.3 km/h in 2015 and 99.9 km/h in 2018 (ref. Table 8 and Figure 24).

SUMMARY OF FINDINGS

4

The analysis presented on the speed data collected in the thirteen surveys conducted between 2000 and 2018 suggests the following conclusions on driver speed behaviours on the Perth metropolitan road network:

(A) Speed Compliance on All Roads in Perth Metropolitan Area

Compliance to Speed Limit

- Under free-flowing conditions over the metropolitan network of across all speed limits, 53% of all vehicles travelled at or below posted speed limits in 2000 survey.
- In 2003-2008 period the compliance rate increased by 3.6% to 57.0%.
- Since 2008 the speed limit compliance rate further increased to 64.3% in 2013, at an average annual rate of 1.64 km/h.
- A further increase in the compliance rate by 2.3% to 66.6% was observed in 2014 survey.
- A slight decrease in the compliance rate by 2.5% to 64.1% was recorded in 2015 survey.
- A significant increase in the compliance rate to 69.5% was recorded in the most recent 2018 survey, the best ever result.

Compliance to Speed Limit by Road Type

- Under free-flowing conditions, over the metropolitan state and local road network of all speed limits in 2000, 60.7% on state road and 49.1% on local roads of all vehicles travelled at or below posted speed limits. Apart from some variability between the surveys, the highest compliance rate was recorded on state road and local road in the 2018 survey at approx. 70.6% and 68.5, 10.0% and 19.4% higher than in 2000 survey, respectively.

Motorcyclists Compliance to Speed Limit

- Based on all travel speeds, not restricted to free-flowing conditions, over the metropolitan road network of all speed limits, over the period 2000 to 2005, 49.0% of all motorcyclists travelled at or below posted speed limits. Despite some variations between the surveys, the highest compliance rate was recorded in the 2018 survey at 56.5%, 7.5% higher than the period 2000 to 2005.

Speeding in Excess of 10 km/h above Speed Limit

Similarly, comparisons of the proportions of drivers travelling at speeds in excess of 10 km/h above the speed limit showed that:

- 34.1% reduction in the number of drivers exceeding this "tolerance level", from 12.6% of all drivers observed in free-flowing traffic environments in 2000 to the average of 8.3% in the period 2003-2008.
- In 2010, the percentage of speeding drivers further decreased by 1.9% to 6.4% and 0.6% to 5.8% in 2011, followed by another decrease by 1.0% to 4.8% in 2012 and 0.7% to 4.1% in 2013, a further decrease by 0.2% to 3.9% in 2014, a minor increase by 0.1% to 4.0% in 2015 and a small decrease by 0.6% to 3.4% in 2018.
- Since 2003 the percentage of speeding drivers have been decreasing at an average annual rate of 0.6 km/h, from 9.4% to 3.4% in 2018.

Speeding in Excess of 10 km/h above Speed Limit by Road Type

- In 2000, the number of speeding drivers on Perth metropolitan state and local roads was recorded at 10.2% and 13.8%, respectively. However, since then, as recorded in the most recent 2018 survey, the percentage of speeding drivers dropped to 2.9% and 3.8% on state and local roads, respectively, representing a substantial reduction of 7.3% and 10.0%, respectively, when compared to the baseline 2000 survey.

Speeding in Excess of 10 km/h above Speed Limit by Motorcyclists

- Over the period 2000 to 2005, 23.4% of all motorcyclists, not restricted to free-flowing conditions, over the metropolitan road network of all speed limits, travelled with speeds exceeding 10 km/h above the speed limit. The percentage of speeding drivers dropped to 11.7% in 2018, 50% less than in the period 2000 to 2005.

Compliance by Speed Limit

- The surveys from 2003 to 2018, apart from some variability between years, indicated an overall improvement in the speed compliance rates when compared to the 2000 survey.

- The poorest compliance to the speed limit was observed on 60 km/h roads ranging from 46.1% in 2000 to 67.8% in 2018, however, a significant increase of 21.7%.

- The compliance rate on the 70 km/h and 80 km/h has on average increased by 16.1% and 15.4%, respectively in 2018 compared to the 2000 baseline survey when average compliance rate for the roads was 52.9% and 59.6%, respectively compared to the rate in 2018 of 68.9% and 75.0%, respectively.

- Compared to the 2000 survey the 2018 survey showed that the higher speed limit roads such as 90 km/h and 100 km/h roads experienced a reduction in the compliance rate of 2.3% and 13.0% on 90 km/h and 100 km/h roads, respectively. The compliance rates in 2018 for the speed limit roads were 71.9% and 67.4%, respectively.

Trends in Percentage of Drivers Travelling at High Speeds by Speed Limit

- Since 2000 all speed limit roads showed substantial reductions in the proportions of drivers travelling at high speeds, 10 or more km/h above the speed limit. Despite some variations in the interim period between 2000 and 2018, all roads on average recorded a reduction in the speeding drivers relative to the percentage recorded in the 2000 survey.

- The difference between 2018 and 2000 in the percentage of speeding drivers ranged from a reduction of 1.8% on 100 km/h roads to 12.1% on 60 km/h roads.

- The percentage reduction in the proportions of speeding drivers ranged between 46.6% on 100 km/h roads to 80.8% on 60 km/h roads.

- Compared to 2000, across all metropolitan roads, the number of speeding drivers in 2018 reduced by 73.3%, from 12.6% in 2000 to 3.4% in 2018.

Compliance and excessive Speeds by Day of Week

- The surveys from 2003 to 2018 indicated that, in general, the greatest compliance to speed limits occurs from Monday to Wednesday and from Thursday to Friday, on average 64% and 60%, respectively, significantly less on Saturday and Sunday, average of 57%.

- Over most of the surveys Sunday, followed by Saturday were found to be the days with the highest percentage of drivers exceeding 10 or more km/h above the speed limit

- Across all surveys, the average weekday percentage of drivers travelling at high speeds was estimated at 6.3%, compared to the average weekend percentage of 8.0%.

- In the most recent 2018 survey, the percentage of speeding drivers on weekdays was estimated at 3.0%, compared to the weekend average of 7.6%.

- The best performing days with respect to excessive speeding in 2018 were Thursday and Wednesday, at 2.6% followed by Monday, Tuesday and Friday at 3.2.

- In general, based on all survey years, the highest percentage of speeding drivers, travelling 10 or more kilometres above the speed limit, would be expected on weekends.

Speeding by Time of Day

- All thirteen surveys indicated that drivers were more likely to travel at excessive speeds, 10+ km/h above speed limits, during night hours, from 7 p.m. to 7 a.m., than during other times of the day - the highest percentage recorded between 2:00 a.m. and 4:00 a.m.

- These driver speed behaviours are fairly consistent from year to year. No significant differences in the patterns were found, although the percentage magnitude varied in line with the overall driver speed behaviours in a particular year.

- On average, the highest travel speeds are expected to occur between 11 p.m. and 6 a.m. The percentage of speeding drivers during this period in 2018 ranged from 4% to 8%.

- In all survey the least number of speeding drivers were recorded between 8 a.m. and 12 a.m., approximately 3% in 2018.

(B) Mean Travel Speeds in the Metropolitan Area

Mean Speed by Speed Limit

- Drivers on the Perth metropolitan 60 km/h, 70 km/h and 80 km/h roads seemed to be travelling at higher average speeds, relative to the speed limits, than drivers on the other higher speed limit roads, such as 90 km/h and 100 km/h roads.

- The mean travel speeds recorded in the 2018 survey, compared to the mean speeds in 2000, were significantly less on some roads and slightly higher on the others. The highest reductions were observed on:
  - 60 km/h -4.8 km/h, from 60.6 to 55.9 km/h
  - 70 km/h -2.9 km/h, from 69.4 to 66.5 km/h
  - 80 km/h -4.2 km/h, from 77.2 to 73.0 km/h, and

The highest increases were observed on:

  - 90 km/h +2.7 km/h, from 82.6 to 85.3 km/h
  - 100 km/h +5.0 km/h, from 91.2 to 96.2 km/h

(C) Speed Compliance and Mean Speeds on 50 km/h and 110 km/h Metropolitan Roads

50 km/h Roads

- Since 2004 the compliance to the speed limit increased by approximately 22%, from 30% to 52%. Similarly, over the same period, the percentage of drivers travelling more than 10 km/h above the speed limit decreased by approximately 11%, from 20% to 9%.

- The mean travel speed reduced from 53.9 km/h in 2004 to 48.9 km/h in 2018, representing a significant drop of 5.0 km/h.

110 km/h Roads

- On 110 km/h roads in the Perth metropolitan area, the percentage of drivers travelling within the speed limit varied between 2007 and 2018, from 76.4% to 84.6%, respectively.

- Similarly, over the same period, the percentage of drivers travelling 10 or more km/h above the speed limit on the 110 km/h roads reduced from 3.4%, to 1.2%, respectively; however, significantly less reduction than the corresponding reduction of the network averages for other speed limit roads in the metropolitan area from 7.7% to 3.4%, respectively.

- The mean speed on the 110 km/h metropolitan roads was estimated at approximately 100.6 km/h in 2007 and 99.9 km/h in 2018.

CONCLUSIONS AND RECOMMENDATIONS

5

Driver speed behaviours in a free flowing traffic environment are largely dependent on a number of factors associated with road environment open/built up, speed limit on roads, vehicle type, road type, region, time of the day and day of the week.

Under free-flowing conditions over the Perth metropolitan network of all speed limits, the thirteen surveys conducted over the period 2003 to 2018 suggest that more drivers complied with speed limits than in 2000. The magnitude of compliance varied between 2003 and 2018, over the period 2003 to 2008 on average being 4.0% higher than in 2000, at 57.0%, with a further improvement in the compliance rate to 63.1% in 2012 and 66.6% in 2014. The 2015 survey recorded a substantial reduction in the compliance rate of 2.5% to 64.1%. The most recent 2018 survey recorded a significant increase of 5.3% in the compliance rate to the ever best 69.5%, 16.5% higher than the baseline 2000 survey.

Similarly, the number of drivers travelling at excessive speeds, 10 or more km/h above the speed limit, has significantly decreased over the time period, from 12.6% in 2000 to the average of 8.3% in the 2003-2008 period. This trend was followed by further reductions of approximately 4.3% to 4.0% in 2014, followed by a minor increase by 0.1% to 4.1% recorded in the 2015 survey. In the most recent 2018 survey a small reduction of 0.6% was estimated to the ever lowest level at 3.4%, 9.2% less than the baseline 2000 survey, representing a 73% reduction in the number of speeding drivers at the Perth metropolitan road network.

Analysis of the trends in the speed compliance rates, the proportions of speeding drivers and mean speeds demonstrate a substantial improvement in driver speed behaviour on the Perth metropolitan network. The positive changes in the travel speeds indices could well be related to the overall speed enforcement strategies implemented over the study period, increase of traffic at the network and other speed reduction and road safety initiatives.

The positive change in the speed indices in 2018 may signal the needs for following up existing and formulation of new speed management and enforcement strategies in Western Australia.

It is recommended that the speed indices derived from the speed data collected over the period between 2000 and 2018 be used as indicative measures of effectiveness of road safety initiatives undertaken in order to reduce excessive travel speeds at the metropolitan network, as well as measures of effectiveness of speed enforcement strategies implemented over the study period, or formulation of the new strategies to improve driver speed behaviours.

Furthermore, these indices can be used as benchmarks in the assessment of effectiveness of new traffic safety strategies, particularly in assessment of strategies related to speed enforcement on the Western Australian road network, and for the purpose of monitoring of driver speed behaviours over time.

The results of the study provide substantial evidence on patterns and characteristics of driver speed behaviours on the metropolitan road network and indicative effects of the factors that are likely to influence driver speed behaviours. The study suggests that any formulation of speed enforcement strategies should incorporate regional, road type, speed limit and temporal factors.

Further studies would be required to investigate relationship between speed compliance, speed enforcement initiatives and road safety in terms of number and severity of crashes considering the factors associated with driver speed behaviours as identified in this study.

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Appendix A
Survey Criteria And Data Collection Guidelines

General Instructions And Criteria For Speed Surveys

Objectives of the Survey

The principal objective of the surveys is to measure changes in driver speed behaviours at general locations of the road network over time.

Changes in driver speed behaviours may be used as one of the significant measures in assessment of effectiveness of speed enforcement interventions, and to a lesser extent as a measure of impacts of other safety awareness non-enforcement programs on driver traffic behaviours.

Other objectives of the survey implied in the driver speed behaviour areas are as follows:

4. To monitor general driver compliance to legal speed limits.

5. To measure road/site specific speed compliance rate.

6. To assess effects of change in speed behaviours on occurrence of speed related crashes.

Survey Sample Size

Achievement of the above objectives would be measured by speed indices determined from the speed data collected over the road network, covering all regions, road types and various legal speed limits.

In order to get a representative sample from the Western Australian population of drivers, it is intended to collect the data from a number of strata based on road types and speed limits across all the MRWA regions. It is estimated that speed data collected at approximately 200 locations over the network would be sufficient to provide reliable statistical indices of the population driver speed behaviours.

In order to preserve representativeness of the state traffic speed data, the sample size for each the two main strata, region and road type, was based on the principal determinant taken as amount of exposure measured in terms of MVKT. The number of survey sites by region and road type is calculated as follows:

No. of Sites (Region) = 200 x MVKT(Region) / MVKT(State)

No. of Sites (Road Type) = No. of Sites (Region) x MVKT(Road Type) / MVKT(Region)

Frequency of surveys

The speed surveys would be conducted annually according to specific guidelines outlined below.

Survey Period

Annual surveys would be conducted over the same period each year. The surveys should be completed over the period of four months, March to June.

School holiday periods should be avoided.

Physical Locations of Spot Road Surveys

For the purpose of consistency and reliability of data, annual surveys would be conducted *at the same physical locations* each year, unless there were reasons for change due to equipment installation difficulties, road works, road closures, road modifications, or some other justified reasons. In such a case, an alternative similar location would be found either on the same road or another road of the same type within the region.

Since the aim of a spot speed survey is to measure speeds of vehicles in a “free” flowing traffic it is necessary to choose a location on a road which will provide such conditions for vehicular movements. Such conditions should prevail over the whole time period assigned to the location survey. In placing speed survey equipment the following guidelines should be observed:

1. Equipment to be installed at a location determined by the start and SLK or referenced intersecting roads, within the specified speed zone (refer to the Location Table).

2. For a short speed zone section, the speed measuring equipment should be installed approximately at the mid-point of the section.

3. The survey spot should be located at a traffic "free" flowing section of a road.

4. The spot must be chosen at a road section such that no factors within the "free" flowing section could cause changes in vehicular speeds other than the changes voluntarily induced by the drivers (e.g. speed limit signs, major intersections, road works, etc.).

5. No installation should take place within a "school zone".

6. Road features such as bridges, culverts, railway level crossings and flood ways should be avoided.

7. Equipment should not be installed at sections of roads with overtaking lanes.

8. Whenever it is possible, the equipment should be installed at a mid-block rather than at a close distance to an intersection.

Installation of Speed Survey Equipment (Classifier)

The survey equipment (classifier) should be installed at a suitable location within the section of a road defined in the Location Tables, satisfying the speed zone criterion.

Single carriageway (one lane in each direction) sections should be surveyed in both directions (tubes to be placed over both lanes).

Single multiple lane carriageways should be surveyed only on the kerb lane, in which case two classifiers are required, one for each direction.

Dual carriageways (separated by a median strip) should be surveyed on the kerb lanes and median lanes whenever it is feasible, otherwise, one direction the kerb lane and other direction the median lane.

At the *time of installation* the following items should be checked and/or recorded:

1. Speed limit at the classifier installation location.

2. Carriageway (Single, Left or Right).

3. Number of lanes at the chosen location.

4. Lane(s) surveyed (e.g. kerb lane, centre lane, median lane, both left and right directions).

5. Exact description of location with respect to chosen intersecting road, road feature and/or unique objects in the road nature strip.

Duration of a Road Location Survey

In general, each location should be surveyed over seven days, each day of the week included.

In a case when sufficient number of classifiers is not available to complete the survey within a region, then the survey should be conducted according to the specification outlined in the Figure 2 of the survey design. That is, each day of the week will be represented within the sample of each of the road types. Minimum number of days surveyed may range between 2 and 7 days, depending on the number of locations on the same road type.

Road and Weather Conditions

In general, the surveys should be conducted on fine days.

Appendix B

List Of Proposed 2000 Baseline Survey Locations

Metropolitan Area

Road Type	Road No.	Road Name	SLK	Location Description	Hierar. Class
Local	1020003	Canning Rd	6.10	S of WELSHPOOL RD	A
	1210008	Owston St	0.39	N OF WELLINGTON RD 50-383983-6457174	L
	1280001	The Boulevard	2.98	E OF DURSTON RD 50-384361-6466480	A
	1070024	Rae Rd	3.19	E of READ ST	A
	1190997	Farrington Rd	0.35	E OF PROGRESS DR 50-388598-6450505	A
	1130004	Hardey Rd	0.88	W of STANLEY ST	B
	1251738	Northwood Dr	0.94	N of REID HWY BRIDGE 50-392611-6473765	B
	1220143	Brockway Rd	1.61	N of Lemnos St 50-0385609-6463811	A
	1030497	Forrest Rd	1.39	W of Redmond St 50-385527-6449480	B
	1010004	Railway Ave	0.94	N of LOWANNA WY 50-406511-6443662	L
	1010001	Nicholson Rd	2.92	N of MASON RD 50-398480-6444230	A
	1010033	Eight Rd	0.74	S of TILLINGA ST 50-404656-6441970	B
	1010247	Seville Dr	1.78	W of MORGAN RD 50-404770-6443985	B
	1020001	Kalamunda Rd	1.00	E of Davies	A
	1020004	Hawtin Rd	2.30	S of MAUD RD 50-407337-6462453	A
	1020009	Maida Vale Rd	1.54	W of NEWBURN RD 50-405987-6464357	A
	1030027	Miguel Rd	0.18	N of HOWSON WY 50-387425-6466719	A
	1030008	Yangebup Rd	1.58	E of BIRCHLEY RD 50-386919-6445043	A
	1050003	Wellard Rd	3.35	W of PARMELIA AVE 50-388773-6430200	B
	1050002	Calista Ave	0.61	S of MAYDWELL WAY 50-387447-6431640	L
	1061039	Helena Valley rd	1.45	W of Torquata 50-407838-6468420	A
	1070003	Safety Bay Rd	5.66	N of RAND AVE	B
	1090502	West Swan Rd	2.02	S of WOODWARD AVE 50-402858-6472068	A
	1090522	Middle Swan Rd	1.00	W of HARRIS RD 50-405351-6474102	A
	1091173	Lloyd St	1.80	N of EDDIE BARRON DR 50-406883-6472797	A
	1090570	Benara Rd	0.84	W of WALDECK RD 50-0401943-6472731	A
	1091232	Clayton St	1.70	W of KATHERINE ST 50-408229-6469905	B
	1110001	Walter Rd East	0.09	E of RUGBY ST 50-0398997-6470597	A
	1110123	Collier Rd	1.13	E of FAIRFORD ST 50-399120-6469434	A
	1120005	Beechboro Rd Nrth	1.67	S of Telstar 50-0398198-6471907	A
	1120010	Coode St	0.68	S of RUDLOC RD 50-395475-6469385	A
	1120017	Crimea St	1.98	N of WESTLAKE RD 50-0396284-6471964	A
	1120716	Peninsula Rd	1.46	S of RICHARD ST 50-396132-6465635	L
	1120004	Grand Promenade	1.56	N of CATHERINE ST 50-0394761-6468691	A
	1130002	Abernethy Rd	3.22	E of KEANE ST 50-400095-67462362	A
	1130020	Fulham St	2.20	N of ARMADALE RD 50-398729-6462078	L
	1130012	Wright St	2.10	N of ARMADALE RD 50-398548-6462313	L
	1140427	Willery Dr	0.77	S of HOSSACK AVE 50-396392-6453735	A
	1140011	Sevenoaks St	0.76	S of EWING ST 50-398745-6458878	A
	1140583	Orrong Rd	2.50	W of KURNALL RD 50-400884-6459441	A
	1160007	Broome St	1.77	N of GRAHAM CT 50-382372-6459026	L
	1190007	Marmion St	2.29	E of THORNE ST	A
	1190018	Reynolds Rd	0.60	N of GUNBOWER RD	L
	1190931	Le Souef Dr	0.91	N of GAIRDNER DR	L
	1190027	Kintail Rd	0.58	W of THIRD AVE	L

Road Type	Road No.	Road Name	SLK	Location Description	Hierar. Class
Local	1190033	Garling St	0.73	W of DUNFORD ST	L
	1190003	North Lake Rd	2.46	S of ARCHIBALD ST	A
	1220012	Warath Ave	1.24	E of Curlew	L
	1220011	Victoria Ave	1.24	N of PHILIP RD	L
	1220006	Stubbs Tce	0.61	N of Mooro Dr 50-0386233-6462435	A
	1220225	Stephenson Ave		N of Montgomery Ave 50-0384366-6463818	A
	1250017	Walcott St	0.87	W of DUMBARTON CR 50-391646-6467719	A
	1250119	Sackville Tce	0.77	W of FLAMBOROUGH ST 50-387090-6470820	B
	1250099	North Beach rd	2.49	W of OKELY RD 50-384545-6474335	A
	1250399	Cedric St		W of Civic Pl 50-387093-6470772	A
	1250142	Balcatta Rd	0.91	W of NATALIE WAY 50-387834-6474121	A
	1250067	Main St	0.71	S of MC DONALD ST 50-389039-6469185	A
	1250050	Beaufort St	0.77	E OF FIRST AVE 50-393729-6466785	A
	1250059	Alexander Dr	7.79	N of AUSTRALIS 50-392606-6473767	A
	1260003	Mill Pt Rd	0.82	W of DYSON ST 50-393418-6461399	B
	1260003	Mill Pt Rd	2.49	E of ONSLOW ST 50-391983-6461495	B
	1260001	Manning Rd	2.13	W of ELDERFIELD RD 50-393574-6457519	A
	1260002	Labouchere Rd	0.93	N of KAROO ST 50-391594-6460929	B
	1290251	Berwick St	2.56	S of HAMPSHIRE ST 50-396151-6459938	A
	1290226	Bishopsgate St	0.86	S of LION ST 50-397487-6460987	L
	1290214	Star St	0.88	S of LION ST 50-397773-6461229	L
	1270006	Railway Pde	1.47	N of Heytesbury	A
	1270009	Nicholson Rd	0.74	E of DERBY RD	B
	1270002	Thomas St	1.56	N of Heytesbury Rd	A
	1270008	Onslow Rd	0.71	E of HILDA ST	L
	1280307	Harbourne St	0.34	N of SCADDAN ST 50-388329-6466837	A
	1280309	Lake Monger Dr	0.26	E of ST VINCENTS AVE	A
	1280301	Oceanic Dr	1.20	E of KALINDA DR 50-384341-6465706	A
	1300047	Anzac Rd	1.26	W of KALGOORLIE ST 50-389648-6467118	B
	1311664	Shenton Ave	1.23	E of CONNOLLY DR 50-381516-6487372	A
	1311700	Hodges Dr	1.52	E of CARIDEAN ST 50-381930-6485892	A
	1311665	Joondalup Rd	6.43	S of Brienz Dr 50-383254-6488875	A
	1310002	Marmion Ave	0.54	N of MERMAID WY 50-381408-6484860	A
	1311156	Moolanda Blvd	0.76	Under Ped Bridge 50-0386686-6479669	L
	1311258	Barridale Dr	1.33	N of DALTON CR	L
	1311214	Edgewater Dr	1.07	N of PARKLAND CL 50-385312-6484943	L
	1310631	Flinders Ave	0.56	E of MURRAY DR 50-0381452-6480055	L
	1311551	Timberlane Dr	1.24	N of TEAK CT 50-0385912-6482507	L
	1311287	Whitfords Ave	0.76	S of FLINDERS AVE 50-379879-6479588	A

A – Distributor A

B – Distributor B

L – Local Road

Road Type	Road No.	Road Name	Location SLK	Spot Location Description	Road Type
State/	H001	Albany Hwy	19.04	South of Tonkin Hwy	S
National	H023	Armadale Rd	13.11	W OF LIDDELOW RD 50-394080-6444248	S
	H023	Armadale Rd	1.41	E of Seventh Rd 50-405268-6442664	S
	H052	Brookton Hwy	5.93	East of Holden 50-412774-6446053	S
	H002	Bunbury Hwy	11.31	S of Russell Rd South	S
	H002	Bunbury Hwy (Stock Rd)	0.00	N of South St (S OF LEACH HWY 50-385975-6453067)	S
	H025	Cockburn Rd	0.45	South of Rollinson St 50-382946-6449003	S
	H005	G.E.H.	23.54	E of Bilgoman Rd 50-414010-6470015	N
	H005	G.E.HWY.	8.53	N of Kalamunda Rd 50-402201-6469042	S
	H019	G.E.HWY. Bypass	10.18	G.E.H. Bypass Railbridge 50-404570-6468071	S
	H006	G.N.H.	8.85	N of Padbury Ave 50-406996-6479905	N
	H026	Guildford Rd		E of Moojebing Rd	S
	H028	Karrinyup-Morley Hwy	10.77	W OF LIGHT ST 50-393910-6470997	S
	H028	Karrinyup-Morley Hwy	4.77	E of Telford St	S
	H012	Leach Hwy	2.86	E of Rome Rd	S
	H013	Leach Hwy		S of Belmont Ave	S
	H029	Marmion Ave	4.65	N of Marri St 50-382808-6477617	S

Road Type	Road No.	Road Name	Location SLK	Spot Location Description
	H030	Port Beach Rd	2.30	1.25 km N of Leighton ped bridge
	H021	Reid Hwy	5.82	W OF MIRRABOOKA AVE 50-386150-6474686
	H021	Reid Hwy	17.18	Bennett Brook Bridge 50-400970-6474410
	H018	Roe Hwy	41.20	N of Morrison Rd
	H018	Roe Hwy	34.75	S OF G.E. HWY BYPASS 50-406918-6467038
	H009	South Western Hwy	4.21	Wungong Bridge 50407123-6437480
	H014	Stirling Hwy	1.40	H646 Mounts Bay Rd-Riverside Dr.
	H038	Thomas Rd	3.23	W of Johnston St 50-390219-6433286
	H017	Tonkin Hwy	21.40	MADDINGTON RD BRIDGE 50-398491-6444231
	H017	Tonkin Hwy	7.96	1 km N OF LEACH HWY 50-400968-6463512
	M026	Toodyay Rd	4.01	E of Mayo Rd 50-429473-6485732
	H033	Toodyay Rd	1.85	W of Campersic Rd 50-409841-6475093
	H035	Wanneroo Rd	9.63	S of Beach Rd 50-388549-6476018
	H035	Wanneroo Rd	28.64	S of Menchetti 50-381418-6494037
	H035	Wanneroo Rd /Charles St		N of Waugh St
	H027	Welshpool Rd	0.66	W of Tonkin Hwy
	H036	West Coast Hwy	8.70	N of 122 0003 Alfred Rd 50-383013-6463517

S – State Roads

N – National Highways

Appendix C

List Of 2018 Survey Locations

Metropolitan Area

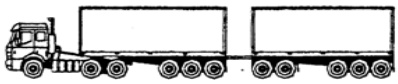
Road Type	Road No.	Road Name	Speed Zone	Location Description used in 2018	Road Type
State/	H001	ALBANY HWY	60	[2064] ALBANY HWY - S OF LADYWELL ST<60>	S
National	H030	CURTIN AVE (PORT BEACH RD)	60	[0655] CURTIN AVE - N OF TYDEMAN RD <60>	S
	H005	GR EASTERN HWY	60	[181] GREAT EASTERN HWY - W OF KALAMUNDA RD <60>	N
	H026	GUILDFORD RD	60	[4268] GUILDFORD RD - W OF WEST RD <60>	S
	H014	MOUNTS BAY RD	60	[51977] MOUNTS BAY RD - W OF POINT LEWIS ROTARY <60>	S
	H032	SOUTH ST	60	[2681] SOUTH ST - W OF STOCK RD <70>	S
	H035	WANNEROO RD /CHARLES ST	60	[0114] CHARLES ST - S OF ELIZABETH ST <60>	S
	H036	WEST COAST HWY	60	[0588] WEST COAST HWY - N OF SCARBOROUGH BEACH RD <60>	S
	H001	ALBANY HWY	70	[2395] ALBANY HWY - S OF TONKIN HWY <70>	S
	H052	BROOKTON HWY	70	[8298] BROOKTON HWY - E OF HOLDEN RD <70>	S
	H025	COCKBURN RD	70	[7692] COCKBURN RD -S OF OKANE CT <70>	S
	H025	COCKBURN RD	70	[1143] COCKBURN RD - S OF SPEARWOOD AV <70>	S
	H028	KARRINYUP RD	70	[373] KARRINYUP RD - W OF ALBERT ST <70>	S
	H028	MORLEY DR	70	[5057] MORLEY DR - E OF ALEXANDER DR <70>	S
	H027	RIVERVALE WATTLE GROVE LINK	70	[7748] ORRONG RD - W OF KURNALL RD <70>	S
	H002	STOCK RD	70	[0748] STOCK RD - N OF SOUTH ST<70>	S
	H038	THOMAS RD	70	[6709] THOMAS RD - W OF JOHNSON RD <70>	S
	H035	WANNEROO RD	70	[5094] WANNEROO RD - S OF CAMBERWELL RD <70>	S
	H036	WEST COAST HWY	70	[6113] WEST COAST HWY - S OF ROCHDALE <70>	S
	H023	ARMADALE RD	80	[7698] ARMADALE RD - E OF SEVENTH RD <80>	S
	H023	ARMADALE RD	80	[7012] ARMADALE RD - W OF LIDDELOW RD <80>	S
	H005	GR EASTERN HWY	80	[7694] !GREAT EASTERN HWY - W OF HARDEY RD <80>	N
	H006	GREAT NORTHERN HWY	80	[3529] GREAT NORTHERN HWY - S OF WEST SWAN RD <80>	N
	H012	LEACH HWY	80	[3633] LEACH HWY - S OF WELSHPOOL RD <80>	S
	H029	MARMION AV	80	[2175] MARMION AVE - N OF MARRI RD <80>	S
	H002	ROCKINGHAM RD	80	[4663] ROCKINGHAM RD - S OF RUSSELL RD <80>	S
	H038	THOMAS RD	80	[5291] THOMAS RD - E OF ORELIA AVE <80>	S
	H038	THOMAS RD	80	[5524] THOMAS RD - W OF GILMORE AV<80>	S
	H033	TOODYAY RD	80	[7700] TOODYAY RD - W OF CAMPERSIC RD <80>	S
	H035	WANNEROO RD	80	[7109] WANNEROO RD - N OF FLYNN DR <80>	S
	H001	ALBANY HWY	90	[51025] ALBANY HWY - E OF DMIETRIEFF RD <90>	S
	H021	REID HWY	90	[6734] REID HWY - W OF MIRRABOOKA AV <90>	S
	H021	REID HWY	90	[7075] REID HWY - W OF WEST SWAN RD <90>	S
	H002	ROCKINGHAM RD	90	[1858] PATTERSON RD - S OF CHARLES ST <90>	S
	H018	ROE HWY	90	[6354] ROE HWY - N OF MORRISON RD <90>	N
	H009	SOUTH WESTERN HWY	90	[4829] SOUTH WESTERN HWY - N OF ELEVENTH RD <90>	S
	H038	THOMAS RD	90	[51026] THOMAS RD - W OF NEWBOLD RD <90>	S
	H019	GREAT EASTERN HWY BYPASS	100	[6283] GREAT EASTERN HWY BYPA - W OF ABERNETHY RD <100>	S
	H002	MELVILLE MANDURAH HWY	100	[5297] ENNIS AV - N OF SAFETY BAY RD <100>	S
	H018	ROE HWY	100	[50014] ROE HWY - W OF WILLERI DR <100>	S
	H018	ROE HWY	100	[5110] ROE HWY - N OF KALAMUNDA RD <100>	N
	H017	TONKIN HWY	100	[5968] TONKIN HWY - S OF KELVIN RD <100>	S
	M026	TOODYAY RD	100	[4442] TOODYAY RD - W OF ROLAND RD <100>	S
	H001	ALBANY HWY	110	[7697] ALBANY HWY - N OF CANNING DAM <110>	S
	H009	SOUTH WESTERN HWY	110	[50620] SOUTH WESTERN HWY - S OF REILLY RD <110>	S

Road Type	Road No.	Road Name	Speed Zone	Location Description used in 2018	Hierar. Class
Local	1230003	KEANE ST	50	[4160] KEANE ST - W OF THE ESPLANADE <50>	A
	1180081	LADNER ST	50	[4646] LADNER ST - N OF SOUTH ST <50>	L
	1040102	MATILDA ST	50	[5404] MATILDA ST - S OF MILDENHALL ST <50>	L
	1140006	WHARF ST	50	[6073] WHARF ST - S OF SEVENOAKS ST <50>	B
	1190931	LE SOUEF DR	50	[7756] LE SOUEFF DR - N OF GAIRDNER DR <50>	L
	1311214	EDGEWATER DR	50	[7798] EDGEWATER DR - N OF PARKLAND CL <50>	A
	1210002	BAY VIEW TCE	50	[5252] OWSTON ST - N OF VICTORIA ST >50>	L
	1190679	GILBERTSON RD	50	[51110] GILBERTSON RD - S OF THOMAS WY <50>	L
	1061072	DARLINGTON RD	50	[51745] DARLINGTON RD - S OF MAYHEW RD	L
	1090998	AMAZON DR	50	[51746] AMAZON DR - E OF CHERWELL AVE <50>	L
	1040263	CAMPBELL RD	50	[51741] CAMPBELL RD - W OF ATLANTIC BLVD <50>	L
	1100417	TAPPING WAY	50	[51742] TAPPING WAY - W OF COONEWARRA WAY <50>	L
	1031102	THE GRANGE	50	[51743] THE GRANGE - S OF CATSPAW AV <50>	L
	1070031	CURRIE ST	50	[51744] CURRIE ST - S OF PARKLAND DR <50>	L
	1110015	BRIDSON ST	50	[51747] BRIDSON ST - E OF ELDER PDE	L
	1120077	LAWRWNCE ST	50	[51748] LAWRENCE ST - E OF CRAVEN ST <50>	A
	1280170	ALDERBURY ST	50	[51761] ALDERBURY ST - E OF LICHENDALE ST <50>	L
	1020174	TRAFALGAR RD	50	[51766] TRAFALGAR RD - N OF WINSTON RD <50>	L
	1090439	MYLES RD	50	[51767] MYLES RD - N OF BLANCHARD RD <50>	L
	1060124	WOOLOOMOOLOO RD	50	[51769] WOOLOOMOOLOO RD - N OF DAMASCUS DR <50>	L
	1010025	SEVENTH RD	50	[51770] SEVENTH AV - W OF CUDAL PL <50>	L
	1010523	LOWANNA WY	50	[51771] LOWANNA WAY - S OF LITTLE JOHN RD <50>	L
	1050234	CHALLENGER AV	50	[5712] CHALLENGER AV - E OF GILMORE AV <50>	B
	1300146	ANGOVE ST	50	[0028] !ANGOVE ST - E OF CHARLES ST <50>	L
	1130020	FULHAM ST	50	[7744] FULHAM ST - N OF ARMADALE RD <50>	AR
	1130012	WRIGHT ST	50	[7745] WRIGHT ST - N OF ARMADALE RD <50>	L
	1160007	BROOME ST	50	[7750] BROOME ST - S OF STANHOPE ST<50>	L
	1190018	REYNOLDS RD	50	[4553] REYNOLDS RD - S OF COOGEE RD <50>	L
	1190027	KINTAIL RD	50	[7757] KINTAIL RD - E OF ARMSTRONG RD <50>	L
	1190033	GARLING ST	50	[7758] GARLING ST - W OF DUNFORD ST <50>	L
	1220012	WARATAH AV	50	[7761] WARATAH AV - E OF CURLEW ST <50>	L
	1220011	VICTORIA AV	50	[7762] VICTORIA AV - N OF PHILIP RD <50>	L
	1290226	BISHOPSGATE ST	50	[7781] BISHOPGATE ST - S OF LION ST <50>	L
	1290214	STAR ST	50	[7782] STAR ST - S OF LION ST <50>	L
	1270009	NICHOLSON RD	50	[7784] NICHOLSON RD (SUBIACO) - E OF DERBY RD <50>	B
	1270008	ONSLOW RD	50	[7786] ONSLOW RD - E OF HILDA ST <50>	L
	1300047	ANZAC RD	50	[7790] ANZAC RD - W OF KALGOORLIE ST <50>	B
	1311156	MOOLANDA BVD	50	[7796] MOOLANDA BVD - N OF MCDOWELL CRES <50>	L
	1311258	BARRIDALE DR	50	[7797] BARRIDALE DR - N OF DALTON CRES <50>	L
	1311217	WEDGEWOOD DR	50	[50644] WEDGEWOOD RD - E OF TREETOP AVE <50>	L
	1310631	FLINDERS AVE	50	[7800] FLINDERS AVE - E OF MURRAY DR <50>	L
	1310609	EDDYSTONE AV	50	[8324] EDDYSTONE AV - N OF CARIDEAN ST <50>	A
	1270001	HAY ST	60	[4238] HAY ST - W OF JERSEY ST <60>	A
	1040506	YALE RD	60	[7719] YALE RD - W OF MCMAHON ST <60>	A
	1280001	THE BOULEVARD	60	[4974] THE BOULEVARD - E OF DURSTON RD <60>	A
	1020001	KALAMUNDA RD	60	[5823] KALAMUNDA RD - W OF ROE HWY <80>	A
	1030001	CARRINGTON ST	60	[0105] CARRINGTON ST - N OF FORREST RD <60>	A
	1220003	ALFRED RD	60	[0024] ALFRED RD - W OF BROCKWAY RD <60>	L
	1250072	WEAPONESS RD	60	[4133] WEAPONESS RD - N OF HALE RD <60>	L
	1092089	HENLEY BROOK AV	60	[51642] HENLEY BROOK AV - N OF GNANGARA RD <60>	L
	1250085	BLYTHE AV	60	[51772] BLYTHE AVE - W OF ROSCORLA AV <60>	A
	1220205	MONTOGOMERY AV	60	[51773] MONTGOMERY AVE - S OF REGENTS BVD <50>	L
	1130004	HARDEY RD	60	[5781] HARDEY RD - E OF GREAT EASTERN HWY <60>	B
	1251738	NORTHWOOD DR	60	[6270] NORTHWOOD DR - S OF AUSTRALIS AV <60>	B
	1191107	SOMERVILLE BVD	60	[6699] SOMERVILLE BVD - W OF MURDOCH DR <60>	B
	1091114	MORRISON RD	60	[6481] MORRISON RD - W OF ROE HWY <60>	A
	1010033	EIGHTH RD	60	[7707] EIGHTH RD - S OF TILLINGA ST <60>	B
	1010247	SEVILLE DR	60	[7709] SEVILLE DR - S OF MORGAN RD <60>	B

Road Type	Road No.	Road Name	Speed Zone	Location Description used in 2018	Hierar. Class
Local	1020004	HAWTIN RD	60	[7711] HAWTIN RD - S OF MAUD RD <60>	A
	1091173	LLOYD ST	60	[7730] LLOYD ST - N OF EDDIE BARRON DR <60>	A
	1091232	CLAYTON ST	60	[7732] CLAYTON ST - W OF KATHERINE ST <60>	B
	1120006	BROUN AVE	60	[5923] BROUN AVE - E OF EMBLETON AVE <60>	A
	1120005	BEECHBORO RD NORTH	60	[7738] BEECHBORO RD - S OF TELSTAR DR <60>	A
	1120010	COODE ST	60	[7739] COODE ST - S OF RUDLOC RD <50>	A
	1120023	MCGILVRAY AV	60	[4430] CRIMEA ST - N OF COLLIER RD <60>	A
	1120004	GRAND PROM	60	[7742] GRAND PROM - N OF CATHERINE ST <60>	A
	1140427	WILLERI DR	60	[7746] WILLERI DR - S OF HOSSACK AVE <60>	A
	1140011	SEVENOAKS ST	60	[7747] SEVENOAKS ST - S OF EWING ST <60>	A
	1190007	MARMION ST	60	[7751] MARMION ST - E OF THORN ST <60>	A
	1220006	STUBBS TCE	60	[7763] STUBBS TCE - N OF QUINTILIAN RD <60>	A
	1250017	WALCOTT ST	60	[7766] WALCOTT ST - N OF DUMBARTON CR <60>	A
	1250119	SACKVILLE TCE	60	[7767] SACKVILLE TCE - W OF FLAMBOROUGH ST <60>	B
	1250099	NORTH BEACH RD	60	[0376] NORTH BEACH RD - W OF DUFFY RD <60>	A
	1250142	BALCATTA RD	60	[7770] BALCATTA RD - W OF NATALIE WAY <60>	A
	1250052	CENTRAL AV	60	[2445] CENTRAL AVE - E OF ALEXANDER DR <60>	A
	1260003	MILL POINT RD	60	[7776] MILL POINT RD - E OF ONSLOW RD <60>	B
	1260001	MANNING RD	60	[7777] MANNING RD - W OF ELDERFIELD RD <60>	A
	1260002	LABOUCHERE RD	60	[3592] LABOUCHERE RD - S OF JUDD ST <60>	B
	1290251	BERWICK ST	60	[50640] BERWICK ST - S OF LANGLER ST <60>	A
	1280307	HARBORNE ST	60	[7787] HARBORNE ST - N OF WISE ST <60>	A
	1280309	LAKE MONGER DR	60	[7788] LAKE MONGER DR - W OF NORTHWOOD ST <60>	A
	1141013	HIGH RD	70	[5239] HIGH RD - W OF NICHOLSON RD<70>	A
	1290004	HAYMAN RD	70	[3216] HAYMAN RD - W OF KENT ST <70>	A
	1020003	CANNING RD	70	[0647] CANNING RD - N OF CARMEL RD <70>	A
	1140459	BANNISTER RD	70	[7749] BANNISTER RD - E OF HOPEWELL ST <70>	A
	1040090	GARDEN ST	70	[8287] GARDEN ST - S OF NICHOLSON RD<70>	A
	1020002	WELSHPOOL RD EAST	70	[4904] WELSHPOOL RD EAST - W OF TONKIN HWY <70>	A
	1090549	GNANGARA RD	70	[51027] GNANGARA RD - W OF HENLEY BROOK RD AV <70>	A
	1020811	DUNDAS RD	70	[7982] ABERNETHY RD - S OF KALAMUNDA RD <70>	A
	1070024	RAE RD	70	[5467] RAE RD - E OF READ ST <70>	A
	1030501	FARRINGTON RD	70	[5741] FARRINGTON RD - E OF PROGRESS DR <70>	A
	1220143	BROCKWAY RD	70	[6280] BROCKWAY RD - N OF LEMNOS ST <70>	A
	1020001	KALAMUNDA RD	70	[7710] KALAMUNDA RD - E OF DAVIES CR <70>	A
	1050003	WELLARD RD	70	[7720] WELLARD RD - W OF PARMELIA AV <70>	B
	1090502	WEST SWAN RD	70	[7728] WEST SWAN RD - N OF HARPER ST <70>	A
	1090570	BENARA RD	70	[0058] !BENARA RD - W OF WEST SWAN RD <70>	A
	1110123	COLLIER RD	70	[7737] COLLIER RD - E OF FAIRFORD ST <70>	A
	1190003	NORTH LAKE RD	70	[50621] NORTH LAKE RD - N OF LE SOUEF DR (SOUTH) <70>	A
	1220225	STEPHENSON AV	70	[7765] STEPHENSON AVE - N OF MONTGOMERY AVE <70>	A
	1250059	ALEXANDER DR	70	[50639] ALEXANDER DR - S OF STANFORD WAY <70>	A
	1270002	THOMAS ST	70	[7785] THOMAS ST - N OF HEYTESBURY RD <70>	A
	1280301	OCEANIC DR	70	[7789] OCEANIC DR - W OF BOLD PARK DR <70>	A
	1311700	HODGES DR	70	[50642] HODGES DR - W OF COUNTRY CLUB BVD <70>	A
	1311665	JOONDALUP DR	70	[7794] JOONDALUP RD - S OF BRIENZ DR <70>	A
	1103098	HESTER AV	70	[3513] HESTER AV - W OF WANNEROO RD <70>	A
	1310239	BURNS BEACH RD	80	[6643] BURNS BEACH RD - W OF JOONDALUP DR <80>	A
	1100474	FLYNN DR	80	[51751] FLYNN DR - E OF WANNEROO RD <80>	L
	1310002	MARMION AVE	80	[3912] MARMION AV - N OF OCEAN REEF RD <80>	A
	1100475	NEAVES RD	90	[51749] NEAVES RD - E OF DEMPSTER PL<90>	L
	1010001	NICHOLSON RD	90	[1020] NICHOLSON RD - S OF ARMADALE RD <90>	A
	1090049	NEAVES RD	110	[51750] NEAVES RD - E OF TIMELY HOSTESS MEWS <110>	L
	1104392	BREAKWATER DR	110	[8417] BREAKWATER DR - W OF WANNEROO RD <110>	L

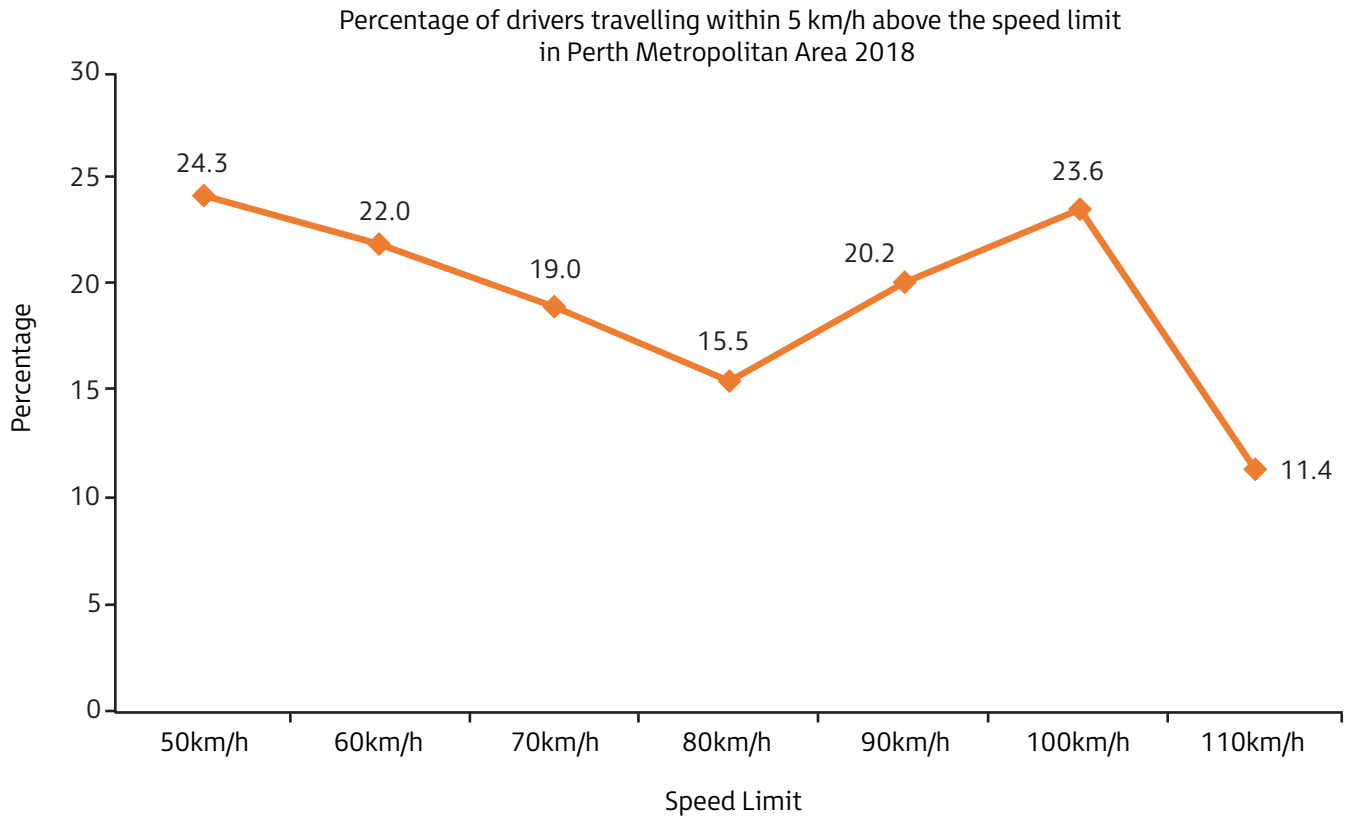
Appendix D

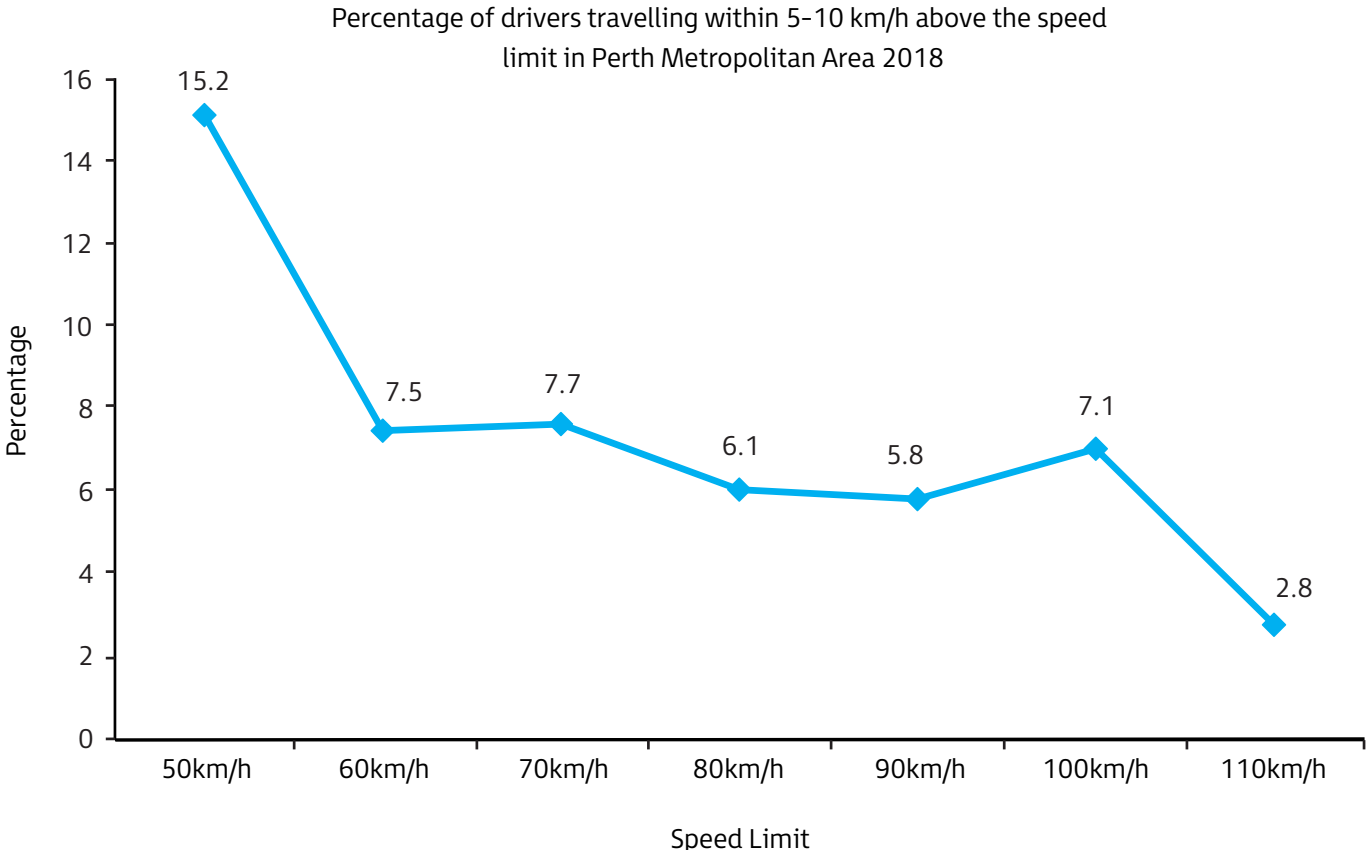
Austroads Vehicle Classes

CLASS	LIGHT VEHICLES	
1	SHORT Car, Van, Wagon, 4WD, Utility, Bicycle, Motorcycle	
2	SHORT – TOWING Trailer, Caravan, Boat	
	HEAVY VEHICLES	
3	TWO AXLE TRUCK OR BUS * 2 axles	
4	THREE AXLE TRUCK OR BUS *3 axles, 2 axle groups	
5	FOUR (or FIVE) AXLE TRUCK *4 (5) axles, 2 axle groups	
6	THREE AXLE ARTICULATED *3 axles, 3 axle groups	
7	FOUR AXLE ARTICULATED *4 axles, 3 or 4 axle groups	
8	FIVE AXLE ARTICULATED *5 axles, 3+ axle groups	
9	SIX AXLE ARTICULATED *6 axles, 3+ axle groups or 7+ axles, 3 axle groups	
	LONG VEHICLES AND ROAD TRAINS	
10	B DOUBLE or HEAVY TRUCK and TRAILER *7+ axles, 4 axle groups	
11	DOUBLE ROAD TRAIN *7+ axles, 5 or 6 axle groups	
12	TRIPLE ROAD TRAIN *7+ axles, 7+ axle groups	

Appendix E

2018 Metro Speed Distribution by Speed Limit Group





Metro

Exceeding by up to 5km/h	%	Exceeding by up to 10km/h	%
50km/h	24.3	0km/h	15.2
60km/h	22.0	60km/h	7.5
70km/h	19.0	70km/h	7.7
80km/h	15.5	80km/h	6.1
90km/h	20.2	90km/h	5.8
100km/h	23.6	100km/h	7.1
110km/h	11.4	110km/h	2.8