



Transport
for NSW

Centre for Road Safety

Speed Camera Programs: 2016 Annual Review

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1 Executive summary

The purpose of the Annual NSW Speed Camera Review is to monitor speed cameras in NSW to ensure they are having a positive road safety effect. This report was prepared in 2016, using data up until the end of the 2015 calendar year.

The NSW Centre for Road Safety (CRS) has reviewed all NSW speed cameras against the criteria in the *NSW Speed Camera Strategy 2012* (the Strategy), culminating in this report.

This document is the fifth in a series of annual reports that addresses the recommendation from the 2011 NSW Auditor-General's audit of speed cameras, to provide the community with information about the road safety impact of speed cameras.

If a camera is found not to have a positive road safety effect, CRS will consider alternative road safety measures at the location. The findings from this annual review also guide future speed enforcement priorities.

1.1 How NSW reviews speed cameras

The review criteria for speed camera programs and individual camera locations are provided within the Strategy. Broadly speaking, review recommendations are measured by two key criteria:

- Reduction in casualty crashes and casualties, and
- Reduction in infringement rates.

At least five years of crash and casualty data are required to make an assessment of a camera's safety benefit. The criteria and methodology are outlined within sections 4 and 7 of this review.

1.1.1 Fixed and red-light speed cameras

Most fixed speed cameras, and approximately one third of red-light speed cameras, have now been installed for at least 5 years. As a result, there is sufficient data available to reliably assess road safety benefits, and this review has developed recommendations to retain, monitor or review these cameras.

Where there is not yet 5 years of post-installation data available, recommendations have not been made.

1.1.2 Mobile speed cameras

Because mobile speed cameras are designed to generally deter speeding across the road network, and because they move regularly, these annual reviews examine crash and speed data for the entire state, rather than individual mobile speed camera locations. This review has identified a number of locations where enforcement is no longer possible, and these locations have been decommissioned (from August 2016).

1.1.3 Point-to-point speed cameras

The point-to-point enforcement program has very few locations where 5 years of data are available, so recommendations are not provided for point-to-point speed camera locations. CRS will continue to monitor NSW point-to-point enforcement lengths.

1.2 Key findings

1.2.1 Mobile speed camera program

Program size as at 31 December 2015: 7,000 hours of enforcement per month at 640 locations

Annual speed survey data indicate that the mobile speed camera program continues to deliver road safety benefits, compared to results prior to the reintroduction of the mobile speed camera program in 2010.

NSW speed survey data for the last seven years shows a reduced number of light vehicles exceeding the speed limit, across all speed zones. However, comparing the 2015 speed survey results against those from 2014, there are an increased number of light vehicles exceeding the speed limit in approximately half of NSW speed zones measured. Specifically:

- More light vehicles were measured exceeding the speed limit by up to 10km/h in 40km/h school zones, 90km/h, 100km/h and 110km/h zones, and
- More light vehicles were measured exceeding the speed limit by 10km/h+ in 40km/h school zones, 50km/h, 90km/h, 100km/h and 110km/h zones.

Tragically, these speed survey data are aligned with increased fatalities in 2015:

	2009	2014	2015
Fatalities on NSW roads	453	307	350
Fatality rate per head of population	6.42	4.1	4.6
Speed-related fatalities on NSW roads	207	127	146

In 2015, the number of infringements issued has stayed relatively stable at around 4,500 infringements per month. Over 99 per cent of vehicles passing mobile speed cameras are not infringed for speeding. This high rate of compliance has remained consistent since 2010 when the program was reintroduced in NSW.

87 mobile speed camera locations were identified in completing this review where enforcement is no longer possible under current program policies, because there is not sufficient space to park the enforcement vehicle and place the required warning signs. These 87 locations are no longer providing a road safety benefit and were decommissioned and replaced in August 2016.

Overall, the mobile speed camera program continues to deliver road safety benefits when compared to the most recent period without the program in operation. However, the road safety benefits of the program may have stalled in recent times, as enforcement hours and locations have become static.

1.2.2 Red-light speed camera program

Program size as at 31 December 2015: 175 cameras at 155 intersections

Overall, there has been a reduction in fatal crashes and injury crashes at red-light speed camera locations since the cameras were installed, compared with the five year period prior to installation.

Specifically, at red-light speed camera locations there has been a:

- 30 per cent reduction in the number of fatal and serious injury crashes
- 42 per cent reduction in fatalities

- 31 per cent reduction in serious injuries
- 39 per cent reduction in pedestrian casualties.

The reduction in fatalities and serious injuries represents a saving of \$105 million to the community.

Of the 155 red-light speed camera locations, 98 locations have not yet been installed for 5 years. Recommendations are not provided for these 98 locations.

For the remaining 57 locations:

- 46 were found to offer continued safety benefits, and
- 11 locations were identified for ongoing monitoring in future years.

None of the red-light speed camera locations were identified for review.

None of the 10 highest infringing red-light speed camera locations were identified for review or ongoing monitoring.

1.2.3 Fixed speed camera program

Program size as at 31 December 2015: 141 cameras at 110 locations¹

Overall, when comparing the five years before the fixed speed cameras were installed to the current five year analysis period (for cameras where these data are available), there has been a reduction in the number of fatal crashes and injury crashes at camera locations.

Specifically, at fixed speed camera locations there has been a:

- 31 per cent reduction in casualty crashes
- 92 per cent reduction in fatalities
- 36 per cent reduction in injuries.

The reduction in fatalities and injuries represents a saving of \$570 million to the community.

Of the 110 fixed speed camera locations, seven locations operate in warning mode and five locations are high risk sites located in tunnels. Recommendations are not provided for these 12 locations.

For the remaining 98 fixed speed camera locations:

- 78 locations were found to offer continued safety benefits,
- 5 locations were identified for review,
- 3 locations were identified for ongoing monitoring in future years,
- 3 locations had insufficient data to review, and
- 9 locations were ineligible for review.

¹ Of the 110 fixed speed camera locations, seven locations operate in warning mode and five locations are high risk sites located in tunnels. Recommendations are not provided for these warning mode and high risk locations.

None of the 10 highest infringing fixed speed camera locations were identified in this review for review or ongoing monitoring. However, there is currently a review underway at Rydalmere, the 5th highest infringing location, which has an overall compliance rate of 99.38%.

1.2.4 Point-to-point speed camera program

Program size as at 31 December 2015: 25 lengths

It remains too early to draw broad conclusions about the effectiveness of the heavy vehicle point-to-point program, as only two lengths have been operational for 5 years or more.

Preliminary analysis of point-to-point speed enforcement lengths shows that there has been a low number of heavy vehicle crashes since the commencement of point-to-point camera operation. Infringement data for average speed offences in point-to-point enforcement lengths show a high level of heavy vehicle compliance and a low number of infringements.

2 Introduction

2.1 The NSW Speed Camera Strategy

The *NSW Speed Camera Strategy* (the Strategy) provides an integrated framework for speed enforcement in NSW, and aims to improve the transparency of NSW speed camera programs. The Strategy was developed in consultation with the NSW Police Force and NRMA Motoring and Services, and reinforces the Government's commitment to reducing fatalities and serious injuries on NSW roads.

The NSW Auditor-General has found that speed cameras change driver behaviour and improve road safety.² The Auditor-General also recommended that speed camera performance information be regularly made available to the public. One of the key actions in the Strategy is therefore an annual review of speed camera programs against defined criteria.

2.2 Annual review of NSW speed camera programs

This annual review monitors automated speed enforcement in NSW. This includes fixed speed cameras, red-light speed cameras, mobile speed cameras and point-to-point speed cameras. However, this does not include the speed enforcement conducted by the NSW Police Force.

This report was prepared in 2016, using data up until the end of the 2015 calendar year. Detailed analysis for NSW speed camera locations is provided within Appendices A – D of this report.

However, detailed analysis is not included for fixed speed cameras operating in warning mode.³ Crash and infringement data is instead provided for these cameras, within Appendix A. Detailed analysis is also not included for fixed speed cameras at five high risk tunnel locations. Speed cameras were generally installed at these locations when the tunnel was constructed, and therefore no pre-installation data are available for analysis.

Based on the findings of the annual review, cameras which are not delivering the expected road safety benefits will be more comprehensively investigated. These comprehensive investigations may result the removal and relocation of the camera.

The findings from the annual review also inform future speed enforcement operations, and address NRMA Motoring & Services' request for an assessment of all high infringing speed camera locations.

2.3 The speeding problem

Speeding, which encompasses excessive speed (driving above the speed limit) or inappropriate speed (driving too fast for the prevailing conditions), is unquestionably recognised as a major contributing factor in both the number and severity of traffic crashes in NSW.

² https://www.audit.nsw.gov.au/ArticleDocuments/200/Improving_Road_Safety_Media_Release.pdf.aspx?Embed=Y

³ For speed cameras operating in warning mode, warning letters are issued to motorists detected speeding, unless they exceed the speed limit by more than 30km/h, in which case a court attendance notice is issued and drivers face significant penalties. A three-strikes system also applies, where if a registered operator of a vehicle is issued two warning letters from the one warning mode camera, an infringement will be issued for a third offence and any further offences at that location.

Speeding increases the risk of having a crash, and increases the risk of serious injury or death in the event of a crash. Studies of survival and impact speed show that small increases in travel speed can result in large increases in braking distances and impact speed, resulting in both an increased risk of a crash and a more severe outcome. This is especially the case for crashes with less protected road users such as pedestrians and cyclists.

2.4 Safety benefits of camera enforcement

Speed camera enforcement is an important road safety initiative with proven road safety benefits, and is a commonly employed method of speed enforcement in many best practice road safety jurisdictions worldwide. Speed enforcement helps to reduce the incidences of speeding on our roads, which in turn reduces the risk of crashes and reduces the likelihood of death or serious injuries in the event of a crash.

Speed enforcement activities aim to reduce speeding by increasing the perceived likelihood of being caught and punished. Speed cameras generally tend to detect an initial high number of infringements followed by a rapid and sustained decrease in infringements as drivers modify their behaviour. This is also reflected by a reduction in crashes over that time.

Appendix A contains graphs of the infringement trends for individual NSW fixed speed camera locations.

2.5 Transparent management of NSW speed camera programs

2.5.1 Speed camera locations are available to drivers

All speed cameras in NSW are signposted and mobile speed camera vehicles are clearly marked.

The NSW Centre for Road Safety website (<http://roadsafety.transport.nsw.gov.au>) lists all speed camera locations in NSW, allowing members of the public to find the locations of all fixed, red-light and mobile speed cameras, and the positions of all point-to-point speed zones.

Members of the public are also able to nominate locations for speed cameras via the safer roads website (www.saferroadsnsw.com.au).

2.5.2 Speed camera revenue directly funds road safety initiatives

All fines from speed and red light cameras are paid into the Community Road Safety Fund. This funds road safety initiatives including engineering works, enhanced enforcement by the NSW Police Force, public education campaigns and community grants.

Speeding fines issued by police are not paid into the Community Road Safety Fund.

3 Types of speed camera programs in NSW

Speed cameras are automated speed enforcement tools that supplement enforcement conducted by the NSW Police Force.

The NSW Police Force routinely nominates locations to be considered for automated speed enforcement, as cameras can operate in locations that may be difficult for police to enforce. Members of the public are also able to nominate locations for speed cameras, via the NSW safer roads website at www.saferoadsnsw.com.au.

Table 1 shows the four types of speed cameras used in NSW.

Table 1: Types of speed camera enforcement in NSW

Speed cameras used in NSW			
Camera Type	Main purpose	Introduced	Program Size (as at 31 Dec 2015)
Fixed speed cameras	Location specific, to address black spot / high risk locations	1997	141 cameras at 110 locations ⁴
Red-light speed cameras	Location specific, to address high risk intersections	2009	175 cameras at 155 intersections.
Mobile speed cameras	General network deterrence	Re-introduced in 2010. (This program was first introduced in 1991, but ceased operation in Dec 2008)	640 locations, 7,000 hours of enforcement/month
Point-to-point speed cameras	Route enforcement (for heavy vehicles only)	2010	25 lengths

3.1 Fixed speed cameras

Fixed speed cameras are located at road lengths where there is a demonstrated crash history or a high crash risk. These cameras detect and deter speeding at a specific location on the road network.

3.2 Red-light speed cameras

Red-light speed cameras are installed at signalised intersections where drivers are vulnerable to right angle crashes and there is an elevated risk of a pedestrian crash. These cameras detect and deter both speeding and red-light running, both of which can result in severe injuries even in lower speed crashes.

⁴ Of the 110 fixed speed camera locations, seven locations operate in warning mode and five locations are high risk sites located in tunnels. Recommendations are not provided for these warning mode and high risk locations.

3.3 Mobile speed cameras

Mobile speed cameras are moved around the road network at various times and locations. This means drivers are less able to predict where enforcement will occur, and so are more likely to comply with the speed limit more often.

Mobile speed cameras are operated from highly visible vehicles. Enforcement is conducted by private contractors that are managed by Roads and Maritime Services. The prevailing speed limit is displayed on a warning sign so that motorists are aware of the speed limit and the mobile speed camera.

The benefit of mobile speed cameras in reducing speeding is not limited to mobile speed camera locations or the time the camera is located there; they produce a sustained change in driver behaviour by increasing the real and perceived likelihood that speeding can be enforced anywhere at any time.

3.4 Point-to-point speed cameras

The NSW Point-to-point enforcement program addresses heavy vehicle speeding along travel routes with a demonstrated history of heavy vehicle crashes and/or speeding. The program targets heavy vehicles because they are over-represented in crashes on known heavy vehicle routes.

Point-to-point enforcement works by measuring the amount of time it takes a heavy vehicle to travel between points and then calculating the average speed of the vehicle. If the vehicle's average speed is faster than the speed limit for the length of road, the driver will be infringed for speeding.

4 Review Criteria for reviewing speed cameras

Speed cameras are used in NSW to reduce the number of people killed and injured in crashes.

The following sections outline the criteria that guide the review of speed camera performance in NSW.

4.1 Measuring the performance of speed camera programs

Table 2: Criteria for measuring the performance of speed camera programs

Program	Measure of Performance
Fixed speed camera program	Reduction in vehicles speeding at fixed speed camera locations
	Reduced frequency or severity of crashes at fixed speed camera locations
Red-light speed camera program	Reduction in frequency and severity of crashes at enforced intersections
	Reduction in frequency and severity of crashes at all signalised intersections (due to deterrent effect across the network)
Mobile speed camera program	Reduction in road trauma across the entire road network
	Reduction in speed-related crashes across the entire road network
	Reduction in speeding across the entire road network
Point-to-point speed camera program	Reduction in heavy vehicle speeding on point-to-point enforcement lengths
	Reduction in the frequency and severity of heavy vehicle crashes on point-to-point enforcement lengths

Results for the above are presented in Section 8.

4.2 Measuring the performance of individual speed cameras

Table 3: Criteria for measuring the performance of individual speed cameras

Camera Type	Performance data	Measure of performance
Fixed speed cameras	Speeds	Reduction in vehicles speeding within 500 metres of the camera
	Compliance data	Increase in compliance at camera location and/or reduction in infringement rates
	Crash data	Reduction in casualties and crashes within 500 metres of the camera
	Risk	Reduction in risk at the location (for example low level of speeding and/or crashes in tunnels)
Red-light speed cameras	Speeds	Reduction in vehicles exceeding speed limit at the intersection
	Compliance data	Increase in compliance at the intersection and/or reduction in infringement rates
	Crash data	Reduction in casualties and crashes at intersection
Mobile speed cameras	Annual speed surveys	Reduction in vehicles exceeding speed limit across the road network, by testing a random sample of locations
	Compliance data	Increase in compliance rates and/or reduction in infringement rates
	Crash data	Reduction in crashes and casualties across NSW
Point-to-point speed cameras	Speeds	Reduction in heavy vehicle speeding within enforcement lengths
	Compliance data	Increase in heavy vehicle compliance within the enforcement length and/or reduction in heavy vehicle infringement rates
	Crash data	Reduction in heavy vehicle crashes within enforcement lengths

Results for the above are presented in Appendices A – D.

5 Data context

5.1 Road crash data

The crash statistics recorded by Transport for NSW in the CRS crash recording database, CrashLink, are confined to those crashes which conform to the national guidelines for reporting and classifying road vehicle crashes⁵, based on the following criteria:

- The crash was reported to the Police,
- The crash occurred on a road open to the public,
- The crash involved at least one moving road vehicle, and
- The crash involved at least one person being killed or injured or at least one motor vehicle being towed away.

The method of reporting tow away crash data changed in October 2014, and as such is no longer comparable to the before period. As a result, this review has focussed on casualty, fatal and serious injury crashes, compared to reviews completed in recent years. This is further discussed in section 7.

5.2 Injury severity

Crash data is presented by severity of injury, and defined as follows:

- **Fatality:** a person who dies within thirty days from injuries received in a road traffic crash.
- **Serious injury:** a person identified in CrashLink (casualty or driver or rider) who is matched to a hospital admission record on the same day or on the day after a crash and did not die within 30 days of the crash, and is admitted with at least one injury diagnosis; or linked to an iCare (Lifetime Care) participant record.
- **Moderate injury:** a person identified in CrashLink (casualty or driver or rider) who is matched to an emergency department attendance record on the same day or on the day after a crash but was not killed or not subsequently admitted to hospital; or a previously defined Minor/Other or No Injury CrashLink record matched to a SIRA CTP record with a MAIS score of 2 (Moderate) or higher.
- **Minor / Other injury:** a person identified as an injury in CrashLink who is not matched to a hospital admission record or emergency department attendance record; or a previously defined No Injury CrashLink record matched to a SIRA CTP record with an MAIS score of 1 (Minor).
- **Injury – Severity uncategorised:** a person identified as an injury in CrashLink prior to 2005 for which data linkage with health records is not available.
- **Casualty:** any person killed or injured because of a crash.
- **Casualty crash:** a crash that results in at least one person killed or injured.

⁵ More information about how crash data is processed in NSW is available online at www.roadsafety.transport.nsw.gov.au.

Crash data reported from 2005 onwards includes additional detail regarding injury severity, and are categorised as:

- Serious Injury,
- Moderate Injury,
- Minor / Other Injury.

Prior to 2005, crash data was not matched to hospital admissions or emergency department presentations, so all non-fatal injuries prior to 2005 were uncategorised with respect to the severity of injury.

5.2.1.1 Updated serious injury definition

NSW previously defined a serious injury to be an injury from a crash which resulted in a hospital admission.

Under the new definition, a serious injury is defined as:

- A person matched to a hospital admission that identifies an injury,
or
- A person that has a SIRA icare (Lifetime Care) claim.

This has decreased the number of serious injuries per year due to the removal of hospital admissions for reasons other than injury.

In addition, further investigation and linkage of hospital data has improved the identification of serious injuries, and refreshed some data, as outlined below.

5.2.1.2 Inclusion of additional moderate injuries

The Centre for Road Safety has recently identified a number of people injured in crashes that did not report to police as having been injured at the time of the crash, but have subsequently made a claim for an injury. These records were identified within Compulsory Third Party (CTP) insurance claims.

Additional records of people injured in a crash were also identified within the NSW Government's emergency department presentation records.

As a result, a number of moderate injuries have been added into CrashLink for people that were previously recorded as not injured. This will have the effect of increasing the numbers of moderate and minor injuries for years 2005 to 2013.

6 Data parameters

6.1 Five years of data

Typically, at least five years of data are required to make an assessment of a camera's performance.⁶

As some camera locations or lengths have been operational for less than five years, the data for these locations are insufficient to reliably assess performance. Preliminary observations have instead been provided for these locations.

6.2 Time periods analysed

Data for the period before the installation of the camera (the "before" period) has been compared against data after the camera's commencement date (the "after" period, when warning letters and then infringements are issued).

To assess the current performance of the speed camera, the most recent five calendar year period (i.e. 2011 - 2015) is selected as the "after" period.

6.2.1 Pre-installation periods

For fixed, red-light and point-to-point camera programs, the five year "before" period ends three months prior to the "commencement date." This is to ensure that the "before" period does not capture the "pre-installation period" when behavioural changes may result from the presence of not-yet operational camera housing.

However, it should be noted that a significant portion of the red-light speed camera locations previously featured a wet-film red-light camera. (The wet-film red-light program preceded the red-light speed camera program). 82 of the 155 red-light speed camera locations previously featured a wet-film red-light camera.

Wet-film red-light cameras were operational for different periods of time, requiring there to be camera housing (poles and camera boxes) at the roadside at these locations. As a result, "before" data for a significant number of red-light speed cameras may have been impacted by drivers' perceptions that there was camera enforcement in place at these locations. It can be assumed that this would have improved drivers' compliance at these locations, compared to other sites where there were no camera housings in place.

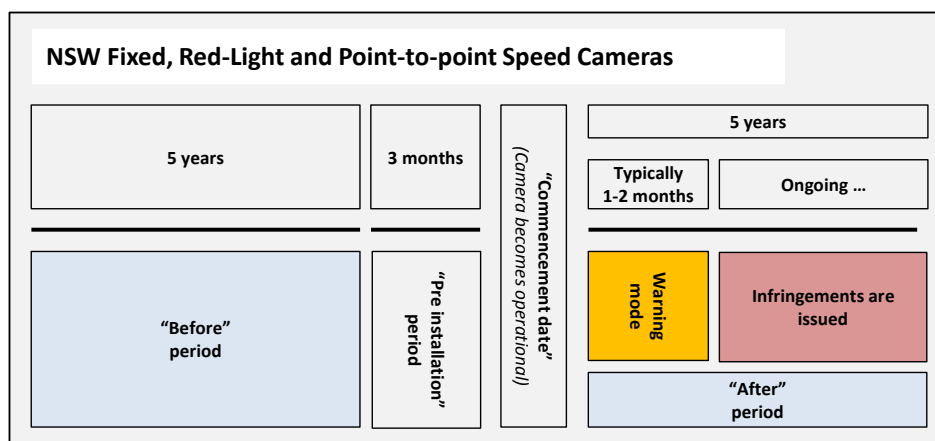
6.2.2 Warning mode periods

Fixed and red-light speed cameras generally operate in warning mode for a one-month period after the "commencement date". A one-month warning mode period also applied for mobile speed cameras when the program was introduced, but has not been applied since then.

NSW point-to-point speed camera lengths generally operate in warning mode for a two-month period after the "commencement date".

⁶ Austroads (2009). *Guide to Road Safety Part 8: Treatment of Crash Locations*. Publication No. AGRS08/09.

Figure 1: Before, After and Warning Mode periods



6.3 Crashes selected for analysis

When reviewing fixed, red-light and point-to-point speed cameras, crash data were examined at individual speed camera locations.

When reviewing mobile speed cameras, crash data were examined for the entire state, due to the nature of mobile speed cameras and their purpose of creating a general deterrence effect across the NSW road network.

6.4 State-wide speed survey data

Vehicle speeds were assessed state-wide via the CRS annual speed survey program.

In 2015, speed surveys for the CRS annual speed survey program were conducted at 175 NSW locations, including a range of roads with a range of speed limits, to gather current information about the speeding behaviour of both light vehicle drivers and heavy vehicle drivers.

The surveys measure free travel speeds, with a headway of four seconds. That is, only the speeds of vehicles that are unimpeded by other traffic are measured. Therefore the survey provides a measure of the speed that drivers choose to travel rather than a measure of traffic congestion.

Speed surveys are not undertaken at specific speed camera enforcement locations. Because of this, this report instead uses infringement data at camera locations as a proxy for speed data.

6.5 Infringement data

Infringement data analysed in this report include penalty notices from July 2002 onwards. No earlier infringement data are available.

All fines from speed cameras are directed to the Community Road Safety Fund to pay for road safety programs across the state. Infringement data for red-light speed cameras, fixed speed cameras and mobile speed cameras are publicly available through the NSW Office of State Revenue (<http://www.osr.nsw.gov.au/info/statistics>).

7 Review methodology

7.1 Fixed speed camera locations

7.1.1 Fixed speed cameras analysed

While at the end of 2015 there were 110 fixed speed camera locations across NSW, road safety benefits were only assessed in detail for 98 fixed speed camera locations within this report.

12 fixed speed camera locations were excluded, as follows:

- Seven locations are currently operating in warning mode.⁷ This report includes information on crashes, warning letters and infringements at these locations within Appendix A (A4 & A5).
- Five locations are located in tunnels (and were sometimes referred to in the review as “high risk” locations). These cameras were generally installed when the tunnel was constructed, therefore no pre-installation data are available. Post installation crash and infringement data for these locations is presented in Appendix A (A6).

The 98 fixed speed camera locations analysed in this report have been operational for the following periods:

Table 4: Operational duration of NSW fixed speed cameras

NSW fixed speed cameras	
Operational for 5 years or more:	95 locations
Operational for less than 5 years:	3 locations
Total:	98 locations

7.1.2 Road length analysed for each camera

Crash data were typically examined within 500 metres either side of fixed speed cameras.

For fixed speed cameras located within a school zone, crash data were examined from patch-to-patch (i.e. the length of road designated as a school zone, as identified by the start and end 40km/h patches marked on the road).

For locations with more than one camera in operation (where cameras are less than 100 metres apart), the crash analysis length was for 500 metres either side of the mid-point of the two cameras.

One fixed speed camera location - the M1 Princes Motorway (formerly the F6, Southern Freeway) Gwynneville - had two cameras operating approximately 1,000 metres apart and infringing in different directions. Within this report, the two cameras were listed as separate locations for the directions they enforce.

⁷ For speed cameras operating in warning mode, warning letters are issued to motorists detected speeding, unless they exceed the speed limit by more than 30km/h, in which case a court attendance notice is issued and drivers face significant penalties.

A three-strikes system also applies, where if a registered operator of a vehicle is issued two warning letters from the one camera location, an infringement will be issued for a third offence and any further offences at that location.

7.1.3 Recommendations

This report considered “before” and “after” crash analysis, and whether the fixed speed camera location has previously been comprehensively reviewed, to develop recommendations as follows:

Table 5: Developing recommendations for fixed speed cameras

Recommendation	Trigger	Outcome
Review	Major roadworks have been undertaken at the location <i>or</i>	TfNSW will undertake a comprehensive review of the camera location.
	There has been a statistically significant increase ⁸ in the number of casualty crashes, and the camera has not been reviewed in the last 5 years.	
Retain and monitor	There has been an increase in the number of casualty crashes, but it is not a statistically significant result.	The camera will continue to be used at the location. The location will also be flagged for ongoing monitoring in future reviews.
Retain	There has been no increase in casualty crashes <i>or</i>	The camera will continue to be used at the location.
	There has been an increase in the number of casualty crashes, but it is not a statistically significant result, and the location has been reviewed within the last 5 years <i>or</i>	
	There has been a statistically significant increase ⁹ in the number of casualty crashes, but the location has been reviewed within the last 5 years.	
Insufficient data	There is less than 5 years of ‘after’ data available.	The camera will be assessed once 5 years of “after” data is available.
Ineligible	There is a review currently underway at the location, <i>or</i>	TfNSW will complete the comprehensive review.
	The camera has been removed.	Nil.

⁸ A p-value of 0.05 has been applied to determine statistical significance

⁹ A p-value of 0.05 has been applied to determine statistical significance

7.1.4 Comprehensive reviews

Where required, comprehensive reviews will be undertaken as per the process in previous years. Depending on the findings of each comprehensive review, the fixed speed camera may be removed, and road safety treatments implemented to address any identified road safety risks. These treatments may involve improved signage, road works, traffic facilities, speed zoning reviews and targeted communications.

7.1.5 Additional technical notes

Additional technical notes for the analysis of fixed speed cameras:

1. The commencement date listed for each location refers to the date that the fixed speed camera commenced infringement (or warning mode) at that location. For locations where more than one fixed speed camera is in operation, the date listed refers to the date that the *first camera* started infringing at that location, unless otherwise specified.
2. For each location, the “before” and “after” periods vary depending on the date the camera commenced infringement, and exclude the three-month period directly before the commencement date.
For each location, the “before” period was defined as the five-year period up to three months prior to the “commencement date” (when infringements commence). The “after” period was defined as the most recent five-year calendar period (2011 - 2015).
3. In instances when there was less than five years of “before” data, the “before” period was adjusted so that it represented an equivalent five-year period.
4. The percentage reduction for crashes and casualties are based on the annual averages in crashes and casualties at each location in the “before” period and the “after” period. This allows an approximate comparison to be made between the five-year “before” period and the most recent five calendar year “after” period (2011 - 2015).
5. The estimated casualty cost for the “before” period and the most recent five calendar year “after” period was calculated using the willingness to pay methodology, which reflects the accumulated value the NSW community is willing to pay or forgo in exchange for a reduction in the probability of crash related injuries and road crash deaths on NSW roads.
The casualty costs used were based on the costs for the weighted average of urban and non-urban fatal and injury reductions, as follows:
 - * \$7,272,032 per fatality,
 - * \$466,010 per serious injury,
 - * \$72,804 per moderate or minor/other injury, and
 - * \$203,823 per uncatagorised injury.
6. For each fixed speed camera location, a test of significance of the observed change in casualty crashes was conducted using the conditional method.¹⁰
This approach compared the number of casualty crashes in the “after” period with the conditional distribution of the casualty crashes in the “after” period given the total casualty crashes in both the “before” and “after” periods.
7. Data for the crash analysis have not been ranked and are presented alphabetically according to the location description of the camera location.

¹⁰ Przyborowski, J., Wilenski, H., 1940. Homogeneity of results in testing samples from Poisson series. *Biometrika* 31, 313–323.

7.2 Red-light speed camera locations

7.2.1 Red-light speed cameras analysed

At the end of 2015, there were 175 red-light speed cameras in total, operating at 155 intersections around Sydney, Newcastle and Wollongong. 19 intersections featured two or more cameras.

All red-light speed camera intersections were analysed in this report, and they have been operational for the following periods:

NSW fixed speed cameras	
Operational for 5 years or more:	57
Operational for less than 5 years:	98
Total:	155

7.2.2 Road length analysed for each camera

Crash data were examined within 10 metres of each intersection with a red-light speed camera.

7.2.3 Analysis of specific crash types

In addition to total casualties at each location, pedestrian casualties were specifically examined given the greater exposure of pedestrians at signalised intersections and the higher likelihood of severe casualty outcomes for this group due to their lack of protection in a crash.

Data were also examined for adjacent, right-through and rear-end casualty crashes, as these are the crash types that typically occur at intersections. Adjacent and right-through crashes are often more severe as drivers and passengers are not as protected from side impact crashes, with low-speed side impact crashes potentially resulting in severe injuries. The frequency and severity of these crash types are expected to reduce at intersections enforced by red-light speed cameras.

Red-light speed cameras are intended to counteract the potential increase in rear-end crashes by also enforcing speed, as it is easier for drivers to brake in time to avoid a rear-end collision when they are driving at lower speeds.

7.2.4 Recommendations

This is the first year that sufficient data has been available to assess individual red-light speed camera locations.

This review considered “before” and “after” crash analysis to develop these recommendations. No red-light speed camera locations have previously been reviewed, so this was not a factor in developing recommendations.

Table 6 (overleaf) outlines the process for developing recommendations for red-light speed camera locations.

Table 6: Developing recommendations for red-light speed cameras

Recommendation	Trigger	Outcome
Review	There has been a statistically significant increase ¹¹ in the number of fatal and serious injury crashes.	TfNSW will undertake a comprehensive review of the camera location.
Retain and monitor	There has been an increase in the number of fatal and serious injury crashes but it is not a statistically significant result.	The camera will continue to be used at the location. The location will also be flagged for ongoing monitoring in future reviews.
Retain	There has been no increase in fatal and serious injury crashes.	The camera will continue to be used at the location.
Insufficient data	There is less than 5 years of 'after' data available.	The camera will be assessed once 5 years of "after" data is available.

7.2.5 Additional technical notes

Additional technical notes for the analysis of red-light speed cameras

1. To identify crashes at each intersection, CRS initially examined crashes geo-coded to be within 90 metres of the traffic signals. Crashes were then assigned to the enforced intersection if they occurred within, or up to 10 metres from, the intersection.
2. These crashes were attributed to the relevant intersection by taking into account the geo-coding as well as the street name, identifying feature(s), and intersection type.
3. Where unclear, the correct location of the crash was confirmed or inferred from the original police report.
4. The commencement of the warning letter period was listed for each camera. For the analysis of intersections with two cameras, the "after" period was based on the earlier of the two commencement dates.
5. Data for each crash type (adjacent, right- and rear-end) was reported based on Road User Movement (RUM) codes. RUM codes describe the first impact that occurred during the crash. Adjacent crashes are indicated by RUM code 10; Right-crashes are coded 21 and rear-end crashes are coded 30. More information on RUM codes can be found in the Definition and notes to support road crash data at <http://roadsafety.transport.nsw.gov.au/downloads/definitions-notes.pdf>
6. The improvement rates for crashes and casualties were based on the annual averages in crashes and casualties at each location before and after the cameras were installed. This allowed an approximate comparison to be made between the five year "before" period and the available data for the "after" period until December 2015 (which is less than five years for a number of red-light speed camera locations).

¹¹ A p-value of 0.05 has been applied to determine statistical significance

Additional technical notes for the analysis of red-light speed cameras

7. The estimated casualty cost for the “before” period and the most recent five calendar year “after” period was calculated using the willingness to pay methodology, which reflects the accumulated value the NSW community is willing to pay or forgo in exchange for a reduction in the probability of crash related injuries and road crash deaths on NSW roads.

The casualty costs used were based on the costs for the urban fatal and injury reductions, as follows:

- * \$6,965,123 per fatality,
- * \$418,789 per serious injury,
- * \$64,437 per moderate or minor/other injury.

8. Crash data were not ranked and were presented alphabetically by suburb of the camera location.

7.3 Mobile speed camera locations

7.3.1 Road lengths analysed

The entire NSW road network was analysed to review the general deterrence effect of the mobile speed camera program.

7.3.2 Program structure and periods of enforcement

In December 2015, the NSW Government announced new higher-visibility mobile speed camera vehicle markings, and additional enhancements to warning signage. Over 2015, the mobile speed camera program operated for 7,000 enforcement hours per month at 640 locations.

7.3.3 Developing recommendations

The review considered whether enforcement can still be delivered at mobile speed camera locations, as follows:

Recommendation	Trigger	Outcome
Retain	Enforcement can still be delivered at these locations.	Enforcement will continue at the location.
Decommission	Enforcement can no longer be delivered at these locations because of operational constraints.	The location will be decommissioned.

7.4 Point-to-point speed camera lengths

7.4.1 Point-to-point speed camera lengths analysed

The NSW point-to-point enforcement program only targets heavy vehicles. The program includes 25 enforcement lengths ranging from 7 – 94km, and includes most major NSW highways.

NSW point-to-point enforcement lengths were installed over the following years:

Year	Lengths installed	
2010	2	(5 years of data is available for these lengths)
2011	14	(3-5 years of data is available for these lengths)
2012	4	
2013	1	(Less than 3 years of data is available for the lengths)
2014	3	
2015	1	
Total:	25	

As for previous years, heavy vehicle crash and infringement data are presented to facilitate analysis of the current impact of individual point-to-point enforcement lengths.

8 Results and discussion

This review has found that speed cameras are continuing to improve road safety in NSW. Results from the fixed, red-light, mobile and point-to-point programs show that drivers are changing their behaviour, which overall is resulting in a reduction in crashes and casualties at camera locations and across the road network.

NSW' four speed camera programs are individually considered below.

8.1 Fixed speed cameras

The analysis of individual fixed speed camera locations is available at **Appendix A**.

Overall, when comparing the five years before the fixed speed cameras were installed to the current five year analysis period (for cameras where these data are available), there has been a reduction in the number of fatal crashes and injury crashes at camera locations.

Specifically, at fixed speed camera locations there has been a:

- 31 per cent reduction in casualty crashes
- 92 per cent reduction in fatalities
- 36 per cent reduction in injuries.

The reduction in fatalities and injuries represents a saving of \$570 million to the community.

In 2015 a total of 314,697 infringements were issued resulting in total fines of \$67 million at fixed speed camera locations.

8.1.1 Individual fixed speed camera locations

Analysis within Appendix A has identified the following findings for individual camera locations:

Table 7: Fixed speed camera locations status

Camera Status:		Number of Cameras
Insufficient data	A more comprehensive analysis over a longer time period is required before drawing any conclusions.	3
Ineligible	The camera has been removed or a review is currently underway	9
5 years of "after" data is available for the camera.	Retain	78
	Retain and monitor	3
	Review	5
Total:		98

The following table identifies fixed speed cameras with notable reductions in casualty crashes:

Table 8: Top performing fixed speed cameras

Location	Casualty crashes		Crashes reduced	% reduction
	Before	After		
Canterbury - Canterbury Road, between Gould Street and Jeffrey Street	74	32	42	57
Auburn - Parramatta Road, between Harbord Street and Duck Street	57	28	29	51
Beverly Hills - King Georges Road, between Stoney Creek Road and Edgbaston Road	84	57	27	32
Burwood Heights - Hume Highway, between Kelso Street and Appian Way	37	17	20	54
Kogarah - Princes Highway, between Gray Street and President Avenue	54	43	11	20

8.1.2 Fixed speed cameras identified to review / monitor

CRS has identified that significant road works have been undertaken at the following 5 locations, and that the cameras should therefore be reviewed:

- Berry - Princes Highway, between Kangaroo Valley Road and Victoria Street
- Foxground - Princes Highway, between Foxground Road and Broughton Creek
- Hungry Head - Pacific Highway, between Boundary Road and Ballards Road
- Terrigal - Terrigal Drive, between Brunswick Road and Bellbird Avenue
- Valla Beach - Pacific Highway, between Valla Beach Road and Oyster Creek

In addition, there is one fixed speed camera location (Rankin Park) for which there has been a statistically significant increase in casualty crashes. However, this location has been comprehensively reviewed within the last 5 years, so it will be retained.

Three locations were also identified for ongoing monitoring in future years:

- Bonnyrigg - Elizabeth Drive, between Brown Road and Humphries Road
- Gwynneville - M1 Princes Motorway, University Avenue Overpass and Mount Ousley Road (southbound)
- South Windsor - George Street, between Rickaby Street and Yarrawonga Street

While there has been an increased number of casualty crashes at these three locations listed above, this was not a statistically significant result.

8.2 Red-light speed cameras

The analysis of red-light speed camera locations is available at **Appendix B**.

Overall, there has been a reduction in fatal crashes and injury crashes at the 155 red-light speed camera locations since the cameras were installed, compared with the five year period prior to installation.

Specifically, at red-light speed camera locations there has been a:

- 30 per cent reduction in the number of fatal and serious injury crashes
- 42 per cent reduction in fatalities
- 31 per cent reduction in serious injuries
- 39 per cent reduction in pedestrian casualties.

The reduction in fatalities and serious injuries represents a saving of \$105 million to the community.

In 2015 a total of 287,868 infringements were issued resulting in total fines of \$95 million at red-light speed camera locations.

8.2.1 Individual red-light speed camera locations

Analysis within Appendix B identifies the following findings for individual camera locations:

Table 9: Red-light speed camera location status

Camera Status:		Number of Fixed Speed Cameras
Insufficient data	A more comprehensive analysis over a longer time period is required before drawing any further conclusions.	98
5 years of "after" data is available for the camera.	Retain	46
	Retain and monitor	11
	Review	0
Total:		155

The following table identifies red-light speed cameras with notable reductions in fatal / serious injury crashes:

Table 10: Top performing red-light speed cameras

Location	Fatal / Serious Injury crashes		Crashes reduced	% reduction
	Before	After		
Paddington / Surry Hills - South Dowling Street at Fitzroy Street / Moore Park Road	20	7	13	65

Location	Fatal / Serious Injury crashes		Crashes reduced	% reduction
	Before	After		
Paddington - Moore Park Road at Lang Road	9	0	9	100
Strathfield - Arthur Street at Centenary Drive	10	1	9	90
Moore Park / Paddington - Anzac Parade / Flinders Street at Moore Park Road	10	2	8	80
Darlinghurst - Craigend Street at McLachlan Avenue	12	6	6	50

8.2.2 Red-light speed cameras identified to retain and monitor

Eleven locations were also identified for ongoing monitoring in future years:

- Blacktown - Bungaribee Road at Balmoral Street
- Blacktown - Newton Road at Flushcombe Road
- Campsie - Canterbury Road at Bexley Road
- Granville - Woodville Road at M4 westbound on-ramp
- Milperra - Newbridge Road at Henry Lawson Drive
- Mosman - Military Road at Cowles Road
- North Ryde - Wicks Road at Epping Road
- Petersham - Gordon Street at New Canterbury Road
- Petersham - Parramatta Road at West Street
- Smithfield - Victoria Street at Hassall Street
- South Penrith - Parker Street at Jamison Road

While there has been an increased number of fatal / serious injury crashes at these eleven locations, this was not a statistically significant result.

8.3 Mobile speed cameras

The analysis of the mobile speed camera program is available at **Appendix C**.

Annual speed survey data indicate that the mobile speed camera program continues to deliver road safety benefits, compared to results prior to the reintroduction of the mobile speed camera program in 2010.

8.3.1 Light vehicles

NSW speed survey data for the last seven years shows a reduced proportion of light vehicles exceeding the speed limit, across all speed zones. However, comparing the 2015 speed survey results against those from 2014, there are an increased proportion of light vehicles exceeding the speed limit in approximately half of NSW speed zones measured. Specifically:

- More light vehicles were measured exceeding the speed limit by up to 10km/h in 40km/h school zones, 90km/h, 100km/h and 110km/h zones, and
- More light vehicles were measured exceeding the speed limit by 10km/h+ in 40km/h school zones, 50km/h, 90km/h, 100km/h and 110km/h zones.

Tragically, these speed survey data are aligned with increased fatalities in 2015:

	2009	2014	2015
Fatalities on NSW roads	453	307	350
Fatality rate per head of population	6.42	4.1	4.6
Speed-related fatalities on NSW roads	207	127	146

8.3.2 Heavy vehicles

The speed survey results also indicate that there has been a decrease in the proportion of heavy vehicles exceeding the speed limit over the last seven years; but while this is true for most speed zones, it is not the case across the board. The exceptions are:

- Increased proportion of heavy vehicles exceeding the speed limit by up to 10km/h in 40km/h school zones and in 90km/h zones.
- Increased proportion of heavy vehicles exceeding the speed limit by 10km/h or more in 90km/h and 100km/h zones¹².

Comparing the 2015 results against the 2014 results, there are an increased proportion of heavy vehicles exceeding the speed limit (up to 10km/h, and 10km/h or more), for approximately one third the speed zones measured.

8.3.3 Infringements

In 2015 there were a total of 49,412 infringements issued from mobile speed camera enforcement resulting in \$9.51 million of fines. The cost of conducting the mobile speed camera program in 2015 was \$21.76 million.

The total number of mobile speed camera infringements issued in 2015 decreased by 11 per cent compared to 2014.

8.3.4 Vehicle compliance rate

In 2015 the compliance rate was 99.8%. This high rate of compliance has remained consistent since 2010 when the program was reintroduced.

8.3.5 Mobile speed camera sites decommissioned

CRS identified 87 mobile speed camera locations where enforcement was not possible under current program policies, because there was not sufficient space to park the enforcement vehicle and place the warning signs.

These 87 locations were no longer providing a road safety benefit and were decommissioned in August 2016.

¹² The heavy vehicle speed limit is 100km/h. Results presented indicate the % of heavy vehicles exceeding 100km/h.

Overall, the mobile speed camera program continues to deliver road safety benefits when compared to the most recent period without the program in operation. However, road safety benefits of the program may have stalled in recent times, as enforcement hours and locations have become static.

The general decrease in speeding over the six years to the end of 2014 provides evidence that the general deterrence and road safety gains provided by mobile speed cameras could continue to be realised via a larger and less predictable program. Such an approach would allow greater coverage of the road network at various times and locations, and increase the deterrent effect due to the unpredictability of the exact locations of speed enforcement.

8.4 Point-to-point speed cameras

The analysis of the point-to-point speed camera program is available at **Appendix D**.

It remains too early to draw broad conclusions about the effectiveness of the point-to-point program, as only two lengths have been operational for 5 years or more. While there have been small increases in the number of casualties from crashes involving a heavy vehicle in the five years since these two lengths were installed, there have been notable increases in the heavy vehicle traffic along these routes. It should also be noted that there has been a 30 per cent reduction in the number of casualty crashes on these lengths.

Infringement data for average speed offences in point-to-point enforcement lengths shows a high level of heavy vehicle compliance within the enforcement lengths and a low number of infringements (which is consistent with results in other point-to-point programs). A total of 2,802 speeding infringements, resulting in total fines of \$1.29 million, were issued at NSW point-to-point lengths in 2015.

International studies have found that point-to-point enforcement is typically associated with very high rates of compliance with posted speed limits, even when traffic volumes are high.¹³ For example, a 2015 evaluation in Norway found that average speed camera enforcement reduces deaths and serious injuries by 49 per cent.¹⁴ In addition, a 2016 study from the UK found a 36.4 per cent reduction in the mean rate of fatal and serious collisions for average (point-to-point) speed cameras.¹⁵

¹³ Soole, D. W., Fleiter, J. and Watson, B. (2011) *Point-to-point speed enforcement: A technological overview, review of the empirical evidence and recommendations for better practice*, Draft final report for Austroads Steering Committee, Austroads, Sydney, Australia.

¹⁴ Hoye, A. (2015) *Safety effects of section control - An empirical Bayes evaluation*, Accident Analysis and Prevention 74 (2015) 169–178

¹⁵ Owen, R. Ursachi, G. and Allsop R. (2016) *The Effectiveness of Average Speed Cameras in Great Britain*, London, UK