Road Safety Camera Commissioner

REPORT OF THE ROAD SAFETY CAMERA COMMISSIONER TO THE MINISTER FOR POLICE AND EMERGENCY SERVICES

Investigation into the effect of electronic speed advisory gantries on motorist behaviour

Release date: 7 May 2014

AT A GLANCE

In my first two Annual Reports, I have made recommendations to VicRoads to ensure the accuracy, reliability of the speed measurements and efficiency of Victoria's six electronic speed advisory signs (ESAS) are the same as Victoria's fixed road safety camera systems. Following these recommendations, the Minister for Police and Emergency Services directed me to conduct a technical investigation into the effects, if any, of the electronic speed advisory signs on motorists' behaviour.

The results of the study showed that motorists are actively using the ESAS to assess the accuracy of their speedometers, and while doing so, motorists slow down slightly in anticipation of receiving a reading from the ESAS before accelerating again to a slightly higher speed.

I am satisfied by the results of this study that motorists find the ESAS systems installed in Victoria to be of assistance to them in assessing the accuracy of their speedometers and in driving to the relevant speed limit.

Although the data collected shows that motorists are consistently camera surfing, I am satisfied that speed on all major Victorian highways, should be measured by point-to-point road safety camera systems. In my view, point-to-point safety cameras are the only practical method of ensuring compliance with the speed limit over a considerable length of road and the fairest method of speed measurement for motorists.

PURPOSE

1 The purpose of this report is to document the Road Safety Camera Commissioner's findings following an investigation into the effect electronic speed advisory signage (ESAS) has on motorists' behaviour on the Princes Freeway between Geelong and Melbourne.

BACKGROUND

2 In my annual reports of financial years 2012-13 and 2013-14, I recommended to VicRoads that all six electronic speed advisory signs installed along major highways in Victoria should be maintained to the accuracy level of the fixed road safety cameras installed in the state.

3 VicRoads are to be commended for making these devices available to assist motorists to monitor and control their speed on Victorian roads, so that they can adhere to the relevant speed limit. The six speed advisory signs are installed at the following locations:

a. Princes Freeway, Lara,

b. Western Freeway, Ballarat,

c. Western Freeway, Ballan,

d. Hume Freeway, north bound, Beveridge

e. Hume Freeway, south bound, Barnawartha North, and

f. Calder Freeway, Diggers Rest.

4 VicRoads has advised me that only one ESAS of the six installed, has the same accuracy level as the fixed road safety cameras in Victoria. That is the installation on the Melbourne bound carriageway of the Princes Freeway between Melbourne and Geelong.

5 My recommendation to VicRoads to increase the accuracy level of the remaining speed advisory signs is based on the premise that installing such equipment on Victorian roads should reinforce public confidence in the road safety camera system, as long as the ESAS systems are accurate and reliable. If they are not, they can become a trap for motorists who may rely on the accuracy of a speed measurement of an ESAS they drive past.

6 In light of the recommendations I have made in my annual reports, the Minister for Police and Emergency Services directed me to undertake an investigation into the effects of electronic speed advisory signage on motorists' behaviour, under section 10(c) of the *Road Safety Camera Commissioner Act 2011*.

SCOPE AND METHOD OF INVESTIGATION

7 The ESAS installed near the Beach Road overpass on the Melbourne bound carriageway of the Princes Freeway West near Lara, has been operational since 2007, and was chosen as the location of the test. The installation is:

a. Approximately 3.7 kilometres north of the road safety camera at the Avalon Road overpass, and

b. Approximately seven kilometres south of the road safety camera at the Point Wilson Road overpass.

8 The electronic speed advisory sign at the Beach Road overpass uses the same basic components and speed measurement method as the fixed road safety cameras installed along The Princes Freeway. It is calibrated to the same level of speed measurement accuracy and repeatability as the road safety cameras. This means that speed measurements made by the cameras and the speed advisory sign, are directly comparable.

9 To measure the effect of electronic speed advisory signage on motorist behaviour, three independently calibrated temporary speed measurement devices were installed by SGS Australia Pty Ltd on the Melbourne bound carriageway of Princes Highway West at the following locations between 1 February 2014 and 28 February 2014, inclusive:

a. Approximately 900 metres before the Beach Road overpass,

b. Approximately 160 metres before the Beach Road overpass, at the location of the speed advisory sign's sensors, and

c. Approximately 550 metres after the Beach Road overpass.

10 A temporary speed measurement device was installed at the location of the ESAS sensors as the ESAS does not retain records of speed measurements it has made. Further, as there is signage delineating the location of the point of measurement, motorists would naturally be inclined to make any alterations to their behaviour before this location, in anticipation of receiving a measurement of the accuracy of their vehicle's speedometer.

11 Data recorded by the three temporary speed measurement devices was analysed to determine what effect, if any, the speed advisory sign has on the behaviour of motorists in the length of road close to the speed advisory sign. This data was also used to determine whether any behaviour changes affect the likelihood of motorists being detected speeding by fixed road safety cameras installed on the Princes Freeway.

12 Traffic volume and speed data recorded by the two fixed road safety cameras during the period 1 February 2014 to 28 February 2014, on either side of the speed advisory sign, was also analysed to understand if the speed advisory sign still has any residual effect on motorist behaviour further along Princes Highway. The road safety camera locations are:

a. Melbourne-bound at the Avalon Road Bridge in Lara, and

b. Melbourne-bound at the Point Wilson Road Bridge in Point Wilson.

13 The two locations for road safety camera data were selected on the basis that there is minimal variation in traffic volume along this section of the Princes Freeway due to low numbers of vehicles entering and exiting the freeway from other roads. The road safety cameras on the Princes Freeway closer to Melbourne would be unsuitable for this type of analysis with additional lanes, more entry and exit ramps and much higher traffic volumes.

14 The length of road where the five data measurement points are located, the two fixed road safety cameras and the three temporary speed measurement devices at and near the ESAS system, have a speed limit of 100km/h and a three lane layout:

a. Lane One, which is the left-hand lane,

b. Lane Two, which is the middle lane, and

c. Lane Three, which is the right-hand lane.

RESULTS

DATA RECORDED BY TEMPORARY SPEED MEASUREMENT DEVICES

15 During the period 1 February 2014 and 28 February 2014, the temporary speed measurement devices recorded a total of:

a. 802,095 vehicles on approach to the speed advisory sign,

b. 780,174 vehicles at the speed advisory sign, and

c. 808,928 vehicles past the speed advisory sign.

16 The difference in number of vehicles recorded is due to motorists entering and exiting the freeway at Beach Road.

17 The distribution of traffic volume by lane is set out in **Table One** below:

Location	**Traffic volume and percentage**		
	Lane One	*Lane Two*	*Lane Three*
900 metres before Beach Road	280,492 (34.97%)	369,827 (46.11%)	151,776 (18.92%)
Speed advisory sign sensors	255,060 (32.69%)	364,060 (46.66%)	161,054 (20.64%)
550 metres after Beach Road	282,557 (34.93%)	366,758 (45.34%)	159,613 (19.73%)

Table One *– Number and proportion of traffic volume at all lanes between 1 February 2014 and 28 February 2014*

18 The highest number of vehicles recorded by the temporary speed measurement devices over any day of the week between the hours of 7 AM and 7 PM, or the "peak" period, is on Sunday at approximately 28,000 vehicles. The Monday to Saturday peak time average is approximately 20,000 vehicles.

19 In the "off-peak" period, which is from 7PM to 7AM, the traffic volume is lower, with an average volume of 7,000 vehicles. Additionally, the lowest traffic volume is recorded on Saturday and Sunday evenings.

20 The average speeds recorded by the three measurement locations are at their highest during the weekdays and lowest during the weekends. This effect is most pronounced in Lane Three, where the average speed on Sundays is approximately 3km/h below that recorded during weekdays.

21 In general, the average speed of motorists is seen to be lower at the speed advisory sign than their approach speed. Once past the speed advisory signage, motorists increased their

speed to a level that was slightly higher than their approach speed to the speed advisory sign.

22 In respect of motorist behaviour in individual lanes, the results, which are summarised in **Table Two** below, showed that:

a. Lane One, was shown to be the "slow lane", with the lowest recorded average speed. The change in average speed of motorists between the three temporary speed measurement devices was minimal, increasing by only 0.2 km/h from 96.58 km/h to 96.79 km/h.

b. In Lane Two, the average speed of motorists slowed from 99.42 km/h to 98.5 km/h at the speed advisory sign and then increased again to 99.92 km/h once they had travelled past the speed advisory sign. This lane's average speed was the closest to the speed limit.

c. Lane Three, which is generally the "overtaking lane", had an average speed of 103.01 km/h on approach to the speed advisory sign, slowed down to an average of 101.18 km/h and then sped up to 103.46 km/h.

Location	**Average Speed (km/h)**			
	Overall	*Lane One*	*Lane Two*	*Lane Three*
900 metres before Beach Road	99.10	96.58	99.42	103.01
Speed advisory sign sensors	98.38	96.43	98.50	101.18
550 metres after Beach Road	99.53	96.79	99.92	103.46

***Table Two** – Average speed of all motorists between the three temporary measurement devices between 1 February 2014 and 28 February 2014*

23 An interesting aspect of the study is the "standard deviation" of speeds recorded at the three locations. An explanation of "standard deviation" is included in **Appendix A**. Using the standard deviation in conjunction with the average speed of the measurements recorded by each of the three devices, we are able to determine if there is an overall change in the behaviour of motorists. **Table Three** summarises the standard deviations recorded at each measurement location.

Location	**Standard Deviation (km/h)**			
	Overall	*Lane One*	*Lane Two*	*Lane Three*
900 metres before Beach Road	5.14	5.43	3.97	4.44
Speed advisory sign sensors	4.68	5.17	3.84	4.05
550 metres after Beach Road	5.46	6.17	4.02	4.23

***Table Three** – Standard deviation of speed of all motorists between the three temporary measurement devices between 1 February 2014 and 28 February 2014*

24 The results show that motorists will generally converge to a lower speed at the speed advisory sign's sensors than their approach speed before diverging again, once past the speed advisory sign itself. However, it should be noted that Lane One consistently had the

highest speed variation of all the lanes, and that Lane Two had the least variation of the three lanes.

25 The lower level of speed variation seen in Lane Two and Lane Three, suggests the entire population of motorists in these lanes decelerates on approach to the speed advisory gantry and accelerates once past it, with broadly the same magnitude.

26 Since the variation of recorded speeds in Lane One spread out further once past the speed advisory sign, it suggests that some motorists will accelerate on seeing their travelling speed is lower than the speed limit, while others maintain their lower speed on passing the speed advisory sign, in effect, not altering their behaviour.

27 Additionally, as Lane One is closest to the entry and exit ramps for vehicles at Beach Road, some of the speed variation recorded could be attributable to traffic slowing down in anticipation of a lower speed limit at the exit and motorists still accelerating following a merge on to the freeway.

28 All graphs, relating to the speed of vehicles recorded by the temporary speed measurement devices, are presented in **Appendix C**.

DATA RECORDED BY THE ROAD SAFETY CAMERAS

29 Data recorded during the period 1 February 2014 to 28 February 2014 by the two fixed road safety cameras before and after the speed advisory sign was compared in order to determine if there was any difference in motorist behaviour from the first camera to the next.

30 On 8 February and 9 February 2014, VicRoads was conducting roadworks near the road safety camera at Avalon Road Bridge. These works required the camera to be deactivated for the majority of this time, resulting in incomplete data for these two dates. The data was normalised, by adding the average traffic volume and incidents detected for all other days during the recording period, to those dates.

31 When the data is normalised to account for the two days where the road safety camera at Avalon Road Bridge was deactivated, both road safety cameras recorded similar levels of traffic volume and vehicles speeding. **Appendix B** shows the data recorded by the road safety camera in more detail.

32 The average speed recorded at both fixed road safety cameras is lower than that recorded at the electronic speed advisory sign. The average speed of traffic during the recording period, at both fixed road safety camera systems, was approximately 95 km/h. This average speed is lower than the average speed at the speed advisory sign, which is approximately 98 km/h.

33 The standard deviations of recorded speeds were approximately 4.09 km/h at Avalon Road Bridge and 4.29 km/h at the Point Wilson Road Bridge, respectively. This is a similar standard deviation to that recorded at the speed advisory sign, suggesting all motorists slow down by a similar amount on approach to the road safety cameras.

34 These results suggest that the magnitude of the effect on motorists behaviour from the ESAS, is limited to its immediate vicinity and is only a fraction of that from fixed road safety cameras. Motorists travelling past the speed advisory sign, use it to check the accuracy of their speedometers, but by the time motorists have travelled further down the road, they will have reverted to their normal speed in free flowing traffic.

CONCLUSIONS

35 The data recorded by the three temporary speed measurement devices, shows that motorists are using the electronic speed advisory signage to assist them in assessing the accuracy of their speedometers and adhering to the relevant speed limit. Accurate and properly maintained ESAS systems are clearly of assistance to motorists in informing them of the true speed their vehicles are travelling at, at a particular point. This will reassure those motorists who wish to drive within the relevant speed limit.

36 Predictably, how individual motorists respond to that information, depends entirely upon the mindset of the particular motorist. For example:

a. Some motorists shown to be travelling under the permitted speed limit are reassured by the confirmation that they are travelling within legal limits, and maintain their speed,

b. In contrast, other motorists, faced with accurate information that they are travelling at a speed less than the speed limit, see this as reason to increase speed and reach their destination quicker, while

c. Some motorists who find themselves travelling above the legal speed limit and who are aware of the operation of road safety cameras along the Princes Freeway, will presumably reduce their speed, at least until the road safety cameras have been passed. In other words, this is another form of camera surfing.

37 I am encouraged by the fact that, although many motorists increase their overall speed after assessing the accuracy of their speedometers at the electronic speed advisory gantry, the number of vehicles detected exceeding the speed limit by the road safety camera at the Point Wilson Road Bridge, does not increase compared to the number detected at the Avalon Road Bridge.

38 The electronic speed advisory signage has a very similar effect on motorists' behaviour to the road safety camera systems in Victoria. Most motorists will converge on a lower average speed when approaching the speed advisory sign, before accelerating slightly above the original speed at which they were travelling, once they have received a reading. I have previously referred to this behaviour as "camera surfing", a behaviour which was also seen during my technical investigation into the road safety cameras installed along EastLink.

39 However, I am disappointed in the differences in average speed in free-flowing traffic, as recorded by the two temporary speed measurement devices on either side of the ESAS, compared to that recorded by the two fixed road safety cameras. The free flowing average speed of approximately 99 km/h is significantly different to the average speed of 95 km/h recorded by the two fixed road safety cameras.

RECOMMENDATIONS

40 I am satisfied electronic speed advisory signs that are well maintained and calibrated to the same accuracy level as Victoria's fixed road safety camera systems, are of assistance to motorists in driving within the relevant speed limit and assessing the accuracy of their speedometers.

41 After considering data produced by this investigation, which again shows motorists are consistently camera surfing, I am convinced that speed on all major Victorian highways should be measured by point-to-point road safety camera systems, similar to those currently installed on the Hume Highway and Peninsula Link.

42 I am satisfied that point-to-point road safety cameras are the only practical method of ensuring compliance with the speed limit over a considerable stretch of road, and the fairest method of speed measurement for motorists.

CONSULTATION

43 This report was written in consultation with SGS Australia Pty Ltd and the Department of Justice.

APPENDIX A

A standard deviation (σ), is an attribute used in statistics and probability, representing the degree of variation or spread from the average (μ) within a population of data or measurements. A low standard deviation means a population of measurements is closer to the average, while a high standard deviation means that there is a wide distribution from the average in its population. It should be noted that the standard deviation is a constant value above or below the average.

The measurement of a standard deviation is based on the distribution of measurements in a set of data falling within what is known as a "bell curve", which is also known as a "normal distribution". A standard deviation, depending on how far from the average value of the population it is, will contain a defined proportion of the total population. **Figure A1** shows an idealised normal distribution and the proportion of the population contained in each standard deviation.

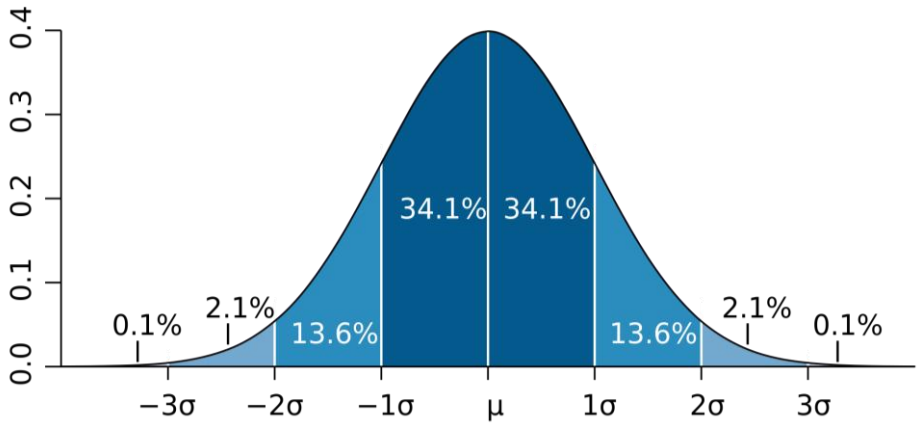


Figure A1 *– An ideal normal distribution with relative proportion of each standard deviation (σ). Cumulatively, approximately 68.2 percent of the population in a data set is contained within one standard deviation of the mean, or average, value (μ), and approximately 95.4 percent of the population is contained within two standard deviations. (Image credit: Wikipedia)*

The average, or mean value of a population (μ), is determined by the following formula:

$$\mu = \frac{1}{N}\sum_{i=1}^{N} x_i$$

The standard deviation of the population (σ), is determined by the formula:

$$\sigma = \sqrt{\frac{1}{N}\sum_{i=1}^{N}(x_i - \mu)^2}$$

Where:

- **x** represents any value in the population, and
- **N** represents the total number of values in the population.

APPENDIX B

Data recorded by the fixed road safety camera at Avalon Road Bridge, Lara

	TRAFFIC VOLUME				INCIDENTS DETECTED			
DATE	**LANE 1**	**LANE 2**	**LANE 3**	**TOTAL**	**LANE 1**	**LANE 2**	**LANE 3**	**TOTAL**
1/02/2014	9268	13809	5265	28342	4	15	40	59
2/02/2014	11129	17211	10195	38535	16	17	33	66
3/02/2014	9400	14006	5243	28649	4	13	38	55
4/02/2014	9351	13985	4963	28299	7	14	18	39
5/02/2014	6911	10429	3978	21318	3	16	20	39
6/02/2014	9486	14031	5202	28719	8	19	30	57
7/02/2014	6721	10019	3768	20508	4	11	16	31
8/02/2014*	**9111**	**13592**	**5424**	**28128**	**6**	**15**	**27**	**48**
9/02/2014*	**9111**	**13592**	**5424**	**28128**	**6**	**15**	**27**	**48**
10/02/2014	4739	6633	2382	13754	2	17	14	33
11/02/2014	9322	13686	5066	28074	6	10	26	42
12/02/2014	9612	14121	5316	29049	3	20	25	48
13/02/2014	9571	14231	5389	29191	9	19	23	51
14/02/2014	9984	14947	5916	30847	7	12	39	58
15/02/2014	9431	13896	5159	28486	10	22	34	66
16/02/2014	10185	15738	7984	33907	8	16	39	63
17/02/2014	8292	12490	4685	25467	4	15	17	36
18/02/2014	7628	10803	3946	22377	6	6	21	33
19/02/2014	9418	14192	5384	28994	4	8	20	32
20/02/2014	9443	13750	4959	28152	7	17	17	41
21/02/2014	9835	14909	5696	30440	7	14	28	49
22/02/2014	8981	13435	5031	27447	4	19	35	58
23/02/2014	10173	15673	8048	33894	7	19	33	59
24/02/2014	9112	13524	4924	27560	5	13	25	43
25/02/2014	7392	11395	4580	23367	7	18	24	49
26/02/2014	7497	10659	3809	21965	2	17	20	39
27/02/2014	9563	13929	5183	28675	11	17	25	53
28/02/2014	10072	14953	5915	30940	4	10	32	46
TOTAL	**250738**	**373640**	**148834**	**773212**	**171**	**424**	**746**	**1341**
AVERAGE	*9111.08*	*13592.8*	*5424.16*	*28128.08*	*6.28*	*15.08*	*27.12*	*48.48*
PER CENT	*32.39%*	*48.32%*	*19.28%*	*100.00%*	*12.78%*	*31.61%*	*55.61%*	*100.00%*

Table B1 *– traffic volume and incidents detected by the fixed road safety camera monitoring Melbourne bound traffic at the Avalon Road Bridge, Lara.*

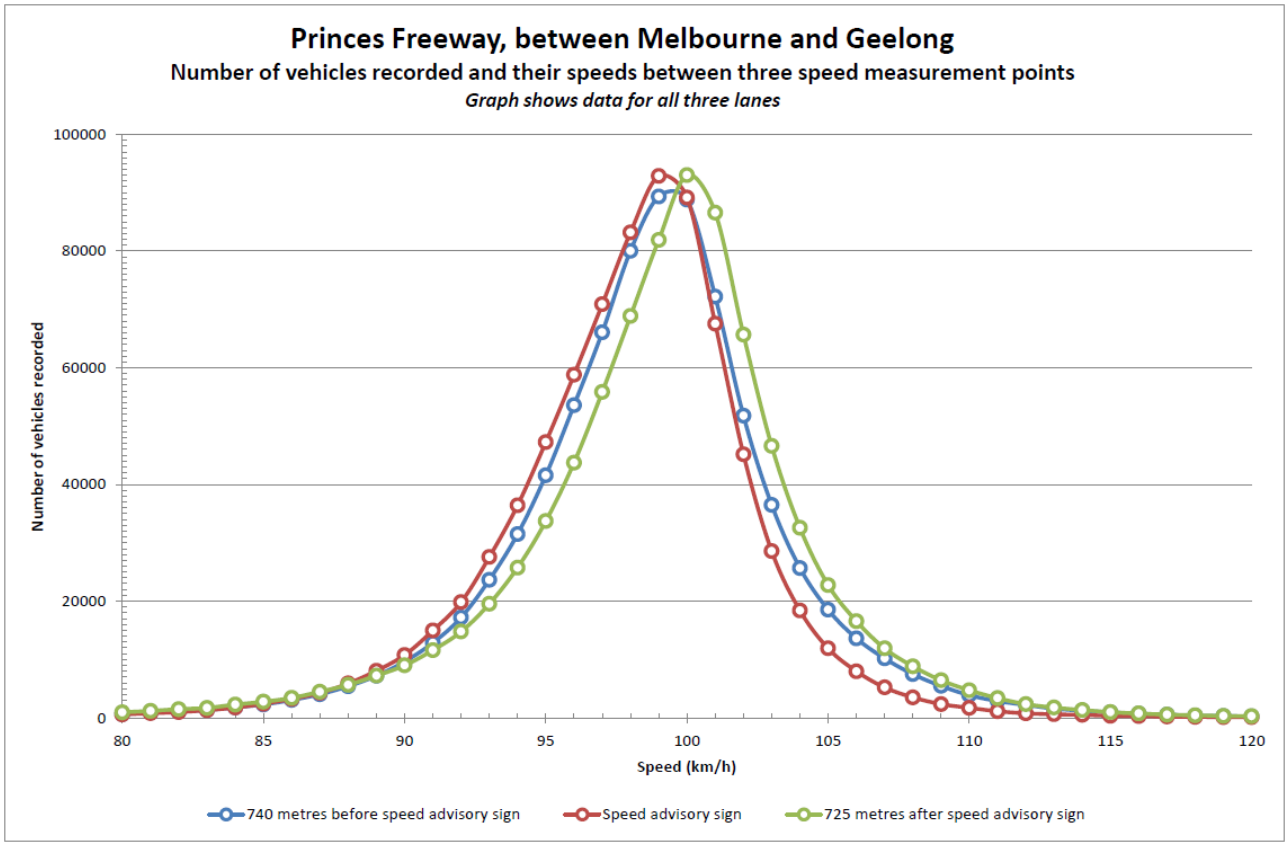
*** Note:** On 8 February 2014 and 9 February 2014, VicRoads conducted roadworks near the road safety camera installed at Avalon Road Bridge, which meant it was deactivated during the majority of these two dates. In order to equalise the two sets of data, the values for traffic volumes and incidents included for those dates are averages for the data recording period, excluding those two dates.

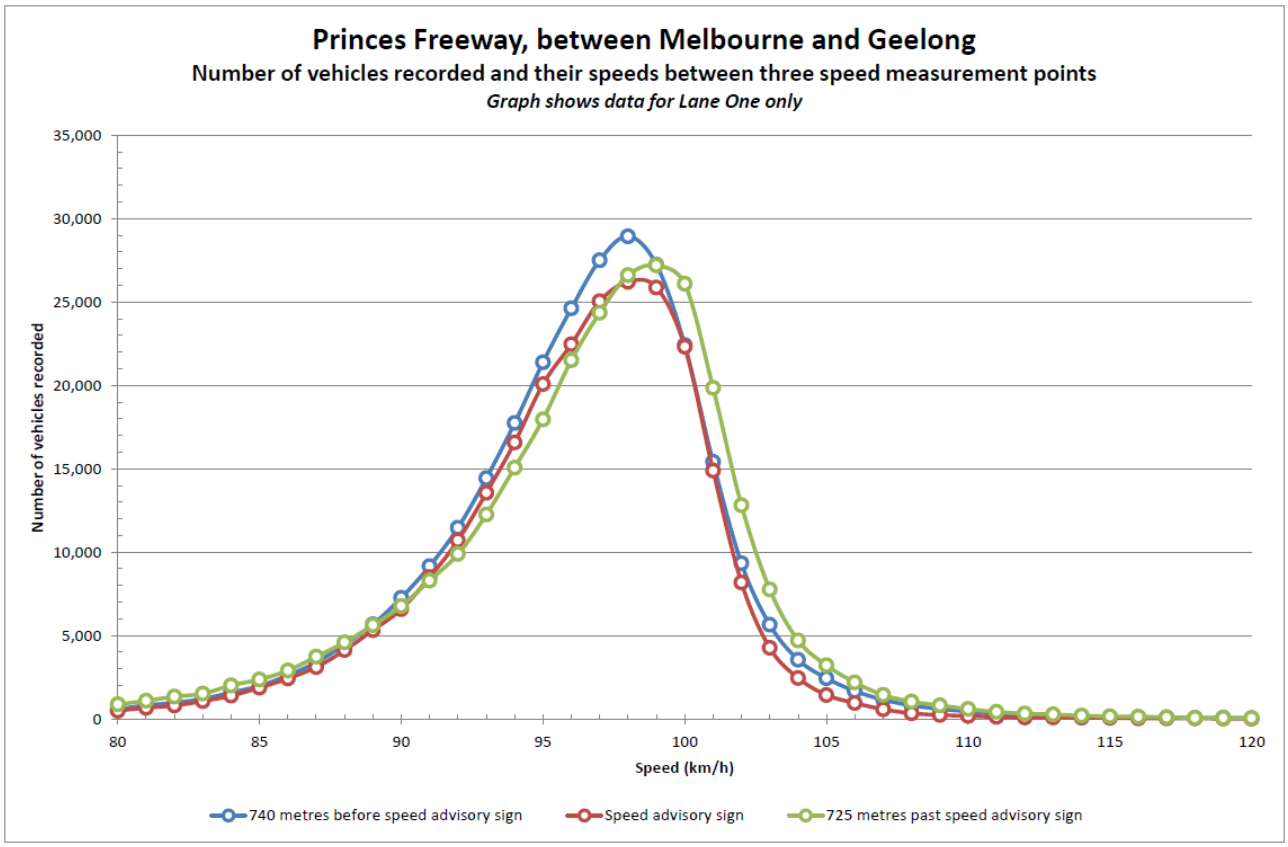
Data recorded by the fixed road safety camera at Point Wilson Road Bridge, Point Wilson

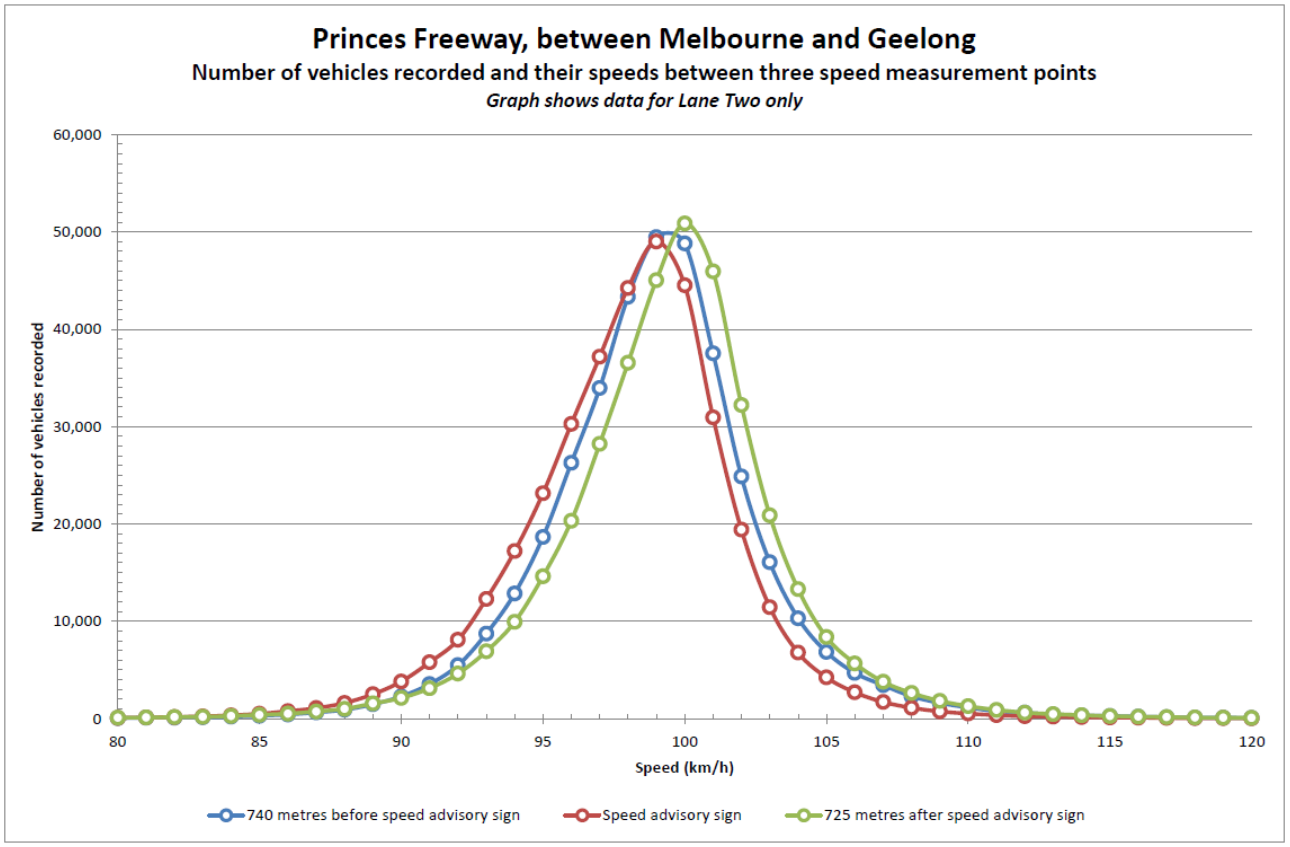
	TRAFFIC VOLUME				INCIDENTS DETECTED			
DATE	**LANE 1**	**LANE 2**	**LANE 3**	**TOTAL**	**LANE 1**	**LANE 2**	**LANE 3**	**TOTAL**
1/02/2014	8746	13176	4809	26731	6	14	36	56
2/02/2014	10563	16560	9540	36663	12	25	34	71
3/02/2014	8511	12979	4763	26253	8	11	35	54
4/02/2014	8607	12769	4514	25890	3	10	16	29
5/02/2014	8176	12402	4496	25074	4	17	21	42
6/02/2014	8592	12978	4870	26440	6	12	25	43
7/02/2014	9064	13559	5134	27757	5	12	18	35
8/02/2014	7941	13321	5388	26650	4	19	27	50
9/02/2014	9818	15743	7982	33543	9	23	45	77
10/02/2014	8477	12232	4608	25317	6	18	22	46
11/02/2014	8500	12479	4560	25539	3	13	15	31
12/02/2014	8738	13070	4883	26691	5	16	20	41
13/02/2014	8713	13104	4962	26779	11	10	27	48
14/02/2014	9038	13321	5649	28008	5	19	24	48
15/02/2014	8692	12788	4953	26433	11	21	30	62
16/02/2014	9502	15197	7687	32386	10	12	32	54
17/02/2014	8317	12886	4660	25863	2	17	27	46
18/02/2014	8468	12733	4697	25898	8	17	22	47
19/02/2014	8533	13194	4979	26706	4	12	26	42
20/02/2014	8336	12811	4728	25875	8	8	21	37
21/02/2014	8850	13936	5321	28107	8	22	33	63
22/02/2014	8238	12809	4760	25807	9	27	28	64
23/02/2014	9431	15219	7724	32374	9	19	35	63
24/02/2014	8287	12818	4753	25858	3	20	19	42
25/02/2014	8650	12852	4826	26328	2	17	23	42
26/02/2014	7681	11576	4236	23493	3	15	21	39
27/02/2014	7643	11888	4548	24079	7	19	23	49
28/02/2014	9033	13874	5475	28382	4	15	21	40
TOTAL	**243145**	**372274**	**149505**	**764924**	**175**	**460**	**726**	**1361**
AVERAGE	***8676.36***	***13239.12***	***5261.08***	***27176.56***	***6.24***	***16***	***25.28***	***47.52***
PER CENT	***31.79%***	***48.67%***	***19.55%***	***100.00%***	***12.86%***	***33.80%***	***53.34%***	***100.00%***

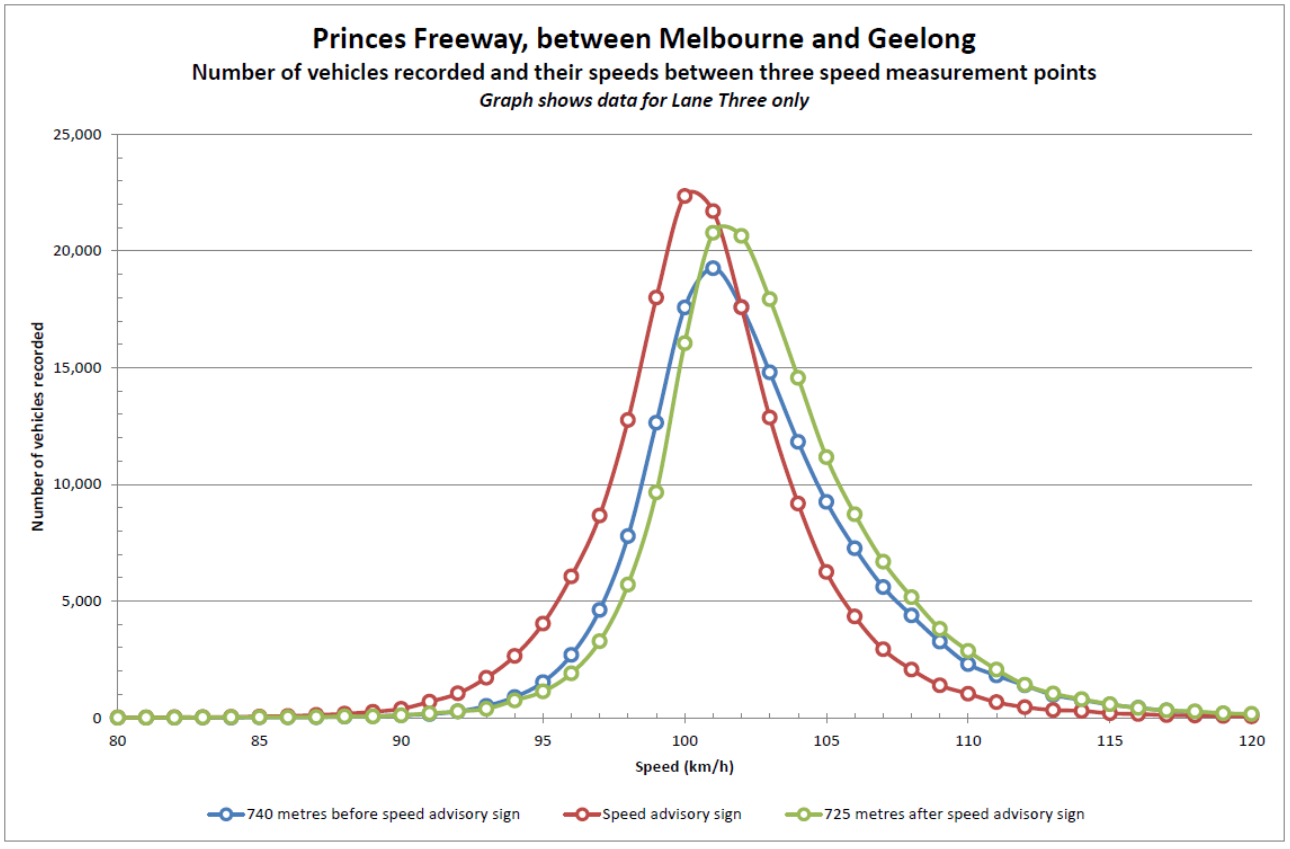
Table B2 *– traffic volume and incidents detected by the fixed road safety camera monitoring Melbourne bound traffic at the Point Wilson Road Bridge, Point Wilson.*

APPENDIX C


Princes Freeway, between Melbourne and Geelong
Number of vehicles recorded and their speeds between three speed measurement points
Graph shows data for all three lanes
Number of vehicles recorded
100000
80000
60000
40000
20000
0
80
85
90
95
100
105
110
115
120
Speed (km/h)
740 metres before speed advisory sign
Speed advisory sign
725 metres after speed advisory sign


Princes Freeway, between Melbourne and Geelong
Number of vehicles recorded and their speeds between three speed measurement points
Graph shows data for Lane One only
Number of vehicles recorded
35,000
30,000
25,000
20,000
15,000
10,000
5,000
0
80
85
90
95
100
105
110
115
120
Speed (km/h)
740 metres before speed advisory sign
Speed advisory sign
725 metres past speed advisory sign


Princes Freeway, between Melbourne and Geelong
Number of vehicles recorded and their speeds between three speed measurement points
Graph shows data for Lane Two only
60,000
50,000
40,000
30,000
20,000
10,000
0
Number of vehicles recorded
80
85
90
95
100
105
110
115
120
Speed (km/h)
740 metres before speed advisory sign
Speed advisory sign
725 metres after speed advisory sign


Princes Freeway, between Melbourne and Geelong
Number of vehicles recorded and their speeds between three speed measurement points
Graph shows data for Lane Three only
25,000
20,000
15,000
10,000
5,000
0
Number of vehicles recorded
80
85
90
95
100
105
110
115
120
Speed (km/h)
740 metres before speed advisory sign
Speed advisory sign
725 metres after speed advisory sign