# NSW SAFETY CAMERA REVIEW

**Prepared by the NSW Centre for Road Safety**

**September 2011**

# OBJECTIVE OF THIS REPORT

The objective of this report is to investigate the effectiveness of safety cameras in reducing the number and severity of crashes as a step in the process of developing an overarching strategy for speed enforcement in NSW.

The specific steps in achieving this objective are to:

1. Review the latest international and national research evidence relating to the effectiveness of enforcement cameras at intersections.

2. Review the performance of the current NSW safety camera program, by analysing intersection crash data.

3. Discuss the implications of the evidence for the future of the NSW safety camera program.

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# EXECUTIVE SUMMARY


International and Australian research clearly demonstrates that increased travel speed is directly related to both the likelihood of a crash occurring and the severity of crash outcomes (see Elvik, Christensen & Amundsen, 2004).

Signalised intersections are complex environments that are demanding of drivers' attention. In addition to vehicle traffic, intersections often operate in locations of greater pedestrian activity. Speed enforcement at intersections is particularly important since slight reductions in vehicle speed will significantly reduce crash occurrences and the severity of outcomes for pedestrians and vehicle occupants in the event of a crash.

Crashes at signalised intersections can be particularly severe because they often involve a 't-bone' collision where the front of one vehicle collides with the relatively unprotected side of another vehicle. Studies show (see Rosen & Sander, 2009) that side-impact crashes are only survivable at much lower speeds than frontal crashes, especially given the tendency for motorists running a red-light to 'speed up' in order to get through the intersection.

Safety cameras combine enforcement of obedience to traffic signals with enforcement of adherence to speed limits. The addition of speed enforcement to red light cameras addresses the risk of people speeding up to get through the changing traffic light and encourages motorists to always drive within the speed limit, thereby reducing the need to run a red-light or brake heavily on approach to an intersection.

Given the safety benefits of red-light cameras and fixed speed cameras, the use of dual function red-light speed cameras at intersections is expected to reap similar safety results. It is estimated safety cameras could result in a minimum 25 per cent reduction in crashes at intersections (based on evaluations of red-light cameras and fixed speed cameras: Cameron, 2010; and results from the Victorian program: Budd, Scully & Newstead, 2011).

Safety cameras were introduced in NSW in January 2010 to both replace existing red-light cameras and to treat new intersections, and were supported by an extensive public education campaign. Surveys conducted by the RTA in both 2009 and 2011 found that around 80 per cent of NSW drivers approve the use of safety cameras (Walker, Murdoch, Bryant, Barnes & Johnson, 2009; Roads and Traffic Authority, 2011)

New analyses carried out by the NSW Centre for Road Safety for this report show that safety cameras at both locations previously enforced by red-light cameras and new locations have resulted in a statistically significant 26 per cent reduction in crashes and a 34 per cent reduction in injuries at these intersections.

An expanded program of safety cameras should be considered.

# 1. Review of international and Australian evidence

## 1.1 Introduction

Current and past research in Australia and internationally provides compelling evidence that increased travel speeds are directly related to both the likelihood of a crash occurring and to the severity of crash outcomes.

A key Australian study (Kloeden, McLean, Moore & Ponte, 1997) found that the risk of crashing in a 60 km/h speed zone doubled with every 5 km/h increase in travelling speed above 60 km/h.

Signalised intersections are complex environments that are demanding of drivers' attention. In addition to vehicle traffic, intersections often operate in locations of greater pedestrian activity. Speed enforcement is therefore particularly important since slight reductions in vehicle speed will significantly reduce the severity of outcomes for pedestrians in the event of a crash. For example, research estimates that at an impact speed of 65 km/h a pedestrian has a 40 per cent chance of surviving whilst at an impact speed of 40 km/h a pedestrian has a 90 per cent chance of surviving (for review, see Rosen & Sander, 2009).

In addition, crashes at signalised intersections can be particularly severe because they often involve a 't-bone' collision where the front of one vehicle collides with the relatively unprotected side of another vehicle. Studies show (see Rosen & Sander, 2009) that side-impact crashes are only survivable at much lower speeds than frontal crashes, especially given the tendency for motorists running a red-light to 'speed up' in order to pass the intersection.

Safety cameras enforce both red-light and speeding offences and improve the safety of intersections by deterring drivers from both running red-lights and speeding.

Although red-light cameras and speed cameras are best practice speed enforcement measures around the world, safety cameras are a relatively new technology and as yet have not been the subject of rigorous evaluation. However, based on the recognised benefits of red-light cameras and fixed speed cameras, it is expected that safety cameras would result in similar benefits, if not more, at intersections.

Section 1.2 examines deterrence theory and why speed cameras are effective in influencing driver behaviours. Sections 1.3 and 1.4 discuss the benefits of red-light camera enforcement and speed camera enforcement respectively, while safety camera programs in Australia are reviewed in section 1.5.

## 1.2 General commentary on deterrence

Classical Deterrence theory proposes that individuals will avoid engaging in offending behaviours if they fear the perceived consequences of the act (Homel, 1988). This theory suggests that the most powerful deterrent effects on offending behaviour are produced by the perceived threat of the certainty of apprehension, in this context referring to the perceived likelihood of being caught speeding. Thus, in order for the "fear of punishment" to be effective, motorists must believe that the likelihood of being caught for speeding is relatively high (Davey & Freeman, 2011).

According to the classic driver decision-making model proposed by Naatanen and Summala (1974), drivers balance the subjective risk of the negative consequences of speeding with their motives for engaging in the behaviour when choosing their speed. Therefore, a principal objective of effective deterrence-based speed countermeasures is to increase the drivers' perception of the risks associated with excessive speed. This may be achieved largely via two processes: specific deterrence, and general deterrence.

Specific Deterrence – Occurs when a motorist who has been apprehended and punished for a speeding offence refrains from further speeding behaviour for fear of incurring additional punishment. This is the principle that supports penalties such as demerit points for specific driving offences.

General Deterrence – Occurs when a motorist refrains from speeding as a result of observing others being punished for a speeding offence or they are warned of the impending penalties for speeding or likelihood of being caught. Thus, the threat of enforcement influences the behaviour of motorists generally, irrespective of whether or not they have ever been apprehended.

While there is a strong understanding from drivers that speeding increases the risk of a crash (Petroulias, 2009), speeding remains a prevalent behaviour among motorists in most jurisdictions (see Wegman & Goldenbeld, 2006) including NSW (Taverner Research, 2008). This is likely due to driver overconfidence. Many studies internationally (e.g. Weinstein & Lyon, 1999) and in NSW (e.g. Fernandes et al., 2010) show that drivers tend to see themselves as superior than the average driver, with very few drivers rating themselves as below average. Thus, while drivers acknowledge the risk of speeding, they may believe that this risk does not apply to themselves due to their perceived superior skills. For this reason, enforcement-based deterrence would appear more effective than deterrence focused solely on highlighting crash risk for speeding.

## 1.3 Road safety benefits of red-light cameras

Red-light running has been shown to increase the risk of serious crashes, particularly right-angle crashes which are highly likely to result in injury and death. Studies have shown that red-light cameras at intersections have resulted in reductions in red-light violations and associated crashes. Although results vary considerably, it is estimated red-light cameras result in a 25-30 per cent reduction in injury crashes at intersections (Retting, Ferguson & Hakkert, 2003).

In a methodologically sound study conducted in Oxnard, California, Retting and Kyrychenko (2002) concluded that red-light cameras contributed to a 7 per cent reduction in crashes at all intersections in Oxnard (not just intersections with red-light camera enforcement) as well as a 29 per cent reduction in associated injuries. Furthermore, the researchers found a 32 per cent reduction in right-angle crashes with associated injuries reducing by 68 per cent.

It has been reported that red-light cameras lead to an increase in rear-end crashes due to drivers suddenly stopping on an amber light. However, in a review of international literature, Retting et al. (2003) concluded that while red-light cameras increase the incidence of rear-end crashes, they don't increase injuries associated with those crashes. Given that the severity of right-angle crashes are often more serious than rear-end crashes, Kloeden, Edwards and McLean (2009:3) suggest that if red-light cameras reduce the frequency of severe right-angle crashes, then they may be deemed to be an effective road safety measure. The addition of speed enforcement can be expected to manage down this small increase in rear end crashes.

## 1.4 Road safety benefits of fixed speed cameras

Speed cameras are an increasingly common method of speed enforcement. Many countries throughout the world employ speed cameras as part of their speed enforcement activities, including every state in Australia, the Netherlands, France, the United Kingdom, Finland, Germany, Hong Kong, Canada, the United Arab Emirates, Kuwait, Denmark, Spain, New Zealand, Italy and Norway. These are all jurisdictions with good road safety records, where speed cameras are considered an essential part of a best practice road safety strategy.

Studies on the effects of fixed speed cameras have shown positive effects on both the level of speeding and the number of crashes at the camera location and surrounding area.

### 1.4.1 Findings from Australian Jurisdictions

In a controlled before-and-after study in Victoria, Diamantopoulou & Corben (2002) found that fixed speed cameras in a multi-lane tunnel in Melbourne were associated with a 79 per cent reduction in the proportion of drivers exceeding the speed limit by the enforceable margin of 10 km/h, and a 76 per cent reduction in the proportion of drivers exceeding the speed limit by more than 30 km/h.

An independent evaluation of the NSW Fixed Speed Camera Program revealed the number of vehicles exceeding the speed limit at camera sites was reduced by 71 per cent and this has resulted in fatal crashes being reduced by 90 per cent, and casualty crashes being reduced by 23 per cent (ARRB Group, 2005).

A recent analysis of fixed digital speed cameras in NSW found that the majority of cameras have delivered a road safety benefit and have contributed to a 67 per cent reduction in fatalities and 26 per cent reduction in injuries and crashes at fixed camera locations. However the results varied for individual camera locations with crashes, injuries or fatalities increasing at some while decreasing at others (The Audit Office of NSW 2011).

### 1.4.2 Key International Findings

Mountain, Hirst & Maher (2005) evaluated fixed speed cameras on 30 mph roads throughout Great Britain, controlling for changes in traffic flow, time trends, and regression to the mean using comparison groups for crash and volume trends. Findings demonstrated decreases in mean and 85th percentile speeds and percentage exceeding the limit, and demonstrated reductions in injury crashes of approximately 25 per cent at camera sites over an average 2-year period.

Based on a fixed speed camera program in Norway, Elvik (1997) reported a broad 20 per cent reduction in the number of injury crashes at treated speed camera sites. Sections that conformed to both a crash rate warrant (crash rate of the site was higher than the crash rate for that type of road) and crash density warrant (the segment had at least 0.5 injury crashes per kilometre of road per year) experienced a statistically significant 26 per cent reduction in injury crashes, which is comparable to the results reported by Mountain et al. (2005). The largest effects were found for roads with speed limits of 60 and 70 km/h compared with lower-end and higher-end speed limit roads.

More recently, Retting, Kyrychenko & McCartt (2008) found that the introduction of fixed speed cameras on a freeway in Arizona was associated with an 88 per cent decrease in the proportion of drivers exceeding the speed limit by more than 10 miles per hour. In addition, Novoa, Pérez, Santamarina-Rubio, Mari-Dell'Olmo & Tobias (2010) assessed the effects of fixed camera installations on Barcelona roads (predominantly 50 km/h and 80 km/h roads), and found that the monthly median number of crashes and injuries on 80km/h roads were both significantly lower post-implementation (38 and 62, respectively) than pre-implementation (48 and 79, respectively).

### 1.4.3 Distance Halo Effects associated with Fixed Speed Cameras

A "distance halo effect" refers to a sustained effect of enforcement adjacent to the operational speed enforcement location. As fixed speed cameras typically operate 24 hours per day, this method of enforcement is expected to produce reductions in travel speeds at all times. However, because motorists know the precise location of fixed speed cameras in jurisdictions where they are signposted, deterrence effects are often found for a specific distance around the camera, and tend to be larger when measured near the actual camera site (Christie, Lyon, Dunstan & Jones, 2003; Hess, 2004).

As illustrated below, the safety benefits of fixed speed cameras are localised. Speed survey analysis conducted by the RTA in 2006 found that, unsurprisingly, drivers decrease speed on approach to and on passing the cameras then increase speed again on departure from the cameras. Therefore because they operate only at one point, the deterrent value and safety benefits of fixed speed cameras are limited to a smaller total length of approximately 1,000 metres around each camera, with the largest reductions observed for the closest 500 metres around the camera (see Figure 1).

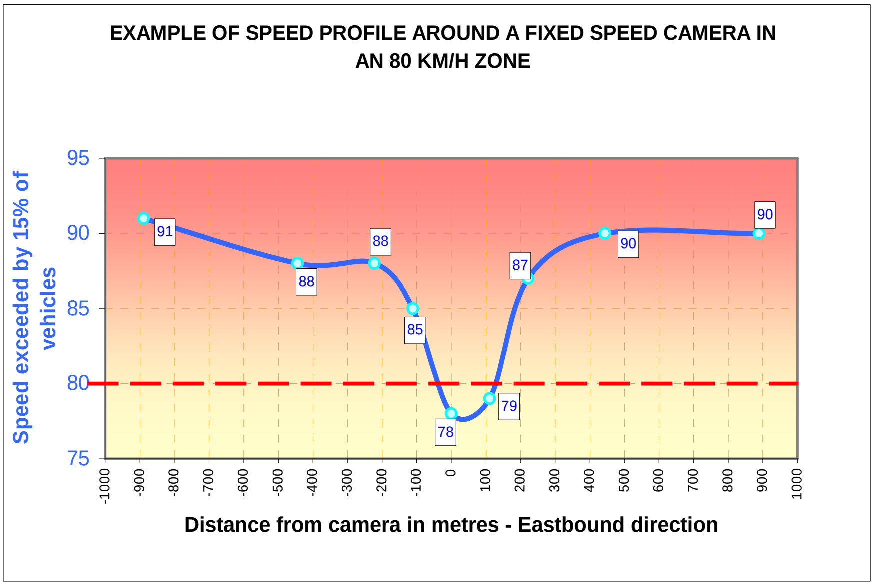


*Figure 1: Example of a speed profile around a fixed speed camera*

In other words, the effects of enforcement only last for as long as drivers perceive a high risk of being detected. Thus, fixed speed cameras appear to be effective in addressing a specific area of risk on the road for specific locations, but less effective in reducing speeding and crashes more broadly across a whole road network as large as NSW, or crashes over a longer length.

After a review of relevant evidence, Elliott & Broughton (2005) conclude that speed cameras are arguably more effective than physical policing methods at reducing violation and crash rates. However, overt speed camera enforcement is associated with a distance halo effect, such that lower but still significant crash reductions are observed within a set radius of a speed camera. While research from Finland demonstrated that the effects of speed cameras extended to between 4km and 10km from the speed camera site (Makinen & Oei, 1992), most research suggests that the distance halo effects of overt speed cameras are not of this magnitude. For example, consistent with the above RTA speed survey data, Keenan (2002) found an approximate 1,000 metre halo effect, with mean speeds 500 metres after passing a speed camera increasing to the same levels they were 500 metres before the camera.

## 1.5 Safety camera programs

Although red-light cameras and speed cameras are best practice speed enforcement measures around the world, safety cameras are a relatively new technology and as yet have not been the subject of many rigorous evaluations. However, based on the recognised benefits of red-light cameras and fixed speed cameras, it is confidently expected that safety cameras would result in similar benefits, if not more, at intersections. Indeed, Cameron (2010) suggests that the estimated crash effects of safety cameras would be a 25 per cent reduction in crashes and of the remaining 75 per cent of casualty crashes, the serious casualty crashes would be reduced by 15 per cent and the non-serious casualty crashes by 8 per cent. It is on this basis that safety cameras have been rolled out in a number of Australian and international jurisdictions.

Safety cameras are used in South Australia, the Australian Capital Territory, Victoria, Western Australia and Queensland. As a rate of enforcement per signalised section, Table 1 below shows that the current NSW program is smaller than the Victorian and South Australian programs, which are currently the two most established programs in addition to NSW.

| State | Program commencement | Number of intersections with RLSC enforcement | Number of signalised intersections as at November 2011 | Rate of enforcement per number of signalised intersections |
|---|---|---|---|---|
| NSW | 2009 | 91 | 3890 | 0.023 |
| *NSW proposed program* | | *200* | *3890* | *0.051* |
| VIC | 2004 | 175 | 3200 | 0.054 |
| SA | 2001 | 82 | 610 | 0.134 |

*Table 1: Safety camera programs in NSW, VIC and SA*

The recent evaluation of the Victorian program is the most comprehensive analysis of the effects of safety cameras available. A number of overseas studies examined the overall benefits of safety camera programs that include both fixed speed cameras and combined red-light speed cameras, such as the safety camera program in the United Kingdom. An evaluation of this program found that cameras lead to an estimated 42 per cent reduction in fatalities and serious casualties at camera sites (Gains, Nordstrom, Heydecker and Shrewsbury, 2005).

### 1.5.1 Victoria

The safety camera program in Victoria has been operating since 2004 (rolled out from December 2004 to January 2009). The Monash University Accident Research Centre (MUARC) recently published a report on the casualty crash effects of Victorian safety cameras

(Budd, Scully and Newstead, 2011). The evaluation estimated that the cameras led to a statistically significant 26 per cent reduction in crashes at intersections where safety cameras are installed and a statistically significant 47 per cent reduction in crashes on the intersection approaches which cameras enforce.

There was also a statistically significant 37 per cent reduction in serious injury and fatal crashes, although there was no statistically significant effect on crash severity; that is, cameras were associated with equal reductions in minor injury crashes as serious injury and fatal crashes.

Additionally it was estimated that the cameras led to a statistically significant 44 per cent reduction in right angle crashes and 'right hand turn crashes'. There was no statistically significant increase in rear-end crashes. Budd et al (2011) noted that this finding may suggest the addition of speed enforcement to red-light enforcement has overcome this observed disadvantage of red-light cameras.

The safety camera program has been estimated to have resulted in a saving of 17 serious or fatal crashes and 36 minor injury crashes per year, representing crash cost savings to the community of over $41 million over five years.

### 1.5.2 South Australia

Safety camera enforcement commenced in Adelaide in 2003 (Kloeden et al, 2009). No evaluations of the program have been published, however data provided by the South Australian Department of Transport Energy for the RTA in 2008[1] showed that preliminary results were encouraging with casualty crashes at red-light camera sites reducing by 31 per cent when the sites were upgraded to dual–function red-light speed cameras. This 31 per cent reduction was compared to a general 20 per cent reduction in casualty crashes at Adelaide signalised intersections that occurred during the same period. This 20 per cent reduction at all signalised intersections was likely to be, at least in part, a consequence of the spreading effect of greater speed compliance by drivers due to publicity regarding the dual function cameras.

[1] Email from Paula Norman from South Australian Department of Transport, Energy and Infrastructure, dated 20 May 2008.

# 2. NSW Safety Camera Program

## 2.1 Current use of safety cameras

The NSW Police Force previously managed wet-film red-light cameras at 183 intersections across the Sydney, Newcastle and Wollongong metropolitan areas. These cameras were becoming outdated and used obsolete technology and the program was handed over to the RTA in December 2008.

Dual function red-light speed cameras (safety cameras) were approved for use in 2009, with a plan to rollout these cameras at 200 intersections within four years (by the end of 2012/13 financial year).

Safety camera locations are new or existing wet-film camera sites selected on the following criteria:

a) Traffic light intersection;

b) Frequency and severity of crashes – fatal, injury, total; and

c) Appropriate road geometry and conditions, such as road width, that allows for the installation and the operation of the camera technology.

All approaches to safety camera locations are signposted with a single sign that says 'safety camera ahead'. This signage provides advanced warning to drivers of the camera.

Intersections are a complex traffic environment that are demanding of drivers' attention, therefore a single sign is used because placing too much additional signage on the approach to an intersection increases driver distraction creating a hazard for other road users, particularly pedestrians. The use of a single sign is also the practice in other jurisdictions.

The first safety camera site at the intersection of the Cumberland Highway and St Johns Road, Canley Heights commenced issuing infringements on 19 January 2010. The roll out of the safety camera program was initially supported by an extensive public education campaign to raise awareness of the function of safety cameras, however the campaign was not repeated once the program had commenced.

There is an amnesty period during the first 31 days of the camera's operation where drivers who are detected committing an offence receive a warning letter instead of an infringement.

Currently there are safety cameras installed at 91 intersections; 46 infringing both speeding and red-light offences, and 45 in 'warning mode' with cameras infringing red-light offences while speeding offences are issued a warning. These cameras have been in warning mode since April 2011 when the NSW Auditor-General commenced a road safety audit of speed cameras in NSW.

## 2.2 NSW Auditor-General's performance review of speed cameras

The NSW Auditor-General's Performance Audit "Improving Road Safety: Speed Cameras" was tabled in Parliament on 27 July 2011. The audit found that speed cameras change driver behaviour and have a positive road safety impact. Overall the audit found that the majority of cameras had delivered a road safety benefit and contributed to a fall in fatalities, injuries and crashes, but the results varied at some individual cameras.

The audit found that safety camera selection criteria for selecting safety camera locations are consistent with those used in other jurisdictions.

Only limited crash data were available to measure the effectiveness of the NSW safety camera program at the time of the audit. The audit concluded that "it is too soon to determine the impact of safety and mobile speed cameras which were only introduced last year, although early results are encouraging" (NSW Auditor-General, 2011:2).

There are a number of recommendations made by the Auditor-General, all of which are relevant to the selection of locations for safety cameras and the ongoing review of these locations. These recommendations are aimed at addressing the perception that speed cameras are used to merely raise revenue by both improving the road safety value of speed cameras and the transparency around the selection of camera locations.

These include the development of an over-arching speed camera strategy for NSW that sets performance criteria for all camera types, annual reviews of speed camera effectiveness and the annual publication of trends in crashes, revenue and speeding or infringement data for each speed camera.

The RTA has accepted all the recommendations of the Auditor-Generals performance audit of speed cameras and will implement these recommendations.

## 2.3 Attitudinal research

The RTA regularly monitors community attitudes to road safety issues in order to identify and address the needs and concerns of RTA customers and develop effective road safety initiatives.

In October 2009, the RTA conducted a comprehensive survey of 1,500 NSW drivers' attitudes to speeding. Based on this research, the NSW Centre for Road Safety presented a paper at the 2009 Australasian Road Safety Research, Policing and Education Conference that clearly explained driver attitudes toward speeding and speed enforcement issues. This research found that, while speeding was recognised as the most significant factor in the road toll, there was still a large number of drivers who continue to speed (Walker et al, 2009).

The research also identified that there was a high level of support for existing speed enforcement practices in NSW as well as practices in other jurisdictions such as the use of red-light speed cameras (82 per cent) and point to point enforcement (63 per cent).

A follow-up research survey of the same scope was conducted in March-April 2011 (Roads and Traffic Authority, 2011), which identified that there was a high level of support for existing speed enforcement practices in NSW, including 79 per cent of respondents approving of safety cameras (see Figure 2 below).

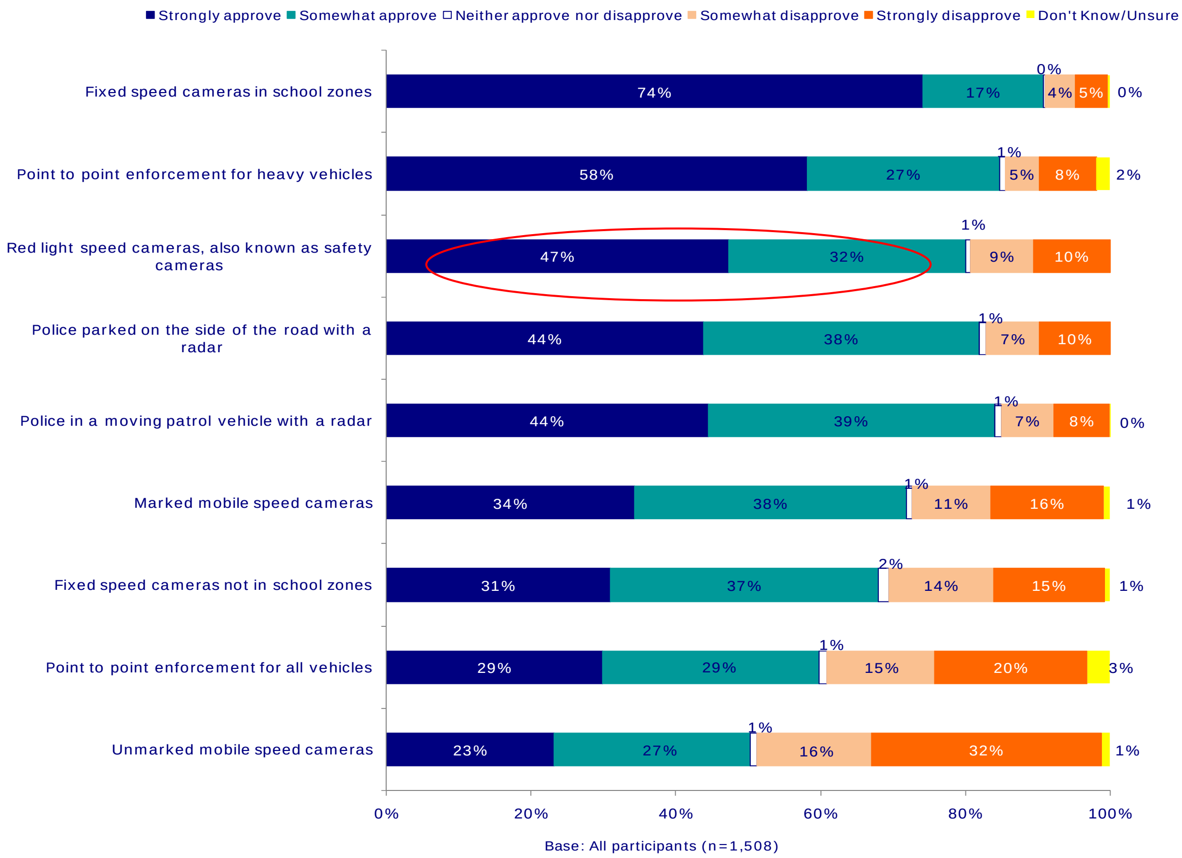


*Figure 2: NSW drivers' attitudes to speed enforcement methods*

# 3. Analysis of NSW crash data

The NSW Auditor-General's analysis of safety cameras was conducted in July 2011. At the time, the RTA did not have a complete set of crash data for an 'after' period that would allow for meaningful analysis of the effect of safety cameras in NSW. The NSW Centre for Road Safety has now used a more complete crash data set to conduct a further analysis to determine the effect of introducing safety camera (combined red-light and speed cameras) enforcement at intersections.

All crashes on the road network are assigned a spatial location. For the purposes of the analysis of the effect of safety cameras at intersections, crashes were selected if they were:

- Within 30m of a traffic control signal at an intersection currently[2] equipped with an enforcing safety camera,
- Within 10m of the identifying feature (typically, the cross street) associated with the crash, and
- Coded as being located at or near an intersection.

For the purposes of this analysis, the three month (91 day) interval prior to the first warning letter at each intersection was assumed to be a construction period, during which the movement of traffic through the intersection may have been atypical. Crashes occurring during this period were excluded from the analysis.

Then, crashes were assigned to two groups: those occurring in a five year (1,826 day) period immediately preceding the assumed construction period; and those occurring between the date of the first warning letter and the 31st of March 2011. Because crashes occurring more recently are subject to relatively high levels of new data entry and revision, it was considered necessary to focus only on the period for which reasonably complete and reliable crash data were available.

For the 57 intersections with safety cameras that were enforcing prior to the data cut-off date, the table below shows the numbers of crashes and casualties occurring before and after installation of safety cameras. These intersections include both intersections that previously had a red-light camera (44 intersections) and intersections that have never had camera enforcement (13 intersections).

[2] As at September 2011.

| | 5 years pre | | | Period post | | |
|---|---|---|---|---|---|---|
| Traffic control signal ID No. | Days | Crashes | Casualties | Days | Crashes | Casualties |
| 16 | 1826 | 27 | 18 | 190 | 2 | 1 |
| 44 | 1826 | 79 | 52 | 275 | 2 | 1 |
| 45 | 1826 | 40 | 22 | 275 | 8 | 2 |
| 64 | 1826 | 39 | 25 | 276 | 2 | 1 |
| 65 | 1826 | 41 | 30 | 155 | 3 | 1 |
| 79 | 1826 | 32 | 22 | 168 | 2 | 2 |
| 84 | 1826 | 49 | 31 | 204 | 7 | 4 |
| 102 | 1826 | 17 | 8 | 143 | 1 | 0 |
| 110 | 1826 | 51 | 33 | 281 | 4 | 8 |
| 164 | 1826 | 53 | 38 | 231 | 4 | 3 |
| 206 | 1826 | 25 | 14 | 186 | 3 | 0 |
| 209 | 1826 | 37 | 21 | 252 | 9 | 6 |
| 226 | 1826 | 27 | 15 | 141 | 0 | 0 |
| 322 | 1826 | 40 | 25 | 211 | 1 | 1 |
| 345 | 1826 | 2 | 1 | 163 | 0 | 0 |
| 346 | 1826 | 77 | 45 | 275 | 6 | 3 |
| 348 | 1826 | 40 | 23 | 141 | 4 | 0 |
| 402 | 1826 | 35 | 25 | 169 | 1 | 0 |
| 404 | 1826 | 25 | 15 | 141 | 2 | 1 |
| 437 | 1826 | 33 | 24 | 141 | 2 | 0 |
| 439 | 1826 | 34 | 25 | 226 | 0 | 0 |
| 471 | 1826 | 94 | 56 | 217 | 6 | 3 |
| 502 | 1826 | 41 | 25 | 274 | 9 | 9 |
| 515 | 1826 | 26 | 14 | 204 | 4 | 5 |
| 534 | 1826 | 59 | 38 | 275 | 3 | 0 |
| 577 | 1826 | 34 | 19 | 141 | 3 | 0 |
| 604 | 1826 | 27 | 20 | 182 | 0 | 0 |
| 654 | 1826 | 34 | 18 | 168 | 3 | 0 |
| 656 | 1826 | 48 | 34 | 185 | 3 | 2 |
| 741 | 1826 | 25 | 13 | 176 | 0 | 0 |
| 827 | 1826 | 36 | 19 | 207 | 4 | 1 |
| 871 | 1826 | 40 | 31 | 268 | 0 | 0 |
| 886 | 1826 | 23 | 9 | 218 | 3 | 0 |
| 899 | 1826 | 41 | 31 | 184 | 2 | 1 |
| 969 | 1826 | 32 | 20 | 107 | 0 | 0 |
| 973 | 1826 | 48 | 27 | 245 | 6 | 4 |
| 1129 | 1826 | 28 | 13 | 107 | 3 | 2 |
| 1135 | 1826 | 27 | 22 | 107 | 1 | 0 |
| 1224 | 1826 | 18 | 10 | 107 | 0 | 0 |
| 1237 | 1826 | 35 | 25 | 107 | 1 | 0 |
| 1238 | 1826 | 49 | 31 | 137 | 5 | 2 |
| 1447 | 1826 | 46 | 33 | 281 | 5 | 5 |
| 1478 | 1826 | 32 | 20 | 172 | 1 | 1 |
| 1576 | 1826 | 34 | 39 | 281 | 0 | 0 |
| 1646 | 1826 | 45 | 22 | 212 | 6 | 2 |
| 1768 | 1826 | 44 | 33 | 259 | 3 | 2 |
| 1769 | 1826 | 50 | 32 | 276 | 2 | 3 |
| 1839 | 1826 | 44 | 35 | 267 | 6 | 4 |
| 1852 | 1826 | 38 | 16 | 107 | 3 | 2 |
| 2193 | 1826 | 22 | 14 | 141 | 0 | 0 |
| 2224 | 1826 | 52 | 29 | 469 | 12 | 6 |
| 2449 | 1826 | 22 | 20 | 107 | 1 | 2 |
| 2468 | 1826 | 37 | 23 | 200 | 6 | 6 |
| 2505 | 1826 | 56 | 35 | 156 | 7 | 2 |
| 2567 | 1826 | 37 | 23 | 200 | 2 | 1 |
| 2618 | 1826 | 29 | 19 | 141 | 1 | 0 |
| 2642 | 1826 | 21 | 12 | 141 | 0 | 0 |

*Table 2: Crashes and casualties before and after installation of safety cameras*

The daily crash and casualty rates were calculated for before and after safety cameras were installed at these intersections (excluding the 91 day construction interval). This analysis is summarised in the following table, along with the p value derived from a binomial statistical test:

| Pre safety camera<br>5 year period | Post safety camera<br>Until 31 March 2011 | Change |
|---|---|---|
| 0.0209 **crashes** per day per intersection - treated | 0.0154 **crashes** per day per intersection | 26% reduction - significant ($p<10^{-5}$) |
| 0.0134 **casualties** per day per intersection- treated | 0.0088 **causalities** per day per intersection | 34% reduction - significant ($p<10^{-5}$) |

*Table 3: Summary of crash and casualty data*

# 4. Discussion

The NSW road toll has trended broadly downwards over the period covered by this analysis, and some modest safety improvements might be expected simply on this basis. However, it can be seen that safety cameras deliver a very large safety benefit at the intersection where they are installed; one which is much too large and statistically-robust to be explained by state-wide trends.

It should be noted that these gains are, in most cases (44 existing red-light camera intersections), *in addition* to any reductions in road trauma caused by the initial installation of a red light camera, so that the total reduction from camera enforcement is even greater than the figures in Section 3.

Safety cameras in NSW have already led to large and sustained reductions in the number of crashes and the number of casualties at the intersections where they enforce. The safety cameras at the 57 intersections included in the analysis conducted for this report are preventing crashes at a rate of around 114 each year and preventing casualties at a rate of around 95 each year.

Moreover, the level of infringement (and therefore of speeding) typically falls during the life of a fixed camera, as road users become increasingly aware of the need to change their behaviour by limiting their speed or adhering to traffic lights. In this report's analysis, the average duration of enforcement was just over six months, some of which was in warning mode, meaning that many of the cameras are yet to achieve their full benefits of the changes in speeding and red-light running behaviour. Increased safety dividends should therefore be expected as these cameras achieve their full effect.

Based on a human capital approach, it can be shown that, on average, each safety camera currently generates savings to the NSW community of approximately $300,000 per annum at the intersection where it is sited. Based on the community's willingness to pay, the savings are approximately $800,000 per safety camera intersection per year.[3] These figures ignore fine revenue and road safety benefits accruing in other parts of the road network.

On the basis of the analysis presented, and having regard to the fact that there are many NSW traffic signal intersections with elevated crash histories that do not yet have safety cameras installed; a more extensive program could readily be justified to the community. At current rates, a program of 200 safety camera locations may prevent 400 crashes per year and prevent 333 casualties, with savings to the community in the range of $60m to $160m per year, depending upon the method of calculation. As occurred in South Australia, it would also be expected that there would also be a broader general deterrence effect of these cameras to other intersections, with improved compliance at non-treated intersections meaning the real benefits to the community would be substantially larger than these estimates.

[3] RTA Economic Analysis Manual, Version 2, 1999. Corporate Finance Strategy, 19/11/2009

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