MONASH University
Accident Research Centre

DEVELOPMENT OF STRATEGIES FOR BEST PRACTICE IN SPEED ENFORCEMENT IN WESTERN AUSTRALIA

SUPPLEMENTARY REPORT

by

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Title and sub-title: Development of strategies for best practice in speed enforcement in Western Australia: Supplementary report

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Abstract:
This report is a supplement to the final report of a 2006 study with the same title. The objective of the 2006 research was for the results and recommendations to be utilised to enhance speed enforcement strategies in WA, by assisting the WA Police in developing formal business cases for the deployment of enforcement technology (what, where and how) and the purchasing of enforcement technology (number, mix and type). The supplementary research aimed to include newly reviewed and emerging technologies available such as point-to-point speed cameras; update the recommended mix of speed enforcement practices, the circumstances in which each should be applied, and the objective seeking to be achieved; and review available infringement management models worldwide in terms of their ability to facilitate a reduction in speeding effectively and efficiently through deterrence and detection.

In the 2006 study, a package of speed enforcement programs was defined for the WA road environment which recognises its relatively unique characteristics of vast size and light traffic density, except in Perth. Evidence of the effects on speeds and road trauma in other jurisdictions due to speed camera systems and manual speed enforcement was reviewed and synthesised to provide strategic understanding of their mechanisms. A suitable speed enforcement method for each part of the WA road system was defined and the road trauma reductions and economic benefits were estimated. The recommended speed enforcement package, when fully implemented, was estimated to produce 26% reduction in fatal crashes, 12% reduction in crashes resulting in hospital admission, and 9% reduction in medically-treated injury crashes. The package was subsequently proposed for implementation by the Monash University Accident Research Centre (MUARC) in their recent recommendations for a new road safety strategy for Western Australia spanning the period 2008-2020.

The extension project reviewed new evidence and information about point-to-point speed cameras; updated previous evaluations of the randomly-scheduled overt mobile speed cameras in Queensland; and reviewed offence processing and likely deterrence effects of the camera programs in Victoria, Queensland, Sweden, France and the United Kingdom. The effects of reducing speeding offence detection thresholds in Victoria were also reviewed.

Key Words:
Traffic enforcement Speeding

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EXECUTIVE SUMMARY

Tasks and objectives

During 2006, the WA Office of Road Safety commissioned MUARC to develop strategies for best practice in speed enforcement in the state (Cameron and Delaney 2006). The principal tasks of the 2006 project were to:

- Conduct an analysis of current Australian and international activity, research and literature in relation to best practice in speed enforcement strategies and technology;

- Develop recommendations on the implementation of best practice in speed enforcement specifically for the WA setting; and

- Develop a detailed implementation plan in order to move from the current situation to what has been recommended.

Since being proposed for implementation by MUARC in their recent recommendations for a new road safety strategy for Western Australia spanning the period 2008-2020, to ensure the most up-to-date best practice methods are adopted, an extension of the 2006 project was commissioned in December 2007 with the following objectives:

1. Review of the 2006 report to include newly reviewed and emerging technologies available such as point-to-point speed cameras;

2. Update the recommended mix of technological and non-technological speed enforcement practices, the circumstances in which each should be applied and the objective seeking to be achieved, given the inclusion of these new and emerging technologies and practices (e.g., point-to-point);

3. Identify and review available infringement management models worldwide including processing and camera management in terms of their ability to facilitate a reduction in speeding effectively and efficiently through deterrence and detection.

This supplementary report should be read in conjunction with the final report of the 2006 study (Cameron and Delaney 2006).

Previously recommended speed enforcement package

The previously recommended package of speed enforcement programs, together with the recommended level of program input (usually operational hours per month), is shown in the tables below. The second table shows the crash savings per month, by severity of crash, which derive from the percentage crash reductions if the program is implemented in that part of the WA road system. The social cost savings have been calculated from the crash savings using the Federal government’s road trauma cost figures (BTE 2000), indexed to 2005 prices.

Point-to-point speed camera systems on highly-trafficked rural highways were also an option reviewed, however the evidence of their effects from the UK was too limited at the time of the 2006 study to allow further consideration.

The previously recommended speed enforcement package, when fully implemented, was estimated to produce 26% reduction in fatal crashes, 12% reduction in crashes resulting in hospital admission, and 9% reduction in medically-treated injury crashes.

Speed Enforcement Program	**Speed Enforce-ment Hours per month**	**Speeding Tickets Issued per month**	**Program BCR**	**Program Crash Reduction**		
				Medical treatment crashes	Hospital admission crashes	Fatal crashes
URBAN ROADS (Perth)						
Covert mobile speed cameras on urban highways	9,000	90,000	6.1	11.5%	11.5%	65.3%
Laser speed detectors at black spot sites on urban local roads	1,025	3,413	29.78	3.76%	4.46%	4.46%
Overt fixed speed cameras on Perth freeways	Continuous at 24 sites	35,613	7.33	7.76%	15.52%	15.52%
Total for urban roads			**8.01**	**6.0%**	**6.2%**	**24.9%**
RURAL ROADS (Rest of WA)						
Overt mobile speed cameras randomly scheduled on rural highways	3,000	30,000	36.8	28.5%	28.5%	28.5%
Mobile radar units on rural local roads	15,000	11,250	6.3	24.1%	24.1%	24.1%
Total for rural roads			**11.81**	**26.2%**	**26.4%**	**26.8%**
Total package for WA roads			**9.98**	**9.0%**	**12.3%**	**26.0%**

Speed Enforcement Program	**Crash savings per month**			**Social Cost Saving per month ($'000)**	**Program Cost per month ($'000)**	**Fine Revenue per month ($'000)**
	Medical treatment crashes	Hospital admission crashes	Fatal crashes			
URBAN ROADS (Perth)						
Covert mobile speed cameras on urban highways	10.7	3.0	1.11	3,974.64	634.1	9,000
Laser speed detectors at black spot sites on urban local roads	5.2	2.4	0.11	1,551.51	51.9	341.3
Overt fixed speed cameras on Perth freeways	1.2	0.7	0.04	441.27	59.4	3,561.3
Total for urban roads	**17.0**	**6.1**	**1.3**	**5,967.42**	**745.4**	12,903
RURAL ROADS (Rest of WA)						
Overt mobile speed cameras randomly scheduled on rural highways	6.5	6.4	1.13	5,673.94	154.5	3,000
Mobile radar units on rural local roads	6.2	4.9	0.62	3,864.00	653.5	1,125
Total for rural roads	**12.7**	**11.4**	**1.7**	**9,537.93**	**808.0**	4,125
Total package for WA roads	**29.8**	**17.5**	**3.0**	**15,505.4**	**1,553.3**	17,027.6

Extension project

The extension project reviewed new evidence and information about point-to-point speed cameras; updated previous evaluations of the randomly-scheduled overt mobile speed cameras in Queensland; and reviewed offence processing and likely deterrence effects of the camera programs in Victoria, Queensland, Sweden, France and the United Kingdom. The effects of reducing speeding offence detection thresholds in Victoria were also reviewed. The following conclusions were reached:

1. Point-to-point speed cameras are likely to be effective speed enforcement systems covering substantial lengths of freeways and highways in WA with limited access/egress opportunities. Economic analysis has identified 40 road links where the application of point-to-point systems would have benefit-cost ratios of 10 or greater.

2. The Victorian covert mobile speed camera program is reliant principally on the prosecution of speeding drivers to achieve specific deterrence. Thus it is heavily dependent on processing all of the offenders detected (within limits of legal integrity) in order to achieve its effects. The efficiency of processing speeding offences detected by mobile cameras in Victoria, as well as offences detected by fixed cameras, is improved by the existence of "owner-onus" legislation making the vehicle owner initially liable for the offence.

3. The Queensland overt mobile speed camera program achieves substantial general deterrence around camera sites, producing local effects which amalgamate to produce a broad general effect due to the random scheduling in space and time and the comprehensive coverage of crash sites by camera sites. Prosecuting a substantial number of speeders detected by the cameras appears necessary to give real fear of detection/punishment behind the thinly spread enforcement operations.

4. The Swedish overt fixed speed camera program focuses on general deterrence of speeding on the camera routes exclusively, and places relatively little emphasis on specific deterrence. The density of cameras on the specific routes, no matter whether each is operational or not, produces a strong general deterrence effect. The high perceived risk of detection is supported by the prosecution of only a relatively small number of offenders. The effect of the program is limited to the camera routes and there is the question of whether general deterrence can be maintained long-term.

5. The French speed camera program is focused on specific deterrence of speeding through a high rate of surveillance of each driver and the capacity to prosecute all of the offences detected. Some general deterrence of speeding at camera sites is also achieved, especially at fixed camera sites. The efficiency of the French system is assisted by owner-onus legislation and the requirement that the owner is immediately liable to pay the fine.

6. The UK speed camera program is focused on general deterrence through the very conspicuous operation of large numbers of fixed and mobile cameras. However, the operations do not produce a broad effect which extends the strong local effects.

Specific deterrence appears to be a secondary effect of the program and is focused on excessive speeders because of the relatively high enforcement threshold.

7. A reduction in the speed enforcement threshold will produce a short-term increase in the offence detection rate, but in the medium to long term the offence rate will return to its previous level. In addition, the proportion of drivers exceeding the old enforcement threshold will reduce substantially because of more effective deterrence of speeding above that level.

8. Based on the review of speed offence processing models in other jurisdictions, it was concluded that the number of offences estimated to be processed, in the originally recommended package, was over-stated and could be reduced. The reduction in the offence processing load reduces the cost of the package and increases the benefit-cost ratio, as shown in the tables below. The benefit-cost ratio of the alternative to the originally recommended package is also increased. A second alternative package, involving the use of both covert and overt mobile speed cameras on urban highways in Perth, may combine the best features of these two forms of operation and produce crash reductions and a benefit-cost ratio between those of the originally recommended package and the alternative.

Speed enforcement package	Reduction in fatal crashes	Reduction in hospital admission crashes	Reduction in medical treatment crashes	Package Benefit-Cost Ratio
1. Originally recommended package (covert mobile speed cameras in Perth)	26.0%	12.3%	9.0%	9.98
2. Originally recommended package (covert mobile speed cameras in Perth) – REVISED (reduced offence processing)	26.0%	12.3%	9.0%	10.08
3. Alternative to recommended package (overt mobile speed cameras in Perth) – REVISED (reduced offence processing)	20.4%	15.2%	13.4%	10.81
4. Second alternative to recommended package (covert and overt mobile speed cameras in Perth)	23.2%	13.8%	11.2%	10.44

Speed enforcement package	Program Cost per month ($'000)	Program Cost per year ($m)	Speeding Tickets issued per year (short-term)	Fine revenue ($m) at $100 per ticket (short-term)	Fines Enforcement Registry additional cost per year ($m)
1. Originally recommended package (covert mobile speed cameras in Perth)	1,553.3	18.64	2,043,315	204.3	1.530
2. Originally recommended package (covert mobile speed cameras in Perth) – REVISED (reduced offence processing)	1,538.5	18.46	1,495,960	149.6	0.831
3. Alternative to recommended package (overt mobile speed cameras in Perth) – REVISED (reduced offence processing)	1,530.3	18.36	755,960	75.6	0.075
4. Second alternative to recommended package (covert and overt mobile speed cameras in Perth)	1,534.4	18.41	1,135,960	113.6	0.514

9. Pending decisions on the application of point-to-point speed cameras, the originally recommended speed enforcement package remains the most effective set of options for WA. It is nearly the most cost-beneficial set of options and would be certainly so if fatal crash reductions were valued more highly, because of the strong effect of covert mobile speed cameras on fatal outcomes in crashes. Randomly-scheduled overt mobile speed cameras have no greater effect on reducing fatal crashes than on non-fatal crashes.

10. Point-to-point speed camera systems have the potential to replace the originally recommended speed enforcement program on Perth freeways, and the recommended programs on parts of the urban and rural highway system. Links of freeway and highway have been identified where point-to-point systems are economically warranted, as summarised in the table below. Decisions about the specific links suitable for application of the point-to-point technology must await consideration of all of the characteristics of the nominated roads.

Region	**Roads warranted for Point-to-Point camera systems**	**Total Length of Links (km)**	**Reduction in fatal and hospital admission crashes**	**Reduction in medical treatment crashes**	**Point-to-Point system capital cost ($)**	**Speeding Tickets issued per year (short term)**	**BCR**
Perth metro-politan	Freeways	74	33.3%	12.6%	4,900,000	496,758	10.35
	Other links in top 40	248	33.3%	12.6%	4,450,000	218,210	16.54
Rural	Links in top 40	2,990	33.3%	12.6%	11,800,000	133,591	15.76

1 INTRODUCTION

1.1 PROJECT TASKS AND OBJECTIVES

During 2006, the WA Office of Road Safety commissioned MUARC to develop strategies for best practice in speed enforcement in the state (Cameron and Delaney 2006). The principal tasks of the 2006 project were to:

- Conduct an analysis of current Australian and international activity, research and literature in relation to best practice in speed enforcement strategies and technology;
- Develop recommendations on the implementation of best practice in speed enforcement specifically for the WA setting; and
- Develop a detailed implementation plan in order to move from the current situation to what has been recommended.

The main objective was for the results and recommendations from the research to be utilised to enhance enforcement strategies in WA. Specifically, to assist the WA Police in developing formal business cases for:

- The deployment of enforcement technology (what, where and how);
- The purchasing of enforcement technology (number, mix and type); and
- Funding options and service delivery models for the purchase and support of the future enforcement technologies and activities.

Since being proposed for implementation by MUARC in their recent recommendations for a new road safety strategy for Western Australia spanning the period 2008-2020, to ensure the most up-to-date best practice methods are adopted, an extension of the 2006 project was commissioned in December 2007 with the following objectives:

1. Review of the 2006 report to include newly reviewed and emerging technologies available such as point-to-point speed cameras;
2. Update the recommended mix of technological and non-technological speed enforcement practices, the circumstances in which each should be applied and the objective seeking to be achieved, given the inclusion of these new and emerging technologies and practices (e.g., point-to-point);
3. Identify and review available infringement management models worldwide including processing and camera management in terms of their ability to facilitate a reduction in speeding effectively and efficiently through deterrence and detection.

This supplementary report should be read in conjunction with the final report of the 2006 study (Cameron and Delaney 2006). Only the most relevant material from that report is repeated here.

1.2 CONTEXT

A speed enforcement strategy for WA needs to recognise the vast size of the State and also its relatively light traffic density compared with other Australian states. The area of WA is more than ten times that of Victoria and even 46% greater than Queensland. While the length of each state's road systems are of the same order of magnitude, the traffic density in Victoria is nearly 30 times higher and even in Queensland it is nearly 2.5 times the WA density. However the proportion of total travel in urban areas in WA (63%, mainly in Perth) falls between the proportions in Victoria (71%) and Queensland (37%).

The Multanova 6f speed camera system is the principal method for the detection of speed offenders in WA, detecting over 616,600 offenders in 2004 compared with about 303,000 offenders detected by non-photographic methods (mobile radar units, which can also be operated in stationary mode, and hand-held laser speed detectors). A small number of hand-held radar units also exist, but apparently laser units are now favoured for hand-held operation. The WA Police Service had provided details of the number of units, costs, operating staff and support vehicle requirements, vehicles assessed (in the case of the cameras) and offences detected per annum, offence processing staff numbers and costs, and offence processing equipment costs (see Cameron and Delaney, 2006, Appendix A).

2 POINT-TO-POINT SPEED CAMERAS

Point-to-point speed cameras, or average speed cameras, are the most relevant new technology for speed enforcement which was not fully covered in the report on the 2006 study. The technology was described, but insufficient information was available at that time about its effectiveness, cost and operational aspects for this to be considered as an option for speed enforcement in WA in appropriate circumstances. This situation has now changed.

2.1 OPERATION OF POINT-TO-POINT SPEED CAMERAS

Point-to-point camera technology uses a number of cameras mounted at staged intervals along a particular route. The cameras are able to measure the average speed between two points or the spot speed at an individual camera site. In order to measure the average speed between two points the cameras must be linked to one another and the time clocks on both machines must be synchronised. The average speed is then determined by dividing the distance travelled by the time taken to travel between the two points. The distance between two camera sites may vary from as low as 300 meters to up to tens of kilometres. An enforcement threshold may also be implemented to allow for acceptable variations in driver speed along the route. Potentially, a lower enforcement threshold could be considered for the average speed measured by this technology than the spot speeds measured by mobile and fixed speed cameras.

In the U.K., point-to-point camera technology, using digital imaging, was first installed on Nottingham's main link road from the M1 Motorway in July 2000, as part of a trial program of additional speed cameras in eight Police areas. Two cameras were mounted along the enforced 40 mph road length approximately 0.5 kilometres apart. In a comparison with traditional wet-film spot-speed fixed cameras, Keenan (2002) found that reported casualty crashes at the Nottingham digital camera site fell from 33 during the year before installation to 21 during the year after, a reduction of 36%. In addition, both mean and 85th percentile speeds were below the 40 mph speed limit along the 0.5km road length enforced by the two cameras. In contrast, crashes at the spot-speed camera sites studied appeared to increase, but not statistically significantly so.

Commenting on the relative merits of the new technology, Keenan (2002) noted that the spot-speed fixed cameras have a site-specific effect whereas the point-to-point camera system has a link-long influence on drivers and their speeds despite enforcement being visible only at the start and end of the enforced road length. Further, Keenan (2002) noted from his study that "around the [spot-speed camera] sites a significant proportion of the drivers observed manipulated their behaviour in close vicinity to the installations, suddenly applying their brakes 50 metres before the camera and then promptly accelerating away from it. Most alarming was the fact that the accident statistics at some of the [spot-speed camera] sites had worsened since the camera installation". While the crash data were probably too few for Keenan to claim that the situation had worsened, it is possible that any speed and crash reduction benefits at the overt fixed spot-speed camera sites were eroded by some drivers behaving in the way Keenan suggests. However, given the policy in the U.K. of making fixed camera sites conspicuous and the placing of advance camera warning signs a requirement of the scheme, there should be less likelihood of drivers being taken by surprise. This effect may be even less likely to be a significant consequence of the point-to-point camera systems.

2.2 EVALUATIONS OF U.K. SYSTEMS

Point-to-point speed camera systems measuring average speeds between two or more fixed cameras have the potential to produce a general effect well beyond the localised effect at overt fixed camera sites. They have been installed at a few sites as part of the comprehensively-evaluated UK Cost Recovery Program, but apart from information which can be gleaned from the detailed information in that program's evaluation reports, there is little scientific evidence of their effects on road trauma. Gains et al (2003) indicated that the two 0.5 km apart point-to-point cameras in Nottingham produced 31% reduction in serious casualties (not statistically significant) which was not significantly different from the road trauma reduction from speed cameras of all types. Keenan (2002) found 36% reduction in casualty crashes at the Nottingham site.

The manufacturer of the UK point-to-point speed camera systems, Speed Check Services, have claimed that systems in Nottinghamshire (now 48 pairs of cameras), Northamptonshire (four pairs of cameras on a 4 km section) and South Yorkshire (eight pairs of cameras on an 11 km section of highway) have substantially reduced speeding and road trauma on the road sections they cover. It is understood that each pair of cameras needs to be hard-wired together in some way, and that this requirement constrains the distance over which the average speed can be measured.

In July 2005, the Scottish government launched a pilot scheme of 15 Speed Check Services SPECS cameras on a 46 km section of the A77 highway in the Strathclyde area. It is described as a complex route including single and dual carriageways with varying speed limits. The southern section is a winding and challenging coastal road in South West Scotland. The route had experienced 20 road deaths and 95 serious injuries over the five-year period 2000-2004. Published descriptions of the system are unclear: apparently there are 14 camera sections, averaging 0.5 mile in length, between which the pairs of cameras are switched on periodically. The cameras are supported by around 50 safety camera warning signs with the message "average speed – speed cameras" and a camera symbol. The intention is to deter speeding along the full length of the route. However, the system does not appear to measure average speeds along contiguous sections of the route nor over the whole route. This may relate to the varying speed limit zones along the highway covered.

A preliminary evaluation of the Strathclyde A77 system by Transport Scotland has found that there was a statistically significant 20% reduction in reported injury crashes (including fatal) during the first two years of operation on the route, compared with crash experience during the previous three years (A77 Safety Group, 2007). Fatal and serious injury crashes each fell by one-third and road deaths were more than halved; however none of these reductions were statistically significant, perhaps due to the small frequencies in each case. A full assessment of the effects of the system on crashes and casualties on the A77 route is planned when three years' experience has been accumulated in July 2008.

To date, the Speed Check Services SPECS point-to-point speed camera system is the only such system to receive Home Office Type Approval in the UK. In 2003, their website indicated that a pair of point-to-point cameras costs £70,000 and requires at least another £100,000 for the computer network to support it. In 2005, Speed Check Services suggested around £290,000 for a fully installed SPECS system, compared to around £45,000 for a single spot-speed camera. There may be economies of scale with larger numbers of cameras because the Scottish government has reported that the 15 camera system in Strathclyde cost £775,000 in 2005.

2.3 EVALUATIONS IN AUSTRIA AND THE NETHERLANDS

A careful evaluation has been conducted of the point-to-point camera system covering speeds through a 2.3 km long urban tunnel in Austria (Stefan 2006). While there are limits on the generalisability to other non-tunnel road environments, the results indicate strong effects consistent with those seen in the preliminary evaluation of the Strathclyde A77 system.

The Austrian tunnel has separate tubes with 3-4 lanes in each direction and carries a total of 91,900 vehicles per day. There is one camera above each of three lanes at the beginning and end of the tunnel, and a separate laser scanner to differentiate between passenger cars and heavy goods vehicles because of the different speed limits applicable to each vehicle type (80 km/h for cars and 60 km/h for HGVs). The system is designed to operate with speeds up to 250 km/h and a maximum traffic flow rate of two vehicles per second and lane. Vehicle detection is independent of the position of a vehicle in or between lanes.

During the first year of operation, average speeds fell by 10-15 km/h and then levelled at average speeds about 5 km/h below the applicable speed limit for each vehicle type. During the same period, 29.4 million vehicles passed through the tunnel and 40,900 drivers were charged with speeding, suggesting a detection rate of 0.139%.

The evaluation found that injury crashes (including fatal) were reduced by one-third, fatal and serious injuries by 49% and slight injuries by 32%. These figures are consistent with those found elsewhere (see section 2.2) and with the expectation that a greater effect is expected on more serious injury crashes than those resulting in minor injury.

The capital cost of the Austrian system was €1.2 million (in 2002) and annual costs of operation and maintenance are about €60,000. When the capital costs were amortised over 10 years at 4% p.a. discount rate, Stefan (2006) estimated that the annual cost of the system is €207,950. Using relatively modest costs for the economic value of crashes prevented, at each level of severity (e.g. €949,900 for a fatality), Stefan's analysis indicated a benefit-cost ratio of 4.9 (or 5.3 if the social benefits of reduced traffic emissions were included).

In the Netherlands, a point-to-point system was installed on the motorway between Rotterdam and Delft in support of a new 80 km/h speed limit. No comprehensive evaluation of the system has been published, apart from information that the proportion of offenders declined to less than 1% (RWS 2003). This result, and the low detection rate observed in the Austrian tunnel, suggests that point-to-point camera systems have the capacity to reduce speeding transgression rates to a lower level than that achieved by overt fixed speed cameras enforcing spot-speeds (1.2% exceeding speed limits by at least 10 km/h in the case of the NSW fixed cameras).

2.4 VICTORIAN EXPERIENCE

Victoria launched a point-to-point speed camera system on the initial section of the Hume Freeway north of Melbourne on 5 April 2007. Four contiguous sections of lengths 8, 14, 7 and 25 km are covered by five double-camera banks, one at the beginning and end of each section in each direction. Three traffic lanes are covered by each bank of cameras; one camera per lane (but not the emergency stopping lane, which is sometimes used by vehicles trying to avoid surveillance). Vehicle detectors in the road pavement trigger each camera imaging. Some camera banks have cameras facing rearward, some facing forward, and some with cameras facing in both directions. The forward facing cameras are aimed at capturing truck prime-mover number plates, and rearward facing to capture motorcycle number plates. Over the four contiguous sections, the number plates of all types of vehicle are captured more than once, but not necessarily at the beginning and end of each section.

Every vehicle passing a camera is digitally photographed, the image stored, the number plate is optically character recognised (OCR'd) on-site and the characters transmitted to a central computer in Melbourne where they are then matched (where possible) with the registration number captured in the same way by a downstream camera. Following a successful match, if the calculated average speed exceeds the enforcement threshold (same as that used with spot-speed cameras), the two matched images are transmitted from the on-site camera systems and are referred to the infringement processing agency for manual verification. An infringement notice is issued in the same way as other camera-detected speeding offences. Because of this form of operation, apparently there has been no constraint on the length of the section over which average speed is measured, unlike the SPECS systems in the UK.

The system used is the Redflex HDX system which comprises the cameras, OCR computers, transmission equipment and the central computer. Redflex hosts and maintains the central computer, but has no access to the registration numbers, images and other information protected for legal integrity reasons. Redflex also maintains the field cameras and supporting equipment. A type approval system is not used in Victoria, but the Redflex system has been subjected to an equivalent test and acceptance plan. The central computer has the capacity to handle more camera banks and it is understood that the Department of Justice has plans to extend the lengths of highway covered. The camera banks are capable of measuring spot speeds and this extension of their use is being considered; a current Victorian requirement for secondary verification of fixed digital speed camera detected offences inhibits this. The system could also measure average speed over any combination of the four contiguous sections; currently up to four separate assessments could be made, in which case the highest detected illegal speed is prosecuted if more than one offence is detected.

The criteria for installing the system on the Hume Freeway were a relatively high number of fatalities and serious injuries, and a high proportion of heavy vehicle traffic with the attendant potential for severe injury outcomes in crashes. Other criteria were relatively few opportunities (or incentives) to enter or leave the highway between a pair of cameras, so that a substantial proportion of traffic has its average speed assessed. In Victoria, another current operational requirement is that the speed limit be fixed for the entire length of the section between pairs of cameras. It is understood that this requirement relates to the current absence of an "average speed offence" in the relevant legislation, which could be used to prosecute such an offence over multiple speed limit zones. Currently, the Victorian system is turned off during periods of lowered speed limits due to road works.

About 1,000 offences per day are detected when the system is operational, suggesting an offence detection rate of 1-2% from an estimated 50,000 to 100,000 vehicles per day on the highway. This detection rate is similar to that detected by the covert mobile speed cameras in Victoria. The shorter sections have somewhat higher detection rates, perhaps because there are fewer benefits to speeders who try to avoid detection by stopping or leaving the highway.

The Victorian point-to-point speed camera system appears to differ fundamentally from the Strathclyde A77 system in that it appears to be aimed at deterring speeding over long sections of highway (minimum 7 km) rather than relatively short sections (average 0.5 mile in Strathclyde). While the Strathclyde system also appears to be aimed at covering the full route, less than half of the route (even if allowing for a "halo" effect) is actually apparently enforced by their conspicuous high-mounted cameras. In a sense, the Strathclyde system may be viewed as a variation of the much more common, overt fixed speed cameras operating in the UK. While the "spot" at which the average speed is measured is in fact about 0.5 mile in length, on average, the Strathclyde system apparently does not aim to average the speed over long sections of highway, unlike the Victorian system. The only constraint on the length of the Victorian sections appears to be the current legislative restriction to lengths with a fixed speed limit throughout.

A press release by Redflex in June 2003 suggested that the contract to provide the ten camera-bank system was valued at $2 million. However, it is understood that the final specification for the system was changed substantially over the next four years.

2.5 COSTS OF POINT-TO-POINT SYSTEMS IN WA CONTEXT

Redflex provided indicative costs of point-to-point systems if they were to be installed in WA. The cost per camera bank depends on the number of traffic lanes to be covered (hence the number of cameras, potentially doubling if forward and rearward imaging is required) and the traffic volume past the camera site (since this affects the computer processing power required for OCR and the image storage requirements). If two camera banks are installed at the same location for surveillance of two directions of travel (as at the five double-camera banks on the Hume Freeway), there are savings in some site infrastructure costs (power supply, OCR computer capacity, etc.). Because of the variations in lane coverage, traffic volumes and imaging requirements, the cost per camera bank can range from $75,000 to $200,000-$300,000. The cost of the central computer to match the previously OCR'd number plate characters (at each camera site) is a relatively small cost compared with each camera bank, at least two of which are required.

Redflex emphasised that the above estimates are only indicative costs, suitable for the cost-benefit analysis envisaged in this report, and would be pleased to provide firmer cost estimates when the number and location of point-to-point camera banks in WA is determined.

2.6 MOBILE POINT-TO-POINT CAMERA SYSTEMS

Redflex also provided information about a mobile version of the point-to-point camera technology which they have developed. Each camera is vehicle-mounted and is triggered by slant radar across one or two traffic lanes. The system also measures spot-speed of each passing vehicle (reflecting Redflex's history in providing spot-speed camera systems). The camera vehicle has a computer to capture the image of each passing vehicle, OCR the registration number plate, and transmit the number plate characters to a central computer for matching with registration numbers obtained in the same way by a second camera vehicle. It is essentially a mobile version of the fixed camera banks.

The two vehicles need to be carefully stationed at designated locations for which the road distance between them has been accurately surveyed. There appears to be no limit to the number of pairs of stations, and distances between them, which could be used for this purpose apart from the need to be able to park the camera vehicles safely. Parallex errors associated with the use of slant radar to trigger each camera are minimised if the two vehicles are stationed many kilometres apart.

For two-lane undivided highways (one lane in each direction), each camera vehicle can captured the images and times of same-direction vehicles and opposite-direction vehicles. A decision can be made to rearward photograph same-direction vehicles and front photograph opposite-direction vehicles, or vice versa. A second camera vehicle operating in the same way at the other end of the route under surveillance then provides the information to match registration numbers and calculate average speeds for vehicles travelling in either direction, and for a focus on front or rear number plates as required.

As noted above, the mobile point-to-point camera vehicles can also measure the spot-speeds of passing vehicles and provide the images to prosecute speeding offences in the usual way. Thus these camera vehicles could represent, in addition to average speed enforcement, a resource to function as overt mobile speed cameras randomly scheduled [at locations defined by their proximity to crash locations] on rural highways, as recommended in the 2006 study. This potential dual role of the camera vehicles could improve the cost-effectiveness of an investment in mobile point-to-point camera technology.

2.7 USE ON FREEWAYS AND HIGHWAYS IN WA

While overt fixed speed cameras measuring “spot” speeds appear to be very effective in reducing speeds and road trauma at specific sites, in general they do not influence drivers other than at those sites (unless the density of cameras is high and above a critical threshold). If the intention is to reduce speeds along a substantial “black” route using a number of overt fixed cameras, there may be a case for using point-to-point camera systems to enforce speeds along the whole route.

The published evaluations of such systems in the U.K. and Austria suggest that they are effective in reducing speeds and casualty crashes along the whole route on which they are installed. It is unclear what routes would be suitable for this form of speed enforcement in WA. The route would need to have a sufficient crash rate to make these relatively expensive systems cost-effective, and have limited access/egress opportunities along its length to make it operationally viable (though the presence of local traffic making small trips along the route is not an issue for the integrity of the system).

In theory, any road would be suitable for point-to-point technology, but the most suitable would be those routes meeting the criteria outlined below. An additional criterion would be those roads with lower-standard safety infrastructure warranting priority attention during the next WA road safety strategy program, but for which substantial reduction and control of speeds is warranted in the short term until the road infrastructure is improved. Information was sought from Main Roads WA about routes which they considered suitable for point-to-point speed camera enforcement, including the length, traffic volume, and crash rate by injury severity level.

2.7.1 Potential criteria for application of Point-to-Point systems in WA

It is proposed that the following criteria be considered for choosing suitable routes in WA for application of point-to-point technology:

- High crash rate per kilometre, particularly fatal and serious injury crashes (this criterion being aimed at potentially justifying the economic benefit to be obtained from this relatively expensive technology)

- Roads currently with lower-standard safety infrastructure warranting priority attention for upgrading, following which the point-to-point technology should be moved to other suitable roads with sub-standard infrastructure

- Speed distribution and speed profile along the road suggesting need to control speed along the full route rather than at individual locations

- Limited opportunities and incentives for traffic to enter or leave significant-length sections on which pairs of point-to-point cameras would be installed at the beginning and end of each section (which could be contiguous with adjacent sections)

- Sections with a fixed speed limit throughout its length, at least in the short term until WA enacts legislation to prohibit an "average speed offence" which could be used to prosecute speeding along a section with multiple speed limit zones.

2.8 SIZE OF ROAD TRAUMA PROBLEM ON SUITABLE ROUTES

In the 2006 study, each of the viable speed enforcement options for application to different parts of the WA road system (in many cases there was more than one option) was analysed to estimate its economic benefits relative to the cost of enforcement (Cameron and Delaney 2006).

A necessary first step in the economic analysis of the speed enforcement options was to determine the size of the road trauma problem in the road environment proposed as the principal focus for the option (Table 1). There was evidence that each option reduces casualty crashes to a measured extent, and some enforcement methods have been found to reduce fatal crashes to a larger extent. The economic analysis considered the reductions in crashes weighted by their social costs. Hence the proportion of fatal crashes, in particular, in each environment needed to be noted by Cameron and Delaney (2006).

Because the specific routes, lengths, traffic volumes and crash rates relevant to point-to-point speed cameras have not yet been determined, it is not yet possible to complete Table 1 in this supplementary study. In addition, if a large proportion of a road environment (e.g., Perth freeways or rural highways) currently recommended for application of another technology (see 2006 study report) is considered suitable for point-to-point enforcement, then the economic analysis of the alternative technologies may need to be revisited following the necessary modifications to Table 1.

Table 1: Road environments proposed as the focus of each speed enforcement option (from Cameron and Delaney 2006)

Type of speed enforcement and road type proposed applicable to	Length of road (km)	Estimated traffic (million veh-km) 1991	No. of casualty crashes 2002-2004 (note *)	Percentage of casualty crashes with fatal outcome
URBAN ROADS (mainly in Perth)				
Covert mobile speed cameras on urban highways	1815	7910	4341	1.41%
Overt mobile speed cameras randomly scheduled on urban highways	1815	7910	4341	1.41%
Laser speed detectors on urban local roads	8200	2090	8859	1.25%
Fixed cameras on Perth freeways	62	230	697	1.43%
RURAL ROADS				
Overt mobile speed cameras randomly scheduled on rural highways	20,194	4170	1776	8.05%
Mobile radar units on undivided rural highways and local roads	123,800 (estimate)	5200	3211	7.04%
Point-to-point speed camera systems on highly-trafficked rural highways	**NK**	**NK**	**NK**	**NK**

* Includes only 2002-2004 crashes with known speed zone at the crash location (i.e. 73.0% of all reported casualty crashes and 87.6% of fatal crashes)

2.9 ECONOMIC ANALYSIS OF POINT-TO-POINT ENFORCEMENT

In the 2006 study it was decided, in the absence of clear scientific evidence of point-to-point speed camera systems having a general effect on road trauma over a substantial length of highway, that it was not possible to conduct a valid economic analysis of the potential introduction of such a system on suitable routes in WA. There were also difficulties in obtaining information on the cost of installing, maintaining and operating such a system in the Australian environment. It was proposed that this decision be revisited when definitive scientific evidence emerges from the UK (especially from the system over a long route in the Strathclyde area) and operational cost information from the pilot program in Victoria becomes available. An economic analysis is now viable.

2.9.1 Unit costs of crashes, enforcement equipment and offence processing

The economic benefits from the road trauma reductions estimated to be produced by each form of enforcement considered in the 2006 study were calculated using the unit costs at each crash severity level published by BTE (2000), updated from 1996 values to 2005 using the Consumer Price Index, as follows:

- Fatal crashes $2,047,615
- Severe injury crashes resulting in hospitalisation $505,390
- Injury crashes resulting in other medical treatment $17,065

Based on the information from Redflex about point-to-point system requirements and costs, it was estimated that each camera bank covering two lanes of traffic (with either forward or rearward imaging, but not both) in each direction would cost $200,000, potentially rising to $300,000 if coverage of more than two lanes is required. Divided highway sections were assumed to require two camera banks in each direction. For two-lane undivided highways, it was assumed that one camera costing $75,000 could be placed at each end of each section and could cover vehicles travelling in both directions. Where sections are contiguous, it was assumed that the camera bank at the end of section could be the entry camera bank for the next section. Both types of system were assumed to require a central computer system, costing $25,000, to receive the OCR'd number plate characters from each passing vehicle, match them, and initiate processes to download the images from the on-site cameras. The fixed costs of the enforcement equipment were amortised over their assumed useful life of 6 years, at 7% p.a. interest rate, to provide an annual cost.

Only fixed-location point-to-point camera systems have been analysed. Although a mobile vehicle-mounted camera could cost about the same as a single fixed camera (one of a pair) covering traffic in both directions, in practice there would be the substantial additional cost of the operator's time. The opportunity to combine this form of operation with randomly-scheduled overt mobile speed camera operations, requiring an operator to be present, needs to be further considered and an economic analysis conducted.

Offence processing costs, for each type of offence record (photographic evidence or on-the-spot notice), per offence detected had been estimated from information provided by the WA Police Service (Cameron and Delaney, 2006, Appendix A). The cost per 1000 speeding infringement notices issued was estimated to be $135.11 for offences detected photographically (as would be the case for notices issued for point-to-point camera detections). The fixed costs of the WA Police back office and equipment to process 667,629 infringement notices in 2004 was estimated to be $1,913,000 (excluding some unknown costs) which was amortised as $254,550 per year at 7% p.a. interest rate over an assumed ten year life.

It is expected that there would be no additional cost to process a speeding offence detected photographically by point-to-point technology than other spot-speeding offences detected by Multanova speed cameras and fixed digital speed cameras in WA. In Victoria, once an average speed offence has been detected by the point-to-point system (cameras plus back-office central computer analysing the time between two images successfully matched), the information and images are transferred to the same infringement processing system as the spot-speed offences detected by speed cameras are.

It should be noted that the estimated costs to process the speeding offences are limited to those borne by the WA Police Service, at this stage, and do not include the additional costs to further process any unpaid offence notices referred to other WA agencies by the Police. It is acknowledged that any increase in the number of speed detection devices, especially a significant increase as proposed by Cameron and Delaney (2006), would result in a growth in infringement activity (especially in the short term) and would impact considerably on the business processes and resources of other agencies, such as the Department for Planning and Infrastructure. It is therefore essential that this 'upstream' consequence be appropriately measured and costed to ensure that other agencies are adequately resourced to meet the increased demand in services. The additional cost of fines enforcement by the Fines Enforcement Registry for the additional speeding infringements is estimated in section 4.5 of this report.

2.9.2 Data provided by Main Roads WA

MRWA provided information on 194 State Highway and Main Road links, each with reasonably homogeneous character along their length with respect to traffic level, road type and use. As well as the 2003-2007 crash history, traffic volumes, road cross-sections and link lengths, the data included an indication of whether the link may be problematic for point-to-point camera enforcement because of closely-spaced intersections and/or numerous other points of access (such as driveways).

The provided data was initially analysed to calculate the total social cost of the crashes (weighting crashes at each severity level by unit costs based on BTE 2000) and the social cost per kilometre of road and per 100 million vehicle kilometres of travel. It was noted that a number of road links which had been previously nominated as potentially suitable for point-to-point enforcement were considered problematic (as defined above) or had relatively low crash social costs per vehicle kilometre, potentially giving them lower priority because of their high safety standard. However, the analysis also suggested many other candidate road links because of their relatively high crash social cost rate, possibly due to their lower standard safety infrastructure.

Final recommendations on road links considered most appropriate for point-to-point camera enforcement were made on the basis of the following economic analysis which also took into account the potential saving in social costs, the appropriate camera configuration for the link, and the cost of processing the likely level of speeding infringements in the short term. These considerations allowed the benefit-cost ratio to be estimated.

2.9.3 Economic analysis and results

The crash reduction benefits of point-to-point enforcement applied to each link were estimated from the crash history during 2003-2007. The crash reductions experienced during the first two years of the Strathclyde A77 system were considered most relevant, in contrast with the larger reductions observed in the Austrian tunnel system, because nearly all the WA links are open road links not involving tunnels (however, the effect in any WA tunnel environment is likely to be greater). Following the Scottish experience, it was assumed that casualty crashes would be reduced by 20% and, of these, serious casualty crashes (including fatal) would be reduced by one-third; non-serious casualty crashes would be reduced to a lesser extent. The crash reductions were then valued by the unit costs based on BTE (2000) to estimate the saving in social costs of crashes per annum.

The annual total number of vehicles which would be monitored by the point-to-point system on each link (assumed to operate continuously) was estimated from the two-way annual daily traffic estimates provided by MRWA. A relatively low short-term offence detection rate of 0.5% was assumed based on experience in the Netherlands (less than 1%) and in the Austrian tunnel environment (0.139%). A substantial short-term effect on transgression rates is expected on the WA links because the threat of detection for speeding along each link will rapidly become known (especially if publicised and intensely sign-posted) and is likely to reduce further in the medium to long term. Assuming a non-prosecutability rate of 20%, the assumed detection rate was used to estimate the annual number of speeding tickets which would result on each link in the short term. The cost of processing these tickets was based on the unit cost of issuing photographically-detected speeding infringement notices, plus a proportionate share of the back-office capital equipment costs (amortised) which would also be necessary to provide capacity to process the offences (see section 2.9.1).

Based on the length of each link, the number of sections over which average speeds would be measured, and hence the number of camera banks, was calculated assuming that no section could be longer than 30 km (based on the 25 km longest section in Victoria). It was also assumed that the sections within a link would be contiguous, so that the interim banks performed the role of both entry and exit cameras for abutting sections. Divided roads with two lanes in each direction were assumed to require two opposite-direction camera banks with two cameras in each bank, at the beginning and end of each section, and three cameras per bank in the case of three-lane divided highways. These considerations allowed the total capital cost of investment in the point-to-point camera system necessary for each link to be estimated, which was then amortised to provide an annual cost to add to the annual costs of speeding ticket processing and supporting back-office capacity.

The benefit-cost ratio (BCR) of the application of the appropriate point-to-point camera system to each road link was estimated by dividing the annual saving in social costs of crashes by the annual costs of capital equipment (amortised) plus offence processing. Forty road links considered suitable (i.e. not problematic) for this speed enforcement approach were estimated to have BCRs close to 10 or greater, the overall BCR for the speed enforcement package recommended by Cameron and Delaney (2006).

Table 2 summarises the economic analysis for the top 40 links, in groups of 10 ranked by BCR, and Table 3 provides the analysis for each individual road link. There were an additional 21 road links, principally in the Perth metropolitan region, that were estimated to have BCRs greater than 10 if point-to-point speed cameras were applied, but the application was considered to be problematic because of numerous access and egress opportunities along each link. The problematic, but otherwise economically justifiable, metropolitan links for application of point-to-point systems included Albany Highway (link 134), Wanneroo Road (links 159 and 160) and Perth-Bunbury Highway (links 136 and 137), all of which had relatively high crash social cost rates per 100 million vehicle-kilometres of travel during 2003-2007.

Table 2: Summary of economic benefits and costs of Point-to-Point (P2P) speed camera systems applied to top 40 road links with high BCRs

Rank of Links	Total Length of Links (km)	Saving in Social Cost of Crashes p.a. ($000s)	Speeding Tickets p.a. (short term)	P2P system capital cost ($)	Total cost of capital equipment (amortised) plus ticket processing p.a. ($)	BCR
Top 10	512	16,197	77,650	2,575,000	$580,313	27.91
2nd 10	633	22,508	261,734	5,225,000	$1,231,310	18.28
3rd 10	1,313	13,344	40,225	4,750,000	$1,017,297	13.12
4th 10	817	15,020	294,910	6,150,000	$1,442,499	10.41

Table 3: Estimated economic benefits and costs of P2P applied to each road link

Region	Link No	Road No	Road Name	Length (km)	Social Cost Saving p.a. ($000s)	Speeding Tickets p.a. (short term)	No. of sec-tions	P2P system capital cost ($)	Total cost of capital equip. (amortised) + processing p.a. ($)	BCR
Metro-politan	45	H009	South Western Highway	58.05	2934.9	14,076	2	250,000	$59,716	49.15
South West	46	H009	South Western Highway	78.88	2341.4	9,102	3	325,000	$72,883	32.13
South West	47	H009	South Western Highway	16.27	1088.9	10,019	1	175,000	$41,887	26.00
Metro-politan	174	H033	Toodyay Road	22.13	1024.5	7,353	1	175,000	$40,510	25.29
Wheat-belt North	190	H005	Great Eastern Highway	42.39	1390.9	6,416	2	250,000	$55,762	24.94
South West	61	H043	Bussell Highway	80.87	1768.4	5,386	3	325,000	$70,964	24.92
Kimb-erley	31	H042	Broome Highway	41.52	1289.7	2,553	2	250,000	$53,767	23.99
South West	60	H043	Bussell Highway	34.86	1371.9	9,308	2	250,000	$57,254	23.96
South West	123	M043	Caves	111.00	2034.0	3,285	4	400,000	$85,614	23.76
Pilbara	35	H046	Dampier Road	25.84	952.6	10,154	1	175,000	$41,956	22.70
Top 10				**511.81**	**16197.2**	**77,650**	**21**	**2,575,000**	**$580,313**	**27.91**
South West	55	H009	South Western Highway	57.07	1209.6	4,618	2	250,000	$54,833	22.06
Gold-fields-Esp.	16	H049	Goldfields Highway	56.26	1145.9	2,997	2	250,000	$53,996	21.22
Metro-politan	153	H021	Reid Highway	21.23	4000.6	40,417	1	825,000	$193,948	20.63
Metro-politan	116	M034	Lancelin	75.14	1417.3	3,428	3	325,000	$69,953	20.26
Metro-politan	150	H016	Mitchell Freeway	25.35	6314.5	155,345	1	1,225,000	$337,201	18.73
Wheat-belt North	48	H004	Brand Highway	174.90	2097.4	3,486	6	550,000	$117,187	17.90
South West	54	H009	South Western Highway	32.61	965.5	7,211	2	250,000	$56,172	17.19
Midwest	25	H007	North West Coastal Highway	100.66	1440.2	3,920	4	400,000	$85,942	16.76
Metro-politan	152	H017	Tonkin Highway	28.21	2932.9	39,650	1	825,000	$193,552	15.15
Kimb-erley	22	H006	Great Northern Highway	61.24	983.9	663	3	325,000	$68,526	14.36
2nd 10				**632.67**	**22507.7**	**261,734**	**25**	**5,225,000**	**$1,231,310**	**18.28**

Region	Link No	Road No	Road Name	Length (km)	Social Cost Saving p.a. ($000s)	Speeding Tickets p.a. (short term)	No. of sec-tions	P2P system capital cost ($)	Total cost of capital equip. (amortised) + processing p.a. ($)	BCR
Pilbara	36	H051	Port Hedland Road	10.38	609.3	13,640	1	175,000	$43,756	13.92
Wheat-belt North	6	H006	Great Northern Highway	216.80	1998.7	1,497	8	700,000	$147,630	13.54
Wheat-belt South	40	H001	Albany Highway	161.04	1563.9	2,476	6	550,000	$116,666	13.41
South West	107	M053	Pinjarra-Williams	66.96	910.4	1,375	3	325,000	$68,894	13.22
South West	62	H045	Coalfields Highway	36.25	724.0	4,615	2	250,000	$54,832	13.20
Great South--ern	41	H001	Albany Highway	84.44	924.8	4,596	3	325,000	$70,556	13.11
South West	56	H009	South Western Highway	36.82	712.4	3,703	2	250,000	$54,360	13.10
Midwest	50	H004	Brand Highway	70.76	920.7	4,138	3	325,000	$70,320	13.09
Wheat-belt South	113	M031	Northam-Cranbrook	352.23	2714.2	1,073	12	1,000,000	$210,350	12.90
Wheat-belt North	2	H005	Great Eastern Highway	276.94	2265.0	3,113	10	850,000	$179,933	12.59
3rd 10				**1312.62**	**13343.5**	**40,225**	**50**	**4,750,000**	**$1,017,297**	**13.12**
Great South-ern	58	H009	South Western Highway	49.90	682.6	3,836	2	250,000	$54,429	12.54
Kimb-erley	14	H011	Victoria Highway	87.51	849.5	962	3	325,000	$68,680	12.37
Wheat-belt North	95	M010	Chidlow-York	46.02	648.6	2,412	2	250,000	$53,694	12.08
Wheat-belt North	87	M002	Bindoon-Moora	86.26	740.8	838	3	325,000	$68,616	10.80
Wheat-belt South	39	H001	Albany Highway	125.04	1087.6	3,647	5	475,000	$101,536	10.71
Metro-politan	155	H018	Roe Highway	30.56	2901.2	45,602	2	1,225,000	$280,543	10.34
South West	57	H009	South Western Highway	184.57	1353.1	1,128	7	625,000	$131,705	10.27
Gold-fields-Esp.	53	H008	South Coast Highway	183.85	1324.1	1,426	7	625,000	$131,859	10.04
Metro-politan	181	H017	Tonkin Highway	12.40	2088.8	67,686	1	825,000	$208,026	10.04
Metro-politan	151	H015	Kwinana Freeway	10.50	3343.3	167,374	1	1,225,000	$343,411	9.74
4th 10				**816.61**	**15019.6**	**294,910**	**33**	**6,150,000**	**$1,442,499**	**10.41**

Two links of metropolitan freeways were estimated to have high BCRs if point-to-point camera systems were applied to them (Mitchell Freeway, link 150, and Kwinana Freeway, link 151). While these two freeway links had relatively low crash social cost rates per 100 million vehicle-kilometres, the number of crashes on them (and their severity) results in a point-to-point system being economically justifiable, notwithstanding that these roads are apparently already very safe roads.

If all metropolitan freeway links are considered (i.e. also Kwinana Freeway, link 147, and the Graham Farmer Freeway, link 156), totalling 74 kilometres, it was estimated that point-to-point camera systems covering five sections would have a BCR of 10.4 (Table 4). This is greater than the BCR of 7.3 estimated by Cameron and Delaney (2006) if 24 overt fixed speed cameras were to be installed on Perth freeways. The capital cost of investment in the point-to-point systems would be greater ($4.9 million compared with $2.4 million for the fixed spot-speed cameras), as would the number of speeding tickets needed to be processed annually in the short term (estimated 497,000 p.a. compared with 427,000 p.a.).

Table 4: Freeway and other types of links in the metropolitan and non-metropolitan regions with high BCRs for P2P application

Region	Road Type	Total Length of Links (km)	Social Cost Saving p.a. ($000s)	Speeding Tickets p.a. (short term)	No. of sec-tions	P2P system capital cost ($)	Total cost of capital equip. (amortised) + processing p.a. ($)	BCR
Metro-politan	Freeways	74	13,290	496,758	5	4,900,000	1,284,463	10.35
	Other links in top 40	248	17,300	218,210	11	4,450,000	1,046,248	16.54
Non-metro-politan	Links in top 40	2,990	40,110	133,591	116	11,800,000	2,544,560	15.76

The other seven metropolitan links included in the top 40 ranked by BCR cover 248 kilometres of highway and would require 218,200 speeding tickets per annum needing to be processed in the short-term. The capital cost of point-to-point systems to cover these links in 11 sections would be $4.45 million and the program would have a BCR of 16.5. This is greater than the BCR of 6.1 estimated by Cameron and Delaney (2006) if covert mobile speed cameras were to operate at 9,000 hours per month on Perth arterial roads and highways, estimated to represent a total of 1,815 kilometres in length. Thus, point-to-point speed cameras have greater economic justification than covert mobile cameras on this sub-set of Perth highways, about 14.8% of the total length.

The non-metropolitan links in the top 40 cover 2,990 kilometres of highway and would require a capital cost investment of 11.8 million to install the point-to-point systems covering an estimated 116 sections (all on undivided roads assumed to require one camera covering both directions at the terminals of each section). About 133,600 speeding tickets per annum would need to be processed in the short term and the overall BCR of the non-metropolitan point-to-point systems is estimated to be 15.8. This BCR is substantially less than the BCR of 36.8 estimated by Cameron and Delaney (2006) if randomly-scheduled overt mobile speed cameras were to operate for 3,000 hours per month on rural highways. In addition, the non-metropolitan links in the top 40 cover less than 15% of the total 20,194 kilometres of rural highway (excluding local roads) considered as the focus for the mobile speed cameras. Nevertheless, some of the non-metropolitan links in the top 10 especially may be considered to warrant the closer enforcement of speeding that point-to-point camera systems provide with perhaps greater certainty than the overt mobile speed cameras can be expected to achieve.

3 PROCESSING OF DETECTED SPEEDING OFFENCES

3.1 IMPLICATIONS OF ORIGINALLY RECOMMENDED PACKAGE

The originally recommended speed enforcement package required additional speeding infringement notices to be issued, at least in the short term until drivers respond to the increased threat of detection, reduce their speed limit transgression rate and consequently reduce the speed offence detection rate from vehicles assessed by the different forms of enforcement. (The reduction in transgression rate, especially from excessive speeding, is considered to be the principal mechanism through which the expected road trauma reductions will result. Other mechanisms include general improvements in driver behaviour as a result of seeing overt enforcement operations, but these are expected to be relatively minor contributors.)

Thus a key resource needed to implement the recommended speed enforcement package is a back-office with the capacity to process the expected increased number of speeding infringement notices. Cameron and Delaney (2006) indicated that 170,276 speeding tickets per month, or 2.043 million per year, would need to be issued in the short term. This is 3.1 times the number of speeding tickets estimated to have been issued by WA Police during 2004. The cost of the manpower to process the higher number of tickets has been included in the economic analyses. However the capital cost of the back-office and offence-processing equipment had been held fixed and had not been escalated to reflect a requirement for additional equipment to replicate its capacity. Since the capital cost of the back-office had been estimated to be about $1.9 million currently, up to an additional $4 million short-term capital investment may be required to expand the back-office capacity in order to provide the infrastructure for the additional offence processing staff.

Thus the total cost to process the estimated 2.043 million speeding tickets per year which would need to be issued in the short term, at least during the first year, would be approximately $18.6 million plus $4 million capital cost, a total of about $22.6 million. However, it is expected that this offence processing load would drop substantially in the medium term as WA motorists react to the increased risk of detection and prosecution when speeding, leading to a reduction in transgression rates and, unless detection thresholds are reduced, a similar reduction in detection rates. While it is difficult to predict that rate at which WA motorists will improve their behaviour in response to this threat, it could be expected that detection rates would be halved in the medium term and be further reduced in the long term.

In the 2006 study report, it was considered important that adequate resource be provided to process all the speeding offences detected by the recommended speed enforcement package and that speeding tickets be issued to a high proportion of offenders (excepting, of course, those offences which are not legally prosecutable for various operational reasons). While all of the enforcement options aim to reduce speeding behaviour by inflating drivers' *perceived* risk of detection, it was considered important that the credibility of the system be maintained by the actual receipt of a speeding ticket close to the time of the offence and with high certainty that this will always occur.

3.2 SPEED OFFENCE PROCESSING IN OTHER JURISDICTIONS

Since the 2006 report, the Office of Road Safety requested a review of infringement management models worldwide in terms of their ability to facilitate a reduction in speeding effectively and efficiently through deterrence and detection of speeding behaviour. This review has been limited to processes in Victoria, Queensland, Sweden, France and the United Kingdom in the time available for this extension project.

3.2.1 Victoria

During the year ended September 2007, the Victoria Police issued 1,148,474 speeding infringement notices for offences detected by mobile speed cameras, fixed digital speed cameras, speed/red-light cameras, and the point-to-point speed camera system on the Hume Freeway (from April 2007 in the latter case). There were also 473,120 on-the-spot infringement notices issued for offences detected by manual Police operations, such as laser speed detectors and moving mode (mobile) radar patrols. The Traffic Camera Office also issued 146,425 infringement notices for red-light running offences detected by red light cameras, and 495,258 notices for toll road offences.

Of the speeding infringement notices, 633,418 were for offences detected by covert mobile speed cameras operating for a total of 71,380 hours during the year or 5,950 hours per month on average. This represents about 8.9 speeding infringement notices per hour of mobile speed camera operation. The other 515,056 speeding infringements detected by non-manual operations during the year were all from fixed camera installations of various types, generally operating for 24 hours per day.

An important feature of the Victorian safety camera system, which bears on the efficiency and cost of processing all of the above photographically-detected infringements, is the existence of "owner-onus" legislation making the owner of the detected vehicle liable for the offence unless he or she makes a statutory declaration nominating the name, address and licence number of the driver at the time. If a driver is so nominated, the infringement notice is then transferred to the driver for fine payment, receipt of demerit points, and perhaps licence loss in some circumstances. Owners who are licensed drivers bear the same penalties. In the case of corporate owners, in cases where a driver is not nominated, the vehicle registration is suspended for three months and a substantial fine administered. The owner-onus legislation makes it unnecessary to identify the driver photographically, allows rearward photographing of vehicles as well as forward, and increases the efficiency of offence processing in Victoria. It is recommended that legislation of this type be pursued in WA to support the efficient processing of camera-detected speeding offences.

MUARC research has suggested that the principal mechanism through which the covert mobile speed camera program in Victoria achieves its effects on road trauma is specific deterrence, i.e. encouraging apprehended speeding offenders to avoid re-offending via the actual experience of detection and punishment (Cameron et al 1995). Some general deterrence (i.e. raising the perceived risk of detection and punishment) is achieved through word-of-mouth communication between offenders and potential offenders, and by mass-media publicity. There is little evidence of a local effect around the sites of covert mobile camera operations and what little there is generally takes place in the weeks after speeding infringement notices are received through the mail specifying the location at which the offence was detected.

3.2.2 Queensland

After rising to just over 6,000 hours per month during 2003, the Queensland mobile speed camera program stabilised around that level throughout 2003-2006. An annual average of 300,250 speeding offences was detected by the program and 249,500 infringement notices per year were issued. From an average of 5,934 hours of camera operation per month, 4.2 offences per hour were detected and 3.5 notices per hour were issued during 2003-2006. Notwithstanding possible differences in traffic volumes at camera sites, this relatively low rate of infringement notices per mobile camera hour in Queensland compared with Victoria is to be expected from the overt, conspicuous Queensland form of operation. It is also substantially lower than that experienced with Multanova mobile speed cameras in WA, from which 17.2 offences per hour were detected and 13.6 notices per hour issued during 2004 when operating at about 3,000 hours per month throughout the state.

The offence detection rate was substantially higher during the early years of the Queensland program, starting at 11.6 detected offences per hour during 1998, then fell rapidly to 6.4 per hour in 2002 as the operational hours were increased each year. Following the 50% increase in monthly hours during 2003, the offence detection rate initially fell again during the next two years, but has since stabilised at the 2003-2006 average level. The prosecutability rate of detected offences has also risen during the life of the program and remained constant at around 83% throughout 2003-2006.

The key mechanism of effect of the Queensland overt mobile speed camera program appears to be general deterrence in a 2 km radius area around camera sites, producing local effects, and a broad general effect achieved by random scheduling in space and time and by comprehensive coverage of crash sites in Queensland by the camera sites. Some specific deterrence of speeding is no doubt achieved by the detection and punishment of speeders, but this appears to be a secondary mechanism.

3.2.3 Sweden

The Swedish speed camera program is based almost entirely on fixed speed cameras placed generally on undivided roads, with a few on divided roads in tunnels. The roads are not the most heavily trafficked, averaging about 6,000 vehicles per day (ranging from 3,000 to 10,000 per day), so presumably the camera installations are warranted by high crash rates and/or known speeding problems. About 870 fixed cameras cover about 120 routes with a total length of around 2,500 kilometres, so on average there are about 7.25 cameras per route with a spacing of about 2.9 kilometres between each pair of cameras. However, the pairs do not operate in point-to-point mode, only assessing spot speeds of passing vehicles. It is understood that an additional 100 fixed cameras will be installed during 2008 (Tingvall, personal communication, January 2008). The camera routes are clearly marked, so the fixed camera program can be considered overt.

When operational, the fixed cameras have an enforcement threshold to detect speeds at least 6 km/h above the applicable speed limit. Just over 1% of vehicles exceed the threshold in 90 km/h speed limit zones, 4% in 70 km/h zones, and 5% in 50 km/h zones, with an overall average of 2-3%. The back-office has the capacity to process about 200,000 offence photographs per year, and this will be increased to 230,000 during 2008. The prosecutability rate is about 50%, in part due to the need to be able to identify the driver in the image, but also due to the vehicle being a motorcycle or having a foreign registration. Because of the constraint on offence processing capacity, any one camera may be operational only 3-4% of the time (Tingvall, personal communication). [A calculation based on the above data suggests that, on average, each camera is operational less than 0.5% of the time.]

Deterrence of speeding on each route is apparently achieved because “the cameras are normally put in a row of 7-15 cameras” and “as the driver does not know which camera is on, he will act as [if] they are all operating" (Tingvall, personal communication). It seems that the overt visibility of apparently frequent surveillance of driver speeds, no matter whether it is real, persuades Swedish drivers that there is a non-zero chance of being caught speeding somewhere on the camera route. There is the question of whether the deterrence effect can be maintained long-term as more and more, perhaps occasionally speeding, drivers become aware that individual cameras are not active some of the time.

Andersson and Larsson (2005) reported that the initial installation of 225 fixed speed cameras on 30 routes totalling about 500 kilometres reduced average speeds by about 8 km/h at camera sites and by nearly 5 km/h between them on the higher-speed routes (average speed before enforcement was 95 km/h). There were statistically significant reductions in personal injury crashes and injured persons. Fatal crashes and fatalities were reduced by 50% and the number of severely injured persons was reduced by 25%; however these reductions could have been due to random variation (not statistically significant). Tingvall (personal communication) confirmed that the speed reductions have been maintained and that the possible short-term deterrence effects have continued long-term. However, there is no evidence that the program has had an effect on roads other than the routes on which the fixed cameras are installed.

The mechanism of effect of the Swedish fixed speed camera program appears to be general deterrence at each camera site and, because the cameras on each route are so dense (and there is the possibility that each one is operational), the local effects amalgamate to provide a general effect throughout the camera route. However, there is no evidence that the route-specific effects extend beyond the camera routes to other roads or more generally. The limited number speeding drivers apprehended and punished makes specific deterrence a likely secondary mechanism only, and probably deters re-offending only on camera routes.

3.2.4 France

Since July 2002, when President Jacques Chirac made road safety a priority for France, the French speed camera program has grown to 1,700 devices in 2007 and there is an aim to have 4,000 by 2012. Two-thirds of the devices are overtly-operated fixed speed cameras and the remainder are mobile cameras operated from an unmarked vehicle without advance warning signage. The roads on which the cameras are operated are generally heavily-trafficked with 24 hour flows apparently averaging about 16,000 vehicles per day, though 56% of the cameras are located on roads with less than 10,000 vehicles per day (Carnis, personal communication).

During 2005, the camera systems checked vehicle speeds on 270 million occasions, an average of six checks per month per driver (Carnis 2007). Each camera recorded about 1000-1500 speeding infringements per month, resulting in a total of about 7.5 million infringements detected during 2006.

Limited information is available about speeding transgression rates on French roads. During 2006, the proportion of passenger cars travelling more than 10 km/h above the speed limit (the enforcement threshold for the speed cameras) was 14% on 110 km/h limit roads, 9% on 90 km/h roads, and 17-23% on 50 km/h roads in villages or towns (Carnis, personal communication). No information is available on detection rates achieved by the cameras, but the information provided in the previous paragraph suggests that it could have been as high as 2.8% of passing vehicles during 2006.

An image of each offending vehicle is transmitted by WiFi to a central office where the owner of the vehicle is identified and an infringement notice sent to that person. The central office has the capacity to handle the outputs from up to 3,000 speed cameras or 15 million speeding infringement notices (Carnis, personal communication). Apparently the prosecutability rate of each offending vehicle is high (over 90%). The French legal requirement that the vehicle owner is immediately liable for the fine and must pay it at the same time as nominating the driver, where applicable, apparently leads to high payment rates. The owner is refunded the fine and the liability transferred to the driver in such cases.

The impact of the French speed camera program on speeds and road trauma has not been thoroughly researched to separate it from other initiatives following President Chirac's statement. Average speeds and the proportion exceeding speed limits by 10 km/h have fallen substantially (but were falling prior to the program commencing in 2003). Road fatalities have fallen from around 7,200 in 2002 to around 4,700 in 2006, a decrease of 35%. The French authorities have estimated that about 75% of this gain has been due to the speed camera program (Carnis 2007).

The mechanism of effect of the French speed camera program appears to be principally based on specific deterrence through a high rate of surveillance of each driver and, at this stage, no constraint on the back-office to prosecute nearly all the offences detected. Some general deterrence of speeding at camera sites is probably also achieved, especially at fixed camera sites. The efficiency of the French system is apparently assisted by a type of owner-onus legislation and the requirement that the owner is immediately liable for the fine.

3.2.5 United Kingdom

While the Cost Recovery Program which led to the rapid expansion of speed cameras in the UK during 2000/01 to 2003/04 has been comprehensively evaluated (Gains et al 2003, 2004, 2005), very little has been published about the processing of offences detected by the cameras. During 2003/04 there were 4,172 cameras funded under the Program, but ICF (2003) had estimated that there were a total of 6,000 cameras. The Cost Recovery Program cameras were predominantly operated in urban areas (speed limit up to 40 mph) with 59% being overt fixed cameras. In rural areas, mobile speed cameras (also operated overtly) represented 59% of the total speed cameras (Gains et al 2005).

No information is available about traffic flows past speed camera sites. In urban areas during 2006, 19% of passenger cars exceeded 30 mph speed limits by 5 mph and 10% exceeded 40 mph limits by the same amount. In rural areas, 17% of passenger cars on motorways and 12% on dual carriageways exceeded the speed limit of 70 mph by 10 mph, but only 2% exceeded the 60 mph limit on single carriageway roads by the same amount (Department for Transport 2007). In contrast, during 2003/04 only 0.3% of vehicles detected at fixed camera sites and 1.8% detected by mobile speed cameras were found to exceed the speed limit by 15 mph (Gains et al 2005). It is understood that the typical speed camera enforcement threshold in Great Britain is 110% of the speed limit plus 5 mph (Heydecker, personal communication), representing 8 mph in excess in 30 mph zones and 12 mph in excess in 70 mph zones.

This relatively high enforcement threshold led to 1.978 million fixed penalty notices being issued for offences detected by the Cost Recovery Program speed cameras during 2003/04. This output from the 4,172 Program cameras operated during the same year can be compared with the 7.5 million speeding infringements detected by the 1,400 speed cameras operating in France during 2006. The difference is apparently due to the relatively low enforcement threshold of 10 km/h in excess of the limit in France. Another explanation may be that the UK speed cameras are required to operate very conspicuously, including the mobile cameras.

The effects of the UK speed camera program have been summarised by Cameron and Delaney (2006). There is little doubt that speeds and road trauma are reduced substantially in the vicinity of fixed cameras and at mobile camera sites (at least when operating). However, there is little or no evidence of general effects which extend beyond the camera sites to broader parts of the UK road system.

The principal mechanism of effect of the UK speed camera program appears to be general deterrence through the very conspicuous operation of both fixed and mobile cameras in large numbers. However, the number of cameras and/or the mode of operation of the mobile units (compare with Queensland) are not sufficient to produce a broad, general effect to extend the strong local effects. Specific deterrence of excessive speeders is probably achieved because even they are detected by the relatively high enforcement threshold, but this mechanism appears to be secondary to the effects of the program.

3.2.6 Conclusions from review of infringement management models

The five jurisdictions reviewed covered speeding infringement detection and processing models ranging from high numbers of offenders detected covertly and prosecuted in Victoria, to low numbers of offenders prosecuted in Sweden because cameras are aimed at general deterrence and only photograph offenders infrequently in order to prevent overloading of the back-office capacity.

The Victorian mobile speed camera program is reliant principally on the prosecution of speeding drivers to achieve (specific) deterrence. The covert operations are generally invisible to all but the most astute drivers, and general deterrence is achieved only through formal and informal publicity (the latter by word-of-mouth from other drivers caught). Thus the Victorian mobile program is heavily dependent on processing all of the offenders detected (within limits of legal integrity) in order to achieve its effects. While this has implications for back-office processing capacity, a very key benefit of the Victorian program is the reduction in the risk of fatal outcome in crashes to a greater extent than other speed enforcement methods. The Queensland overt mobile speed camera program does not appear to have an effect on fatal crashes to any greater extent than non-fatal crashes. The efficiency of processing speeding offences detected by mobile cameras in Victoria, as well as offences detected by fixed cameras, is improved by the existence of "owner-onus" legislation making the vehicle owner initially liable for the offence.

The Queensland program achieves substantial reductions in casualty crashes through overt mobile operations whose effects extend well beyond (in time and space) the localised effects which are to be expected from visible enforcement. The random allocation appears to be responsible for this, as does focusing the camera site zones on crash sites and not other criteria. A capacity to prosecute a substantial number of speeders still passing the overt camera operations appears necessary to give real fear of detection/punishment behind the thinly spread operations aimed at raising the perceived risk above zero. However, the detection rate has fallen substantially over the years of the program operation, perhaps due to greater recognition of camera operations as well as real improvement in transgression rates. The rate of issue of infringement notices during recent years is about one-third of the

10 notices per camera hour assumed in the 2006 study economic analysis, based on the limited information from 2001 then available about the Queensland program.

The Swedish fixed speed camera program is focused on general deterrence of speeding on the camera routes exclusively, and appears to place relatively little emphasis on specific deterrence. The limited numbers of speeders who are prosecuted are likely to be chronic speeders for whom the general deterrent operations have little effect, and/or occasional speeders who are caught by chance through inattention. The density of the cameras on the specified routes, no matter whether each is operational or not, apparently produces a strong general deterrence effect. Prosecution of some offenders appears to be necessary to ensure that the perceived risk of apprehension is in fact real and is communicated via word-of-mouth. However the effect of the program is limited to the camera routes, each with the necessary high density of cameras. There is also the question of whether the general deterrence effect can be maintained long-term when chronic and occasional speeders passing camera sites come to realise that they are seldom prosecuted.

The French speed camera program is focused on specific deterrence of speeding through a high rate of surveillance of each driver and the capacity to prosecute all of the offences detected. Some general deterrence of speeding at camera sites is also achieved, especially at fixed camera sites. The efficiency of the French system is assisted by owner-onus legislation and the requirement that the owner is immediately liable to pay the fine.

The UK speed camera program is focused on general deterrence through the very conspicuous operation of large numbers fixed and mobile cameras. However, the operations do not produce a broad effect which extends the strong local effects. Specific deterrence appears to be a secondary effect of the program and is focused on excessive speeders because of the relatively high enforcement threshold.

3.3 FUNDING OF THE PACKAGE FROM FINE REVENUE

The originally recommended speed enforcement package was estimated to cost $18.6 million per annum to operate (to this should be added the potential increased capital cost of $4 million, amortised on a per annum basis, of providing a back-office infrastructure for the manpower to process the expected speeding tickets needed to be issued, at least in the short term).

Cameron and Delaney (2006) indicated that the fine revenue from the escalated number of speeding tickets, at least initially, would be about $17 million per month or $204 million per annum. Thus the operational costs of the recommended speed enforcement package (estimated $18.6 million per annum short-term) would be of the order of 9-10% of the fine revenue, this percentage probably increasing over time as transgression rates and detected speeding offences fall in response to the escalated enforcement.

Associated with the rapid expansion in speed cameras in the UK since 2000 has been a Cost Recovery mechanism whereby the road safety partnership agencies in each area operating cameras have been able to recover their operational costs from the central government fund receiving the fine revenue. Over the first four years of the Cost Recovery Program, £217.5 million in fines has been received and £175.2 million in costs have been recovered, representing about 80% of the fine revenue (Gains et al 2005). The Cost Recovery Program is tightly controlled by Her Majesty’s Treasury and the camera partnerships only recover their costs after submitting audited accounts. Apparently, this transparent system has not led to any public controversy about the use of (most of) the fine revenue in this way. The surplus fine revenue is transferred to the Government's consolidated fund.

In the 2006 study it was recommended that the Western Australian Government give consideration to funding the operational costs of the speed enforcement package in a similar way. A transparent system whereby it is recognised that the costs of providing an effective system to reduce road trauma and social costs are met from the fines paid by speeding motorists should have broad public acceptance. The surplus revenue could also be the basis of Government investment in other effective road safety programs addressing problems other than speeding.

3.4 RISK MANAGEMENT

It is important during a time when speed enforcement levels are planned to escalate to a higher level than previously that the Police and Government give careful attention to risk management. Delaney, Ward and Cameron (2005) have identified four areas of dilemma which can cause social controversy when major new speed enforcement programs are implemented in a jurisdiction. The two most relevant are legitimacy dilemmas (social concerns about the fairness of the enforcement operations) and implementation dilemmas (acceptance of the enforcement is hampered because difficulties and problems which arose during implementation have not been adequately compensated for in the view of society).

The absence of controversies relating to implementation dilemmas or legitimacy dilemmas during the substantial increase in the Victorian speed camera program during the early 1990's may be related to the attention given by the Victoria Police and the justice department to risk management while the new program was being established. Smith (2000), who had a key role in the justice department at the time, outlines the key issues which were addressed in implementing a program to detect and process a high volume of traffic offences (much higher than previously handled in Victoria). The risk management strategies included:

- independent technical testing and quality assurance (less than ten appeals against the initial five million speeding tickets issued for offences detected by the mobile speed cameras were successful)
- operational procedures that genuinely identified road safety as the primary objective
- winning public support for the program even though the level of fines was substantial
- subjecting the program to independent evaluation research to establish its road safety benefits, or modifications to the program if necessary.

Further details of the risk management principles necessary for successful establishment of a substantial speed camera program are given by Smith, Cameron and Bodinnar (2002).

It is also important to manage public opinion to avoid controversies associated with the credibility dilemma (Delaney et al 2005). This dilemma may arise if there are doubts about the Government's real purpose in escalating speed enforcement, e.g. whether the principal purpose is to raise revenue for the Government through a substantial increase in speeding infringement fine income. The importance of managing public opinion about the credibility of escalated speed enforcement is illustrated by the experience in British Columbia, Canada (Chen 2005). When their mobile speed camera program was introduced in 1996, two-thirds of the population supported the new initiative. The political opposition, reflecting emerging grassroots opinion, portrayed the program as a “cash cow” for the provincial government rather than a safety issue. The program subsequently became an election issue, the opposition party were elected, and the program was terminated in June 2001, notwithstanding that a scientific evaluation published in 2000 had demonstrated the safety benefits of the program (Chen et al 2000).

The experience in a number of jurisdictions indicates that it is important that the strategic principles and aims behind a program of escalated speed enforcement be openly communicated to politicians and the community, making it clear that reduction in road trauma is the objective. There should be transparency in management and operation of the program throughout its life, so that the objective remains clear to all concerned and there is no doubt that no hidden objectives exist.

4 SPEED ENFORCEMENT PACKAGE

The originally recommended speed enforcement package for WA was developed based on the evidence of effects on road trauma at each level of operation, the economic value of each enforcement program, and the overall contribution to reducing road trauma in WA while avoiding overlap of enforcement operations on each part of the road system. The aim was to identify a package which, when fully implemented, would produce at least 25% reduction in fatal crashes, somewhat smaller reductions in less-serious casualty crashes, and have maximum cost-benefits in terms of the return on social cost savings for the investment.

The addition of point-to-point speed camera technology to this recommended package awaits specific decisions on suitable links for its application on WA roads. It may replace other forms of speed enforcement on parts of some road types.

4.1 ORIGINALLY RECOMMENDED ENFORCEMENT PROGRAMS

The originally recommended enforcement programs, together with the level of input (usually operational hours per month) and the expected speeding ticket processing requirements (at least short-term), are shown in Table 5. This table needs to be read in conjunction with Table 6 where the actual crash savings per month are estimated, valued in terms of social costs using the unit crash costs (in 2005 prices), then aggregated across the package components to provide the overall impacts for the full WA road system. The aggregated benefit-cost ratio for the total social cost savings from the package, relative to the total package cost per month, was also calculated in this way.

Table 5 shows that the recommended speed enforcement package, when fully implemented, was estimated to produce 26% reduction in fatal crashes, 12% reduction crashes resulting in hospital admission, and 9% reduction in medically-treated injury crashes. These effects correspond to a reduction of 36 fatal, 210 hospital admission and 357 medically-treated injury crashes and a saving of $186 million in social costs per annum (from the monthly savings in Table 6). The total cost of the enforcement package to produce these savings is estimated to be $18.6 million per annum. The benefit-cost ratio of the package is estimated to be at least 10 and would be higher if the road trauma savings were valued by the “willingness to pay” method to establish unit crash costs.

Table 5: Recommended speed enforcement programs (by level of input), benefit-cost ratios, and expected crash reductions at the individual program level and for the strategic enforcement package overall

Speed Enforcement Program	Speed Enforce-ment Hours per month	Speeding Tickets Issued per month	Program BCR	Program Crash Reduction		
				Medical treatment crashes	Hospital admission crashes	Fatal crashes
URBAN ROADS (Perth)						
Covert mobile speed cameras on urban highways	9,000	90,000	6.1	11.5%	11.5%	65.3%
Laser speed detectors at black spot sites on urban local roads	1,025	3,413	29.78	3.76%	4.46%	4.46%
Overt fixed speed cameras on Perth freeways	Continuous at 24 sites	35,613	7.33	7.76%	15.52%	15.52%
Total for urban roads			**8.01**	**6.0%**	**6.2%**	**24.9%**
RURAL ROADS (Rest of WA)						
Overt mobile speed cameras randomly scheduled on rural highways	3,000	30,000	36.8	28.5%	28.5%	28.5%
Mobile radar units on rural local roads	15,000	11,250	6.3	24.1%	24.1%	24.1%
Total for rural roads			**11.81**	**26.2%**	**26.4%**	**26.8%**
Total package for WA roads		**170,276**	**9.98**	**9.0%**	**12.3%**	**26.0%**
- per year (short-term)		**2,043,315**				

Table 6: Economic benefits and costs of the recommended speed enforcement programs and for the strategic enforcement package overall

Speed Enforcement Program	Crash savings per month			Social Cost Saving per month ($'000)	Program Cost per month ($'000)	Fine Revenue per month ($'000)
	Medical treatment crashes	Hospital admission crashes	Fatal crashes			
URBAN ROADS (Perth)						
Covert mobile speed cameras on urban highways	10.7	3.0	1.11	3974.64	634.1	9000
Laser speed detectors at black spot sites on urban local roads	5.2	2.4	0.11	1551.51	51.9	341.3
Overt fixed speed cameras on Perth freeways	1.2	0.7	0.04	441.27	59.4	3561.3
Total for urban roads	**17.0**	**6.1**	**1.3**	**5967.42**	**745.4**	12903
RURAL ROADS (Rest of WA)						
Overt mobile speed cameras randomly scheduled on rural highways	6.5	6.4	1.13	5673.94	154.5	3000
Mobile radar units on rural local roads	6.2	4.9	0.62	3864.00	653.5	1125
Total for rural roads	**12.7**	**11.4**	**1.7**	**9537.93**	**808.0**	4125
Total package for WA roads	**29.8**	**17.5**	**3.0**	**15505.4**	**1553.3**	17027.6

The use of covert mobile speed cameras on urban highways (arterial roads) in Perth was recommended because of clear evidence of the strong effects of these enforcement operations on fatal crashes, and evidence that an increase in hours committed to this type of speed camera enforcement would further reduce road trauma. A level of 9,000 hours of camera operations per month, representing approximately tripling of the level currently achieved by the existing Multanova cameras in WA, is estimated to produce 65% reduction in fatal crashes on Perth's arterial roads, as well as about 12% reduction in injury crashes. Total social costs of crashes would be reduced by 22%, when crash costs are valued by the "human capital" method (BTE 2000).

4.2 ALTERNATIVE TO COVERT MOBILE SPEED CAMERAS

An alternative to covert mobile cameras on Perth's arterial roads was overt mobile cameras randomly scheduled on the same roads. The evidence of effect of these enforcement operations could not identify a greater effect on fatal crashes, but their effect on casualty crashes overall was substantial and was estimated to be 27% reduction if 9,000 hours of camera operations per month were committed to Perth's arterial roads. A benefit-cost ratio of 7.9 was estimated for randomly-scheduled overt cameras on these roads, compared with

6.1 for covert cameras, when the social cost of crashes was valued by the “human capital” method. The effect on the total speed enforcement package of replacing the covert camera recommendation with randomly-scheduled overt cameras on urban highways in Perth is shown in Table 7. It can be seen that while the total speed enforcement package would apparently be more cost-beneficial (benefit-cost ratio of 10.64 compared with 9.98), the package would not achieve the target 25% reduction in fatal crashes. It was for this reason that the recommended speed enforcement option for Perth’s arterial roads was covert mobile speed cameras. The substantially greater effect of these operations on fatal crashes would also result in this option being more cost-beneficial than the alternative if the social cost of fatal crashes was valued by the “willingness to pay” method (BTCE 1997).

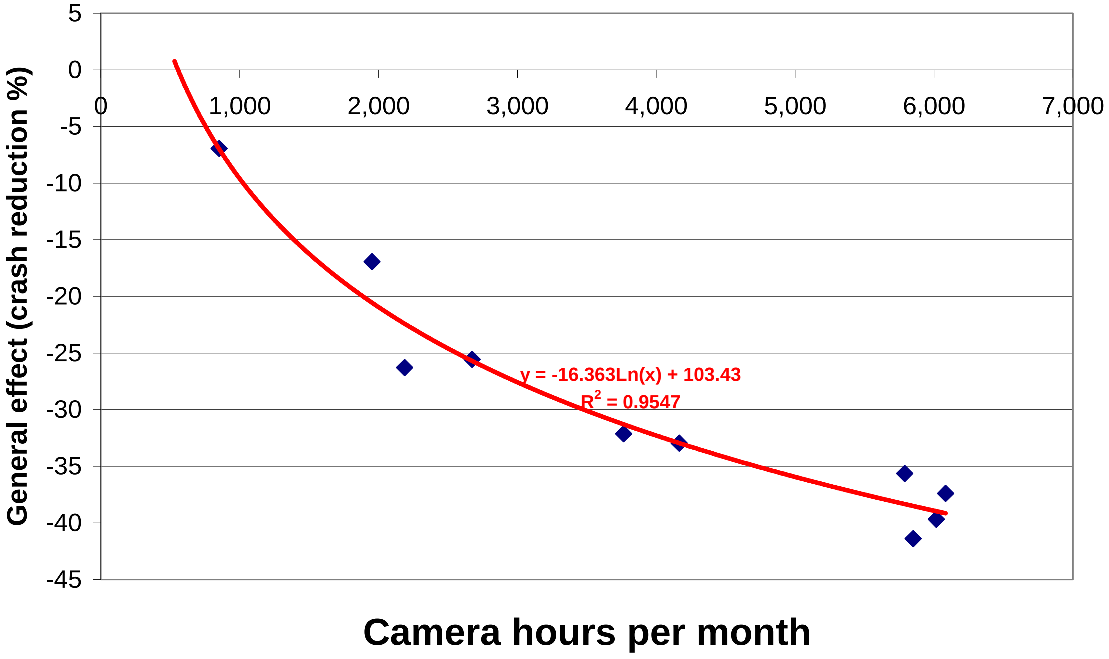
Table 7: Alternative to recommended speed enforcement programs originally considered

Speed Enforcement Program	**Speed Enforce-ment Hours per month**	**Speeding Tickets Issued per month**	**Program BCR**	**Program Crash Reduction**		
				Medical treatment crashes	Hospital admission crashes	Fatal crashes
URBAN ROADS (Perth)						
Overt mobile speed cameras randomly scheduled on urban highways	9,000	90,000	7.9	27.3%	27.3%	27.3%
Laser speed detectors at black spot sites on urban local roads	1,025	3,413	29.78	3.76%	4.46%	4.46%
Overt fixed speed cameras on Perth freeways	Continuous at 24 sites	35,613	7.33	7.76%	15.52%	15.52%
Total for urban roads			**9.39**	**11.2%**	**10.4%**	**12.2%**
RURAL ROADS (Rest of WA)						
Overt mobile speed cameras randomly scheduled on rural highways	3,000	30,000	36.8	28.5%	28.5%	28.5%
Mobile radar units on rural local roads	15,000	11,250	6.3	24.1%	24.1%	24.1%
Total for rural roads			**11.81**	**26.2%**	**26.4%**	**26.8%**
Total package for WA roads		**170,276**	**10.64**	**13.4%**	**15.2%**	**20.4%**
- per year (short-term)		**2,043,315**				

4.3 UPDATE OF QUEENSLAND RELATIONSHIPS

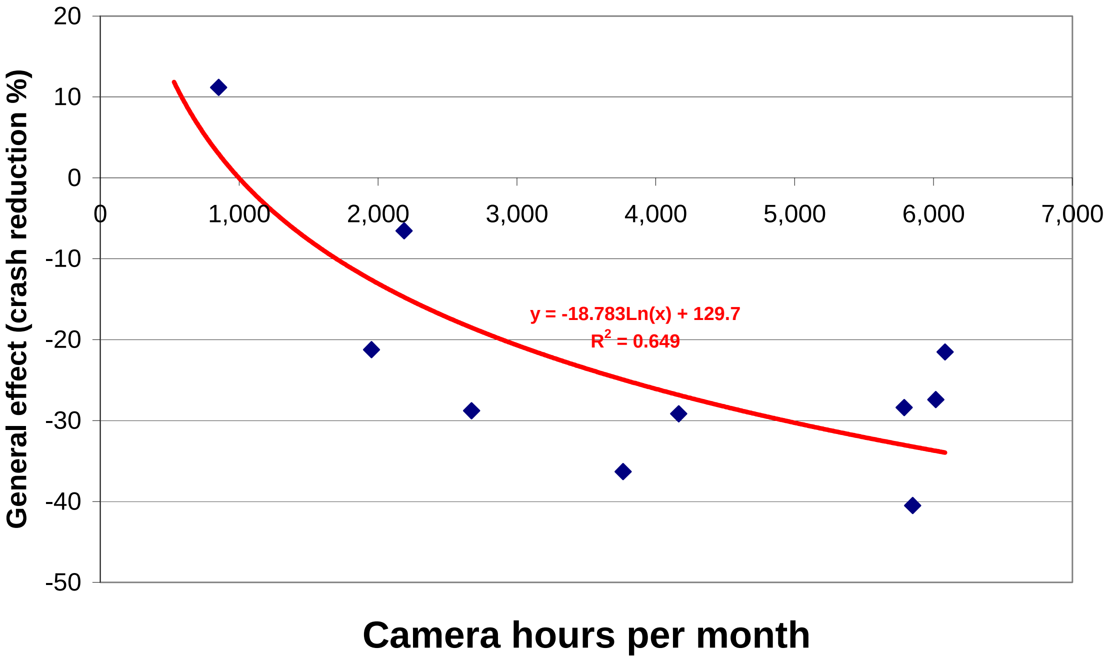
The option of overt mobile speed cameras randomly scheduled on urban and rural highways was analysed based on relationships established from evaluations of the Queensland mobile speed camera program up to 2003. Since those studies, there have been a series of evaluations of the program up to 2006 (Newstead 2004, 2005, 2006). While the Queensland program continued to operate at about 6,000 hours per month throughout 2003-2006, the additional estimates of effect had the potential to improve the reliability of the relationship between camera hours and crash reductions. However, Figure 1 shows that the updated relationship is almost identical to that found in the 2006 study, suggesting only a marginally stronger relationship and hence marginally greater economic benefits.

Figure 1: Relationship between casualty crashes in Queensland and monthly hours of the overt mobile speed camera program with randomised scheduling, 1997-2006 (update of Figure 5 in Cameron and Delaney, 2006, MUARC report 270)



The availability of additional evaluations of the Queensland program also allowed reconsideration of whether the program had greater effect on fatal crashes than non-fatal crashes, a characteristic to be expected for effective anti-speeding countermeasures such as this. Figure 2 shows the estimated reductions in fatal crashes associated with the level of monthly hours operated each year from 1997 to 2006. It should be noted that the individual annual estimated reductions are not as reliable as the reductions in all casualty crashes shown in Figure 1 and that no individual reduction is statistically significant. Nevertheless, the estimates do suggest a relationship between fatal crash reductions and camera hours of the same type as that in Figure 1 for casualty crash reductions. However, there is no evidence that the magnitude of the reduction achieved by the Queensland program on fatal crashes is any greater than that achieved on casualty crashes in general (of which fatal crashes are a part).

Figure 2: Relationship between fatal crashes in Queensland and monthly hours of the overt mobile speed camera program with randomised scheduling, 1997-2006



It was concluded that, notwithstanding the additional information now available, the relationship established in the 2006 study does not need to be updated to reflect a greater effect of randomly-scheduled overt mobile speed cameras on fatal crashes than that previously used in the analysis.

4.4 REVISIONS AND OTHER OPTIONS FOR THE SPEED ENFORCEMENT PACKAGE

Following the review of speed offence processing models in other jurisdictions, it was decided that the number of offences estimated as required to be processed, according to the 2006 study, were over-stated and could be reduced. Specifically:

- Based on Queensland experience where the detection rate of speed offences per hour of overt mobile speed camera operation dropped by nearly two-thirds, it was estimated that the number of speeding tickets issued per month from overt mobile speed cameras operating at the originally recommended hours would be about one-third of that originally estimated in the short term.

- Based on experience in Sweden with the operation of their overt fixed speed cameras intermittently on designated routes, it was proposed that the 24 fixed cameras recommended for Perth freeways could also be operated intermittently without any reduction in effectiveness on road crashes. It was further proposed that the active times of these cameras be scheduled so that they detect offences resulting in about 10,000 speeding tickets issued per month in the short term (compared with 35,600 per month originally estimated from continuous operation of the cameras).

A further alternative to the operation of covert mobile speed cameras on urban highways was also proposed. This was to operate the covert and overt mobile cameras on a 50:50 basis in this road environment. The rationale for this proposal is given in section 4.4.2.

The option to replace the proposed fixed speed cameras on Perth freeways with point-to-point camera systems covering five sections was not considered as an alternative for this road environment because of the absence of evidence from the limited experience to date that such systems operated intermittently would be equally effective. However, if it is decided that the Perth freeway cameras should be operated continuously, then the alternative of point-to-point operation should be revisited because of its superior BCR (see section 2.9, Table 4).

The application of point-to-point speed cameras on the other Perth highway links for which they are suitable and economically warranted (about 15% of the total length of metropolitan highways and arterial roads; Table 4) is an alternative to covert/overt mobile speed cameras on that sub-set of roads. However, further consideration of that option needs to await decisions about the specific highway links to be covered by point-to-point systems, hence the Perth highways not covered, and the traffic densities and offence processing requirements if mobile speed cameras operated on the remaining highways.

In a similar way, the application of point-to-point speed cameras as an alternative to randomly-scheduled overt mobile speed cameras on rural highways needs to await specific decisions about suitable links. While the relative BCR of point-to-point cameras is not favourable, some rural highway links may warrant the closer enforcement of speeding that they can provide with perhaps greater certainty than the overt mobile speed cameras.

4.4.1 Revisions to speed offence ticketing requirements

Table 8 shows the implications for the originally recommended speed enforcement package if the speed offence processing loads are reduced following the Queensland and Swedish experience. The estimated number of speeding tickets required to be issued drops to just under 1.5 million per year in the short term and the estimated benefit-cost ratio of the package rises to above 10. It is expected that this package of enforcement programs and offence processing load would be equally effective as the originally recommended package.

Table 8: Recommended speed enforcement programs – REVISED (shown in bold)

Speed Enforcement Program	Speed Enforce-ment Hours per month	Speeding Tickets Issued per month	Program BCR	Program Crash Reduction		
				Medical treatment crashes	Hospital admission crashes	Fatal crashes
URBAN ROADS (Perth)						
Covert mobile speed cameras on urban highways	9,000	90,000	6.1	11.5%	11.5%	65.3%
Laser speed detectors at black spot sites on urban local roads	1,025	3,413	29.78	3.76%	4.46%	4.46%
Overt fixed speed cameras on Perth freeways (Swedish-style)	**Intermittent** at 24 sites	**10,000**	**9.33**	7.76%	15.52%	15.52%
Total for urban roads			**8.14**	**6.0%**	**6.2%**	**24.9%**
RURAL ROADS (Rest of WA)						
Overt mobile speed cameras randomly scheduled on rural highways	3,000	**10,000**	**37.4**	28.5%	28.5%	28.5%
Mobile radar units on rural local roads	15,000	11,250	6.3	24.1%	24.1%	24.1%
Total for rural roads			**11.84**	**26.2%**	**26.4%**	**26.8%**
Total package for WA roads		**124,663**	**10.08**	**9.0%**	**12.3%**	**26.0%**
- per year (short-term)		**1,495,960**				

The 2006 study considered an alternative to the operation of covert mobile speed on Perth's arterial roads, namely the operation of overt mobile speed cameras randomly scheduled on these roads (see section 4.2 above). This alternative would substantially reduce the speeding offence ticketing load, based on experience with overt mobile speed cameras in Queensland. Table 9 shows that the estimated number of speeding tickets would be about 756,000 per year in the short term and the benefit-cost ratio would increase marginally compared with the same enforcement package analysed in Table 7. It is expected that this alternative package would be no less effective as analysed previously.

Table 9: Alternative to recommended speed enforcement programs – REVISED

Speed Enforcement Program	Speed Enforce-ment Hours per month	Speeding Tickets Issued per month	Program BCR	Program Crash Reduction		
				Medical treatment crashes	Hospital admission crashes	Fatal crashes
URBAN ROADS (Perth)						
Overt mobile speed cameras randomly scheduled on urban highways	9,000	**30,000**	**8.0**	27.3%	27.3%	27.3%
Laser speed detectors at black spot sites on urban local roads	1,025	3,413	29.78	3.76%	4.46%	4.46%
Overt fixed speed cameras on Perth freeways (Swedish style)	**Intermittent** at 24 sites	**10,000**	**9.33**	7.76%	15.52%	15.52%
Total for urban roads			**9.65**	**11.2%**	**10.4%**	**12.2%**
RURAL ROADS (Rest of WA)						
Overt mobile speed cameras randomly scheduled on rural highways	3,000	**10,000**	**37.4**	28.5%	28.5%	28.5%
Mobile radar units on rural local roads	15,000	11,250	6.3	24.1%	24.1%	24.1%
Total for rural roads			**11.84**	**26.2%**	**26.4%**	**26.8%**
Total package for WA roads		**64,663**	**10.81**	**13.4%**	**15.2%**	**20.4%**
- per year (short-term)		**755,960**				

4.4.2 Covert and overt mobile speed cameras on urban highways

A new option for speed enforcement on urban highways (arterial roads) in Perth considered in this extension project was the operation of covert and overt mobile speed cameras on a 50:50 basis. This balance of the two forms of operation was chosen for illustrative purposes only. Such operations are unprecedented and hence the likely effect of the combined operations on crashes and their injury outcomes is unknown. However, research on experience in Victoria regarding moving mode radar operations using marked and unmarked cars, separate operations and combined, suggests that the combined operations had greater effect on crashes than either of the separate operations.

In the case of the urban operation of covert mobile speed cameras, combined with randomly scheduled overt mobile speed cameras, it could be expected that the net effect would benefit from:

(a) the strong effect of the covert mobile cameras on fatal crashes, estimated to result in about 65% reduction in these crashes when the cameras are operated at 9000 hours per month, and

(b) the substantial effect of the randomly scheduled overt mobile cameras on casualty crashes in general, estimated to result in about 27% reduction in non-fatal crashes at each level of severity when the cameras are operated at 9000 hours per month.

To be conservative, the analysis of the combined operations on urban highways in Perth assumed that the effect of this speed enforcement program, at each level of crash injury severity, would be the average of the estimated effects of each individual program operated at 9000 hours per month. This assumes that the intensity of the combined operations at 9000 hours per month would go some way to achieving the separate benefits of each form of operation, but that there would not be full synergy which would produce the maximum effects of each operation.

The estimated effects of the combined program on crashes at each level of severity are shown in Table 10, together with the other revised programs given in Tables 8 and 9. It was assumed that 15,000 speeding tickets would emanate from the 4,500 hours of overt mobile camera operations per month, whereas 45,000 tickets would emanate from 4,500 hours of covert mobile cameras operations per month, making a total of 60,000 tickets per month. These ticketing rates per camera hour of each type are the same as used in Table 8.

Table 10: Second alternative to recommended speed enforcement programs

Speed Enforcement Program	Speed Enforcement Hours per month	Speeding Tickets Issued per month	Program BCR	Program Crash Reduction		
				Medical treatment crashes	Hospital admission crashes	Fatal crashes
URBAN ROADS (Perth)						
Covert & overt mobile speed cameras randomly scheduled on urban highways (50:50)	9,000	**60,000**	**7.1**	**19.4%**	**19.4%**	**46.3%**
Laser speed detectors at black spot sites on urban local roads	1,025	3,413	29.78	3.76%	4.46%	4.46%
Overt fixed speed cameras on Perth freeways (Swedish style)	**Intermittent** at 24 sites	**10,000**	**9.33**	7.76%	15.52%	15.52%
Total for urban roads			**8.89**	**8.6%**	**8.3%**	**18.5%**
RURAL ROADS (Rest of WA)						
Overt mobile speed cameras randomly scheduled on rural highways	3,000	**10,000**	**37.4**	28.5%	28.5%	28.5%
Mobile radar units on rural local roads	15,000	11,250	6.3	24.1%	24.1%	24.1%
Total for rural roads			**11.84**	**26.2%**	**26.4%**	**26.8%**
Total package for WA roads		**94,663**	**10.44**	**11.2%**	**13.8%**	**23.2%**
- per year (short-term)		**1,135,960**				

Another way of considering the expected crash reduction effects of the combined covert and overt mobile speed cameras on Perth's arterial roads is to examine the expected effects if the current 3,000 hours of speed camera activity per month is split, each half committed to covert or overt operation (1,500 hours each), and then each increased by 3,000 hours per month, making a total of 9,000 hours. The increase of 3,000 hours of covert mobile speed camera activity, based on Cameron and Delaney's (2006) Table 4, is estimated to result in 48.7% reduction in fatal crashes and 7.4% reduction in non-fatal casualty crashes, additional to the effects of current camera operations. The increase of 3,000 hours of randomly scheduled overt mobile camera activity, based on their Table 8, is estimated to produce 17.2% reduction in casualty crashes across all levels of severity, again additional. Both types of estimate are general effects and, in the overt camera case, rely on the camera sites covering a substantial proportion of crash sites within two kilometres. However, although these estimates are of the same magnitudes as those estimated previously (see Table 10), they assume that there is no synergy between the two types of operation. Both sets of estimated effects of the combined operations could be conservative.

The second alternative speed enforcement package, shown in Table 10, would require an estimated 1.136 million speeding tickets to be issued per year in the short-term. The benefit-cost ratio would be greater than the originally recommended package, including in revised form (Table 8). It is estimated that this package would produce 23% reduction in fatal crashes (compared with 26% originally predicted), 14% reduction in hospital admission crashes, and 11% reduction in medically treated injury crashes. The social costs of crashes, when crashes are valued by the "human capital" method (BTE 2000), would be reduced by 16%.

4.4.3 Operations of covert and overt mobile speed cameras

In the 2006 study, the current operation of Multanova speed cameras in WA was reviewed and contrasted with the operations of the covert and overt mobile cameras in Victoria and Queensland, respectively (Cameron and Delaney 2006). The Multanova operations were found to have a number of characteristics, as follows:

- Tripod-mounted system operated at the roadside with no attempt to hide the system, a method which is understood to be overt, at least during daylight
- Signage advising drivers that they have passed a camera in operation
- Public announcement of the date and route of camera operations (specifying only the suburb and road name, many of which are arterial roads traversing the suburb over many kilometres) through television and press news segments
- Sites selected on the basis of the following criteria:
    - locations subject to crashes, based on reported crash records
    - locations of "speed-related complaint" from the public
    - locations frequented by vulnerable pedestrians
    - locations where speeds need to be reduced by at least 5 km/h
    - locations where other speed detection methods cannot be used safely.

The operations of covert mobile speed cameras in WA were proposed with the following characteristics, following the Victorian approach:

- Car-mounted system in unmarked car using a variety of popular makes/models
- "Flashless" operations when ambient light permits (or digital technology allows)
- No advance warning or departure signs
- No public announcements of camera locations or camera presence
- Sites identified by "black spot" criteria, similar to current site selection in WA. It is understood that there are about 6000 current sites in WA, with about 1500 in regular use. A broad coverage of the focus road system is important, but a focus on black spot sites is less critical in the case of covert speed camera operations.

In Queensland, the sites for mobile speed camera operation are chosen on the basis of a high number of crash locations in the near vicinity (within a few kilometres). They are not necessarily speed-related "black spots" as, for example, currently defined in WA.

The operations of overt mobile speed cameras in WA were proposed with the following characteristics:

- Conspicuous camera system, either mounted in a designated van or car, or tripod operations used more overtly than in WA at present
- Signage within 10 metres of an operating site advising of camera presence
- No public announcements of camera locations or camera presence
- Numerous sites chosen such that at least 80% of casualty crash locations during the previous three years are covered by areas within 2 km of camera sites (a new set of speed camera sites may need to be defined for Perth based principally on this criterion)
- Random allocation of camera shifts to sites and time blocks (four hours each, excluding late night/early morning), with very limited opportunities for actual operations to depart from the random assignment.

The combined operations (covert and mobile speed cameras operating on the same urban arterial road system) should be focused on sites chosen primarily on their proximity to crash locations within the last three years, supplemented by a sites aiming to give a broad coverage of the arterial road system in Perth. This site selection aims to maximise the general deterrent effect of the overt operations on speeding and crashes for up to two kilometres around camera sites, thus achieve a broad general effect, and to specifically deter speeding behaviour at these sites and elsewhere in Perth by detecting and prosecuting a substantial number of speeders using covert operations.

In addition, there should be no public announcements of camera operations, no matter whether overt or covert, in order to maximise the deterrent effects (as outlined above) anywhere on the Perth arterial road system at any time. The overt operations can be made as conspicuous as possible, using designated vehicles and signage, but the covert operations should be as inconspicuous as possible by, for example, mounting the cameras in unmarked standard cars which are not obvious to drivers travelling in either direction.

4.5 FINES ENFORCEMENT AND FINE REVENUE

The revised and alternative speed enforcement packages considered in this chapter have different implications for the number of speed offences detected and speeding tickets issued, and hence for the costs of processing the offences, fines enforcement, and the fine revenue collected. In general, each of the packages requires essentially the same number of operational police hours and supporting equipment (mobile or fixed location) to detect offences, so that cost is effectively the same with all options considered.

Table 11 shows the estimated fine revenue to be expected from the speeding tickets estimated to result from each speed enforcement package in the short term. The average fine associated with each ticket was taken to be $100, based on information supplied by the WA Police regarding the situation in 2004. It is understood that the average fine per speeding ticket is now greater. The program costs do not include the cost of any additional capital investment in infrastructure to increase the capacity of the back-office to process offences. It is not known to what extent this would be necessary given that the increased offence processing load could possibly be handled by Police over-time in the short term.

Table 11: Costs of original, revised and alternative speed enforcement packages compared with annual speeding tickets and fine revenue in the short term

Speed enforcement package	Program Cost per month ($'000)	Program Cost per year ($m)	Speeding Tickets issued per year (short-term)	Fine revenue ($m) at $100 per ticket (short-term)	Fines Enforcement Registry additional cost ($m)
1. Originally recommended package (covert mobile speed cameras in Perth)	1,553.3	18.64	2,043,315	204.3	1.530
2. Originally recommended package (covert mobile speed cameras in Perth) – REVISED (reduced offence processing)	1,538.5	18.46	1,495,960	149.6	0.831
3. Alternative to recommended package (overt mobile speed cameras in Perth) – REVISED (reduced offence processing)	1,530.3	18.36	755,960	75.6	0.075
4. Second alternative to recommended package (covert and overt mobile speed cameras in Perth)	1,534.4	18.41	1,135,960	113.6	0.514

Also shown in Table 11 is an estimate of the additional costs which would be incurred by the Fines Enforcement Registry to process the expected increase in unpaid speeding infringement notices referred to the Registry by the WA Police for follow-up. Currently about 15% of traffic infringement notices are referred and it was assumed that this proportion of the additional speeding tickets would require follow-up in each speed enforcement package, at least in the short-term. The additional short-term cost to the Fines Enforcement Registry was estimated from information on the staffing requirements and costs of additional infringements, provided by the Registry (Table 12). The program costs in Table 11 are those estimated to be incurred by the WA Police to conduct the speed enforcement operations and process the speeding infringement notices, but not the costs of pursuing unpaid notices.

Table 12: Impact of additional speeding infringement notices referred to the Fines Enforcement Registry on staffing requirements and cost per infringement processed

Additional referrals to Fines Enforcement Registry (per year)	Additional Full Time Equivalent (FTE) staff required	Fixed Cost Component of additional staff $	Marginal Cost per additional lodgement $
8,250 - 16,500	0.5	27,536	2.92
16,500 - 24,750	1	53,071	2.92
24,750 - 33,000	1.5	80,607	2.92
33,000 - 41, 250	2	106,143	2.92
41,250 - 49,500	2.5	133,679	2.92
49,500 - 57,750	3	181,714	2.92
57,750 - 66,000	3.5	213,000	2.92
66,000 - 74,250	5*	309,059	2.92
74,250 - 82,500	5.5*	340,345	2.92
82,500 - 90,750	6*	369,631	2.92
90,750 - 99,000	6.5*	400,917	2.92

* Includes an additional Level 3 Supervisor for each additional 4 FTE staff added to the registry.

The short-term fine revenue ranges from 4 to 8 times the estimated annual operating cost of any of the newly-considered packages. It is expected that speeding transgression rates would be halved in the medium term, as would detection rates (unless enforcement thresholds are reduced), and would reduce even further in the longer term. The costs of operating the package would reduce very little under these scenarios because the offence processing costs are a relatively minor component of the program costs, as can be seen by implication in Table 11. (An estimate of $135.11 per 1000 speeding infringement notices issued for offences detected photographically was derived from information provided by WA Police and used in this and the original analysis.) Thus, in the medium term, the expected fine revenue would be 2 to 4 times the cost of any of the newly-considered packages and the transgression rate would need to fall by three-quarters before the fine revenue would not meet the costs of the first alternative package (package 3 in Table 11).

5 REDUCED ENFORCEMENT THRESHOLD: DE FACTO LIMIT REDUCTIONS

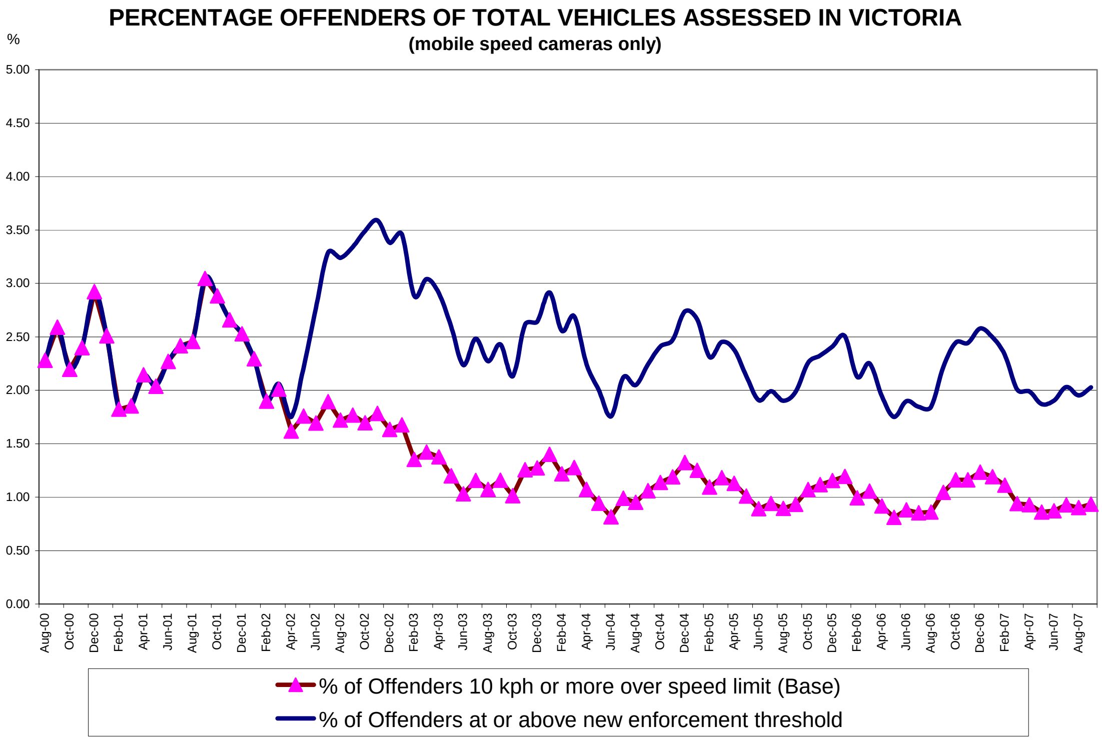
In their recent recommendations for a new road safety strategy for Western Australia, MUARC proposed that speed limits in WA be reduced by 10 km/h in various stages. An additional way of achieving speed reductions, which complements the speed enforcement package, would be through reduction in the speed enforcement threshold. This in turn reduces the *de facto* speed limit, i.e. the speed limit to which motorists drive above the posted speed limit in the belief that they are safe from detection and prosecution even though they are driving illegally.

During 2002, Victoria reduced its speed enforcement threshold in three steps, from the previously well-known threshold of 10 km/h in excess of the posted limit, to an unpublicised level. The threshold reductions were part of a package of speed enforcement intitiatives (50% increase in mobile speed camera hours; "flashless" operation of mobile cameras; and other changes to make them more covert), high-profile speed-related advertising, and a speeding penalty restructure.

An analysis attempted to link each of the elements of the speed-related package with monthly variations in casualty crashes and the injury severity of their outcome (Bobevski et al 2007). The analysis suggested that the second step of the threshold reduction was associated with casualty crash decreases, but it was concluded that the threshold reductions were probably not adequately tested because of uncertainty about the timing of their effects on speeds and crashes. A subsequent analysis evaluated the overall effect of the speed-related package and found that it was associated with 10% reduction in casualty crashes and about 19% reduction in the risk of fatal outcome during the period to December 2004 (D'Elia et al 2007).

A better indication of the longer-term effects of the threshold reduction is indicated in Figure 3 which shows the offence detection rate for offenders at or above the old threshold of 10 km/h, as well as those at or above the new threshold. The percentage of offenders approximately doubled in the first six months, then both the percentage exceeding the old threshold fell as well as the percentage between the new and the old thresholds.

Figure 3: Speed offence detection rates relative to old and new thresholds



After an initial two year period, the offence rates have stabilised but have seasonal variation which was not previously apparent. The percentage at or above the old threshold of 10 km/h has fallen from 2-2.5% to around 1%. This appears to indicate a real improvement in speeding, if the covert operation of the mobile speed cameras can be considered to measure typical on-road behaviour. The percentage of drivers detected at or above the new threshold has stabilised around 2-2.5%, about the same percentage of offenders detected when the old threshold was applicable.

Thus it appears that the threshold reduction has led to a real reduction in speeding, 10 km/h or more above the speed limit, and as noted earlier there was a substantial reduction in road trauma in the period up to December 2004 (D'Elia et al 2007). Unfortunately, there has been no research to indicate whether this reduction in road trauma associated with changes in speed enforcement in Victoria has continued, though it is likely to be the case.

Apart from a short term increase in the detection rate and the number of offenders needing to be processed, after two years the number of offenders to be processed was about the same number per year as that with the old threshold. Thus the threshold reduction in Victoria did not lead to an increased infringement processing load in the medium to long term. The Victorian infringement processing system was originally designed with the capacity to process up to 100,000 speeding offenders detected by mobile cameras per month. That level was exceeded in November 2002.

6 CONCLUSIONS

1. Point-to-point speed cameras are likely to be effective speed enforcement systems covering substantial lengths of freeways and highways in WA with limited access/egress opportunities. Economic analysis has identified 40 road links where the application of point-to-point systems would have benefit-cost ratios of 10 or greater.

2. The Victorian covert mobile speed camera program is reliant principally on the prosecution of speeding drivers to achieve specific deterrence. Thus it is heavily dependent on processing all of the offenders detected (within limits of legal integrity) in order to achieve its effects. The efficiency of processing speeding offences detected by mobile cameras in Victoria, as well as offences detected by fixed cameras, is improved by the existence of “owner-onus” legislation making the vehicle owner initially liable for the offence.

3. The Queensland overt mobile speed camera program achieves substantial general deterrence around camera sites, producing local effects which amalgamate to produce a broad general effect due to the random scheduling in space and time and the comprehensive coverage of crash sites by camera sites. Prosecuting a substantial number of speeders detected by the cameras appears necessary to give real fear of detection/punishment behind the thinly spread enforcement operations.

4. The Swedish overt fixed speed camera program focuses on general deterrence of speeding on the camera routes exclusively, and places relatively little emphasis on specific deterrence. The density of cameras on the specific routes, no matter whether each is operational or not, produces a strong general deterrence effect. The high perceived risk of detection is supported by the prosecution of only a relatively small number of offenders. The effect of the program is limited to the camera routes and there is the question of whether general deterrence can be maintained long-term.

5. The French speed camera program is focused on specific deterrence of speeding through a high rate of surveillance of each driver and the capacity to prosecute all of the offences detected. Some general deterrence of speeding at camera sites is also achieved, especially at fixed camera sites. The efficiency of the French system is assisted by owner-onus legislation and the requirement that the owner is immediately liable to pay the fine.

6. The UK speed camera program is focused on general deterrence through the very conspicuous operation of large numbers fixed and mobile cameras. However, the operations do not produce a broad effect which extends the strong local effects. Specific deterrence appears to be a secondary effect of the program and is focused on excessive speeders because of the relatively high enforcement threshold.

7. A reduction in the speed enforcement threshold will produce a short-term increase in the offence detection rate, but in the medium to long term the offence rate will return to its previous level. In addition, the proportion of drivers exceeding the old enforcement threshold will reduce substantially because of more effective deterrence of speeding above that level.

8. Based on the review of speed offence processing models in other jurisdictions, it was concluded that the number of offences estimated to be processed, in the originally recommended package, was over-stated and could be reduced. The reduction in the

offence processing load reduces the cost of the package and increases the benefit-cost ratio, as shown in Table 12. The benefit-cost ratio of the alternative to the originally recommended package is also increased. A second alternative package, involving the use of both covert and overt mobile speed cameras on urban highways in Perth, may combine the best features of these two forms of operation and produce crash reductions and a benefit-cost ratio between those of the originally recommended package and the alternative (see Table 12).

Table 12: Estimated effects of the original, revised and alternative speed enforcement packages on crashes, and estimated benefit-cost ratio of each package

Speed enforcement package	Reduction in fatal crashes	Reduction in hospital admission crashes	Reduction in medical treatment crashes	Package Benefit-Cost Ratio
Originally recommended package (covert mobile speed cameras in Perth)	26.0%	12.3%	9.0%	9.98
Originally recommended package (covert mobile speed cameras in Perth) – REVISED (reduced offence processing)	26.0%	12.3%	9.0%	10.08
Alternative to recommended package (overt mobile speed cameras in Perth) – REVISED (reduced offence processing)	20.4%	15.2%	13.4%	10.81
Second alternative to recommended package (covert and overt mobile speed cameras in Perth)	23.2%	13.8%	11.2%	10.44

9. Pending decisions on the application of point-to-point speed cameras, the originally recommended speed enforcement package remains the most effective set of options for WA. It is nearly the most cost-beneficial set of options and would be certainly so if fatal crash reductions were valued more highly, because of the strong effect of covert mobile speed cameras on fatal outcomes in crashes. Randomly-scheduled overt mobile speed cameras have no greater effect on reducing fatal crashes than on non-fatal crashes.

10. Point-to-point speed camera systems have the potential to replace the originally recommended speed enforcement program on Perth freeways, and the recommended programs on parts of the urban and rural highway system. Links of freeway and highway have been identified where point-to-point systems are economically warranted, as summarised in Table 13. Decisions about the specific links suitable for application of the point-to-point technology must await consideration of all of the characteristics of the nominated roads.

Table 13: Freeways and highway links warranted for Point-to-Point speed cameras

Region	Roads warranted for Point-to-Point camera systems	Total Length of Links (km)	Reduction in fatal and hospital admission crashes	Reduction in medical treatment crashes	Point-to-Point system capital cost ($)	Speeding Tickets issued per year (short term)	BCR
Perth metro-politan	Freeways	74	33.3%	12.6%	4,900,000	496,758	10.35
	Other links in top 40	248	33.3%	12.6%	4,450,000	218,210	16.54
Non-metro-politan	Links in top 40	2,990	33.3%	12.6%	11,800,000	133,591	15.76

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