Lower Urban Speed Limits – what are the pieces of the jigsaw telling us at this point in time?

Jeremy Woolley, Chris Dyson and Michael A P Taylor
Transport Systems Centre
University of South Australia
GPO Box 2471
Adelaide SA 5001

email jeremy.woolley@unisa.edu.au

Abstract

At present, Lower Urban Speed Limits (LUSL) have been applied to residential streets in many jurisdictions in Australia including parts of Adelaide, South Australia; South East Queensland; areas of New South Wales; and soon Victoria and Western Australia.

Given the current high amount of community support that the anticipation and implementation of such schemes enjoy, what is the emerging evidence to indicate if they are effective in terms of various measures ? The purpose of LUSL is to reduce speeds, thereby enhancing road safety and improving the amenity value of local streets for residents. What is the magnitude of any benefits the implementations are achieving - do we yet have enough of the pieces of the jigsaw to see what the picture is ? What do we mean if we say that the 40km/h limit is working? Do we mean something materially different if we say that the 50 km/h limit is working ?

Although commonly justified on the grounds of road safety, which is readily measurable for a large scheme, the application of LUSL reaches well beyond the call for improved road safety statistics, and an assembly of less well defined factors is involved. Indeed, the support for such schemes could be seen as a cry from the community for some concept of improved amenity for which traffic speed is just an inverse proxy. This consideration is reflected in other approaches in Europe (for example, the MASTER project and Intelligent Speed Adaptation Trials in Sweden) where a framework for speed limits is evaluated in a more holistic light.

This paper seeks to present evidence quantifying the impacts of LUSL in terms of measured speeds and volumes, community attitudes, environmental impacts, travel times and road safety outcomes based on published and emerging evidence. Much of the evidence is based on research into the city wide Unley 40km/h scheme in Adelaide and computer simulation modeling of the mobility and environmental effects of LUSL.

Introduction

Areas with Lower Urban Speed Limits (LUSL) have been proliferating throughout Australia since the late 1990s. Given the range of legislative paths by which speed limits can be applied, some clarification is appropriate at this point. In the context of this paper, the General Urban Speed Limit (GUSL) is imposed by statute and is the limit applicable to all urban areas. It is currently set at 60km/h through Australia. Speed zones are portions of road or areas in which a speed limit other than the GUSL is deemed applicable for special reasons, generally based on engineering assessments or combinations of traffic or land use characteristics. The Local Area Speed Limit (LASL) is taken to represent areas in which a speed limit of less than 60km/h (ie 50km/h or 40km/h) has been implemented and is essentially an extension of the speed zoning principle. Clarification on issues surrounding speed limits in Australia can be found in AUSTROADS (1). LUSL are applied in two distinct ways:

1. Setting the GUSL of a region to a speed less than 60km/h (50km/h is, currently, widely regarded as a suitable compromise between mobility, amenity and threats to safety). Responsibility lies with the appropriate road authorities to signpost roads which are different from this limit, namely major arterials and collectors.
2. An area within a 60km/h general urban speed limit is given a LASL and all affected roads signposted by the local government authority appropriately.

The first approach is proposed for use in Victoria. Other states have applied the second approach with slight variations. At present, 50km/h speed limits have been implemented in New South Wales and South Eastern Queensland (in both cases covering the bulk of populated areas). Victoria and Western Australia are to adopt the 50km/h limt on a widespread basis.

In South Australia, the second approach has been used due to a number of reasons, the most significant being:
1. A strong desire for the 40km/h LUSL in some councils
2. Indecision on where Australia was heading with the 50km/h GUSL

Implementation of 40km/h LASL speed limits was therefore left with councils at their own expense and subject to Transport SA guidelines (Larsson (2)) and approval by the responsible Minister. Many councils in Adelaide are currently pushing for a 40km/h LUSL and through either unanimity or the wait and see approach the push for 50km/h areas has been minimal. The Royal Automobile Association (RAA) of South Australia has been lobbying for a 50km/h GUSL for many years now and it remains to be seen how other councils react, given the lead of the Eastern States with the 50km/h limit and the Adelaide experience with the 40km/h limit.

A Case Study - Unley City Council, Adelaide, SA

The City of Unley (henceforth referred to as Unley) lies between 2 and 5 km directly south of the Adelaide Central Business District. It traverses the whole southern quadrant and so lies in the path of access to the CBD for residents of medium range southern suburbs. The north-south arterials and collectors through Unley are somewhat constricted and barely cope with traffic demands in rush hours. Residents purport to be convinced that a lot of rush hour traffic diverts to residential streets, hence the desire to render residential areas less permeable. Further, the older parts of Unley contain narrow ‘pre-traffic’ streets on which a 60 km/h limit is totally inappropriate. Local Area Traffic Management (LATM) measures of all flavours have been used in Unley since the mid 1970s.

Unley was a pioneer with LUSL in Adelaide and implemented a trial 40km/h zone on a north-south axis in 1991 (LASL (3) and City of Unley (4)). This zone was less than 1 km wide, bounded on the east by an arterial and on the west by an overworked collector. It was relatively easily avoided by most CBD oriented traffic. The trial indicated that a 40km/h LASL was feasible and it was made permanent following traffic monitoring and surveys of resident opinion.

In 1998 Unley took the initiative, with the backing of strong community support and Transport SA approval, to extend the 40km/h LUSL city wide. The limit applies to all local streets in the municipality but not to arterial roads or designated collector roads. It was implemented on 1 January 1999 after an extensive marketing campaign in combination with a three month amnesty period.

As part of this implementation, there was a desire to undertake monitoring and evaluation of the effectiveness of the new speed limit. The Transport Systems Centre (TSC) at the University of South Australia was invited to conduct this assessment and evaluation, in part using data already collected and to be collected by the Council.

The involvement of the TSC has provided Unley with an independent and expert evaluation of its program which invites scrutiny by interested parties outside the Unley Council area. For a full report, see Evaluation of the Unley city wide 40 km/h limit (Dyson et al. (5)).

The objectives of the study were to:

- analyse and interpret speed and traffic volume data, in the Unley city wide 40 km/h LASL and on 60 km/h limit collector roads, generated both before and after the extension of the 40 km/h LASL; assess the effectiveness of the 40 km/h speed limit on the basis of the data collected through the monitoring program;
- monitor and assess community reaction to the program.

The evaluation was conducted over a year involving two stages. The first stage monitored the short-term performance of the scheme between 6 and 12 months after implementation. Traffic data collected by Unley were collated with historical data from 1998. The sample of 112 mid block sites comprised 73 on streets whose limits were reduced in 1999; 13 on streets whose limits had been reduced in 1992; and 26 on collectors with unchanged limits. In the set of streets with changed limits, quieter ones were under represented so that overall mean changes in speed and volume parameters are not properly representative. The second stage extended the monitoring period to 21 months and incorporated enforcement outcomes, from the viewpoints of both SA Police and residents, and interim crash statistics.

Measures of the success of the scheme hinged on reduced traffic speeds and volumes, ongoing community support, perceptions of improved amenity and, if feasible, demonstrated reductions in crash incidence.

Notion of Amenity

Amenity is difficult to define, with many factors contributing to it. Relevant factors and their relative importance clearly vary among individuals, as revealed in free responses in the questionnaire surveys. The notion of reducing the incidence of intrusive or threatening vehicle speeds, as a partial proxy measure of improved amenity, is seen by the community as reducing the “ills” of living in a certain area. Reduced pollution is not, however, necessarily achieved by lowering speeds. The evaluation of amenity is often best achieved through carefully designed questionnaire surveys and focus group sessions, although Klungboonkrong and Taylor (6) described analytical procedures that can be applied to studies of amenity.

Reduction in measured speeds

The change in the 85th speed percentile on each street after the reduced limit was introduced was related to its value before the reduced limit, as shown in Figure 1a. The corresponding change in the mean speed is shown in Figure 1b. Two streets produced aberrant values which are not shown.

Figure 1a

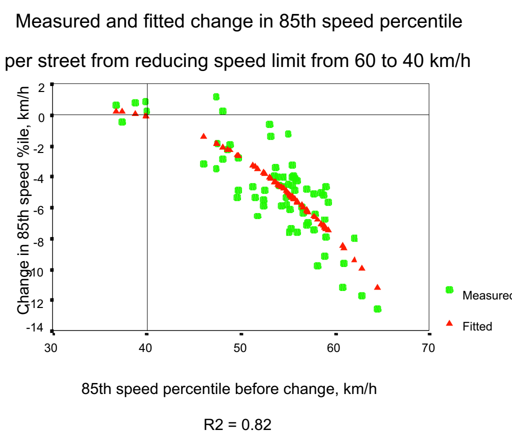
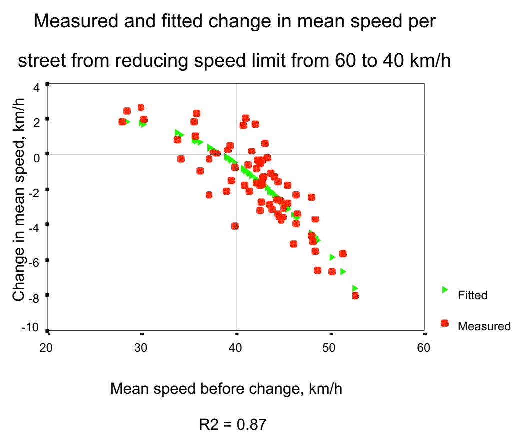


Figure 1b



Streets with the highest major speed parameters before the reduction in the speed limit have shown reductions in these parameters of much greater magnitude than those with moderate speeds. The streets with the lowest speeds have shown an increase in their mean speed. The authors attribute this to some drivers choosing a speed to match more closely the prominent signage. The net effect has been to reduce the variation across streets in their major speed parameters.

Changes in measured volumes
Streets with a 40 km/h limit have been characterised by their Average Daily Traffic (ADT): minor < 800 veh/day; major > 2000 veh/day. Reductions in volumes are summarised in Table 1.

Table 1 Reduction in traffic volume through reducing speed limit on residential streets to 40 km/h

Street characteristic	No. of sites	Mean volume reduction	Comments
Minor residential	46	3%	Very wide ranging change
Medium residential	24	7%	Consistent effect
Major residential	9	9%	Consistent effect
Collectors (@60 km/h)	*7*	*4%*	*Wide ranging change (1 to 9%)*

The comparisons in Table 1, and in Figures 1a and 1b, are not rigorous since the monitoring before and after the change in limit did not take place at the same time of the year. Thus the overall volume and/or speed reduction may be exaggerated but the <u>relative</u> reduction according to street type should be reliable. Thus the busier 60 km/h streets showed bigger reductions in volume with the changed limit than the minor ones. This implies that traffic was diverted to other routes but apparently not all onto the collectors. The arterials through and around Unley may have picked up additional traffic (as would have been intended) but this has not been monitored.

Because minor streets were under represented to a high degree in the sample of streets monitored, there would not have been a large proportion of residents who have experienced a sizeable reduction (> 7%, say) in traffic on their street.

We note also that much of the reduction in volume and speed measured on the major 40 km/h streets took place <u>outside</u> rush hours. This has the effect of ***increasing the contrast*** between rush hours and other periods of the day, so the effect on amenity in a perceptive sense is not necessarily deduced as beneficial.

We define 'rush' per hour as the sum of the speeds of all vehicles passing in an hour, in either one direction of interest, as used here, or in both directions as a measure of total disturbance. Figure 2a and 2b represent contrasting patterns, measured since the change in speed limit. Figure 2a shows a street about which complaints are voiced and which attracts rush hour traffic from a crowded collector. Figure 2b shows a transverse street with no specific complaint that we are aware of.

The contrast shown in Figure 2a between morning rush hour and the rest of the day, is substantially greater than it was before the speed limit was reduced. From the street shown in Figure 2a, since the change in the limit, some non rush hour traffic appears to be successfully diverted to the collector.

Figure 2a

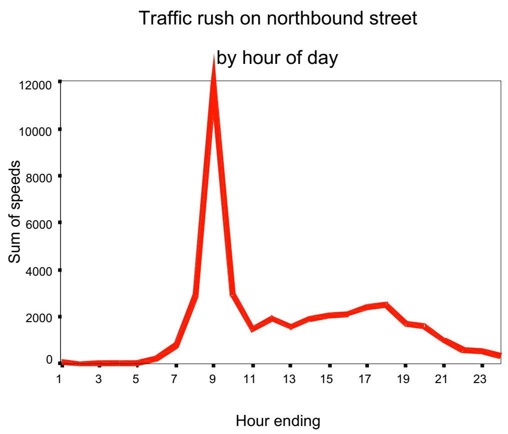
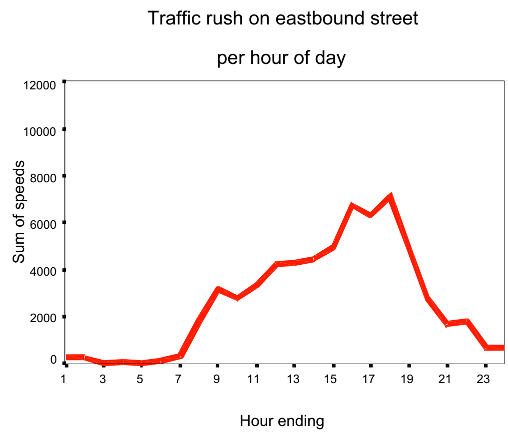


Figure 2b



The total rush on the transverse street, shown by the area under the curve in Figure 2b, is greater than that on the street in Figure 2a but the rising contrast to 9 a.m. is far less, by a factor of at least six. The contrast is far less pronounced on the transverse street.

Vehicle Emissions
Survey respondents in Unley pointed to the additional burden on the driver in selecting the best gear for driving at the lower limit. The question of which speed limit produces more emissions is a complex one. Many begin by reasoning that a lower speed limit equates to lower emissions as vehicles are travelling at lower speeds and should thus produce less emissions, but this is not necessarily so for vehicles cruising at constant speed: see Watson (7) and Taylor (8). However, under normal suburban driving conditions where cruising opportunities are limited, higher speeds produce the potential for more emissions as acceleration tends to dominate differences in different cruising speeds. Thus the driving phases (acceleration, cruise, deceleration and idle) during the journey become critical in the consideration of emissions.

The TSC is currently engaged in a study of emissions to resolve the relative merits of 40 km/h and 50km/h LASL in terms of emissions using an instrumented research vehicle. Results are yet inconclusive but the length of the street is emerging as a critical factor and more work is being conducted on the mix of street lengths in various council areas. The TSC has previously conducted work on the effects of LATM devices on fuel consumption (Zito and Taylor (9)) and significant savings can be made if a LASL is implemented in preference to LATM devices.

A further complication is that certain emissions behave in a non-linear manner with speed. For example, Carbon Monoxide (CO) output is high at low speeds, low at higher speeds but increases again at higher speed. Therefore the type of emission being considered is also important. Engine cold starts also create increased emissions and again the mix of driving phases whilst the engine reaches a stable operating temperature is critical.

Noise
As with air emissions, relationships of a LUSL with noise are not entirely straightforward. For a single average passenger vehicle passing a point at a constant speed, each 10km/h increase in speed increases noise by 3dB(A). Therefore vehicles passing a house at 60km/h are likely to be 6dB(A) louder than vehicles travelling by at 40km/h.

One aspect of acoustics which is less intuitive is that sound intensity is logarithmic. This means that sound levels cannot be added linearly and thus sound level does not provide an intuitive measure of noise pollution. Two noise levels of the same magnitude added together produce an increase of 3dB(A) (eg 60 dB + 60 dB = 63 dB) which is just noticeable. In order for apparent loudness to double there has to be a tenfold increase in the traffic volume. Another complicating factor is the nature of the noise itself. Freely flowing vehicles in residential streets are unlikely to cause any unusual disturbance, however, a heavily accelerating vehicle in the middle of the night is likely to generate many complaints. Therefore the time at which the noise occurs and the nature of the noise (namely accelerating and hard braking) are the most important factors when considering annoyance. In connection with the data shown in Figure 2a, vehicular separation at the height of the morning rush hour was around 12 seconds (150 m) and residents would experience a series of "isolated" passby events

Travel Times and Traffic Modelling Impacts
The TSC has conducted computer based traffic modelling investigations. Taylor (8) examined the likely traffic impacts of alternative speed limits (40, 50 and 60 km/h) using a network modelling study. Comparisons were drawn between traffic performance under different traffic design standards, with isolated and coordinated traffic signals control, and under different traffic congestion levels. The overall results from the study were:
- journey speeds in the test networks were considerably less than the set speed limits
- differences in overall travel speeds and journey times were proportionately much less than in the speed limits themselves
- signal coordination offered significant advantages for delays and traffic progression, except at higher congestion levels where some over-saturation was experienced
- there were indications that coordinated signal operation combined with a 50 km/h speed limit could yield traffic operation conditions at least equal to those for the 60 km/h speed limit with isolated traffic signal control

On the basis of the link-based traffic parameters, the following additional results emerged:
- delays measured relative to the free flow travel time as determined using the specific speed limit were least for the 40 km/h speed limit
- all other link-based measures of traffic efficiency - travel time, changes in free flow travel times, fuel usage and pollutant emissions - tended to suggest that operations under a 60 km/h speed limit with coordinated signal control gave the best results

Road Safety Outcomes
LUSL have been rightly promoted on the grounds that the lower the impact speed, the higher the survivability of pedestrians. This naturally translates to vehicle occupants and other road users involved in a crash. Hence a major selling point is a reduction in crash severity and the avoidance of a certain proportion of crashes altogether. There are possibly five factors involved in safety outcomes through lowered speed limits.

1 Where impacts occur, speeds and acccelerations/decelerations are likely to be lower.
2 This assumes drivers obey the limits for reasons of expediency (enforcement), or because the lower speed seems inherently suitable due to the streetscape, or because they embrace the lower limit per se, or a combination. We do not know how or whether this choice affects road safety outcomes.
3 The existence of a special speed zone alerts drivers to circumstances where they are expected to show particular care. (Some aspects of this may be temporary, until the novelty wears off. Others may be relatively permanent.) Any observed reduction in crash incidence may not necessarily be correctly attributed to reduced speeds only.
4 Pedestrian adjustment to lower speeds affects their judgement of safe crossing opportunities on residential streets. They also need to be aware that drivers who do not respect the lower limit may be travelling <u>much</u> faster than the norm. The need to be 'tuned' to 40, 40-'plus' and 60 km/h appears to place additional demands on pedestrians.
5 Increased 'ownership' of lower speed roads by residents may affect the on-road behaviour of pedestrians, cyclists, children at play, etc.

The first point has been well researched and discussed (for example McLean et al (11)). The other four points are also likely to have considerable influence and the challenge remains for researchers to somehow quantify these.

In the context of this paper, it is still too early to draw any conclusions on crash outcomes and overall road safety benefits. Many of the schemes in place have been operating barely one year and it would be inappropriate to draw any conclusions at this point in time. There may have been a reduction in the number of crashes with property damage only (this would be the most easily validated outcome).

Enforcement
Enforcement is another aspect of LUSL which requires some attention. In the case of the Unley implementation, surrounding councils still maintained a 60km/h speed limit. Therefore Unley stood out as a unique area but arguably an area large enough so that people would only dramatically alter their chosen route around the council at great inconvenience. A common perception was that it was "outsiders" that were doing the bulk of speeding in the 40km/h area. The reality is that 40% of speeding notices issued by police from speed camera enforcement were for those residing within the 40kmh boundary and only 30% for those residing south of Unley (ie those commuting to the city).

Questionnaire Surveys
Support for 40km/h speed limits in Unley has been strong and broadly matches levels reported throughout Australia (AUSTROADS (12)). In 1999 a survey was made of 880 residents, and in 2000 a different set of 882 residents. In 2000, belief that speeds had fallen was steady at 65%, but there was a decline in those thinking residential streets are safer (60%) and in those supporting the city-wide 40 km/h limit (58%). All three approval ratings stood at 67% in 1999. Approval was at 71% before the change of limit took place. There was polarisation between those who want more enforcement and those who are critical of the way it is managed – predominantly on wide, busy 40 km/h limit streets. A notorious stretch (13 m wide, 600 m long) brought the comment from respondent that "*obstructions should be erected down the centre to stop the planes landing*".

Focus Groups
There are concerns that the GUSL might spawn a scatter of 50 km/h zones interspersed with the few 40 km/h zones now in existence. Discussions generally reinforced views expressed by the much larger number of survey respondents except for a notable expression of being hard done by from those living on 60 km/h collectors. Under a GUSL these would be 50 km/h streets.

Community Support and Perception
Community support for the 40 km/h scheme in Unley has fallen more between 1999 and 2000 (20 months after the change) than it did between 1998 and 1999 (7 months after the change). This is despite speeds having continued to fall, albeit marginally, between 1999 and 2000. We note that by September 2000, over a period of 17 months, 16% of survey respondents said they had been fined for speeding on a 40 km/h street. Those who

had been fined were much more critical of the scheme but this observation cannot as yet be claimed to be a causal connection. This rate is, to put it in context, about half the rate in Adelaide on 60 km/h roads, revealed in similar questionnaire surveys but exposure rates have not been assessed. However, willingness to accept the appropriateness of being fined in relation to a 40 km/h limit appears to be much diminished.

Experiences from other states

Some states have conducted extensive experiments with speed limits lowered from 60 km/h. In NSW, 26 LGAs trialed a 50 km/h urban limit between October 1997 and March 1998 in cooperation with STAYSAFE and the NSW Roads and Traffic Authority (RTA). The trial achieved reductions in average speeds of **1.5 to 2.0km/h** and a **7%** reduction in casualties in some councils. Of the 26 councils involved in the trial, 58% supported the 50 km/h limit and 12% were against. Community opinion also varied, with two surveys showing 66% and 41% support for the lower limit (Walsh 13) and RTA (14). As a result of the trial, the NSW Minister for Roads invited all NSW LGAs in June 1998 to implement the 50 km/h urban limit and that all costs would be funded by the RTA.

Another major implementation of the 50 km/h limit was in South East Queensland, where the limit was introduced to all built up areas on 1st March 1999. Initial results showed positive effects both in reduced mean speeds and in public acceptance. Reported support for the scheme seemed higher than in NSW and has increased since the introduction of the scheme. Mean speeds for sites in Brisbane have been reported to decrease from 49.3km/h to 43.1km/h (**6.2km/h**). One aspect of the scheme was a high profile three month amnesty period which seemed to have been instrumental in the transition to the lower limit with ongoing public support. Although no formal evaluation seems to have been initiated, key stakeholders monitoring the new scheme include Queensland Transport, the Police and the LGAs (Walsh and Smith (15)).

Conclusions

The implementation of the 40km/h speed limit in the City of Unley has generally been a success in terms of reducing vehicle speeds, volumes and improving resident amenity, though there is some polarisation and questions of equity. The verdict is still out regarding the appropriateness of the lower limit on vehicle emissions and road safety outcomes.

The lesson learnt from the Unley experience is that the 40km/h limit is working sufficiently well at most times of the day. The morning peak period provides the greatest contrast in vehicle volumes and speeds and it seems the lower speed limit is not sufficient to deter through traffic at this time. The missing piece of the jigsaw may well be how traffic can be influenced during this peak period to improve amenity of the residents. Enforcement may well be a solution targeted on the morning peak but as with all enforcement this is subject to community backlash and available police resources. The future challenge for lower 40km/h speed limits seems to be how to encourage self regulation to drive as appropriately, or considerately, during the morning peak as at other times of the day. However, without further moves to spread working hours, this problem seems unlikely to go away.

References

1. AUSTROADS (1996). *Urban speed management in Australia*. AUSTROADS Report AP –118/96.
2. Larsson, P (1997). Traffic control standard – 40 km/h local area speed limits. *Proc AITPM Seminar and Workshop on Speed Management and Control*. AITPM, SA Branch, Walkerville.
3. LASL Trial Working Party (1993). 40 km/h Local Area Speed Limit Trial Unley – South Australia: final report and recommendations. Department of Road Transport, Walkerville.
4. City of Unley (1996). *40 km/h Local Area Speed Limit continuing trial report*. City of Unley, Unley.
5. Dyson C B, Woolley J E, Roach G, Taylor M A P and Eddy, C (2000). *An evaluation of the Unley city wide 40 km/h limit*. Report to Unley Council, yet to be released.
6. Klungboonkrong, P and Taylor, M A P (1999). An integrated planning tool for evaluating road environmental impacts. *Journal of Computer-Aided Civil and Infrastructure Engineering 14* , pp.335-345.
7. Watson, H L (1995). The effect on vehicle emissions of reducing urban speed limits. *Motoring Directions* **1**(4), pp.17-22.
8. Taylor M A P (1998). Network modelling of the traffic, environmental and energy effects of lower urban speed limits. *Proc 3rd Conference of the Hong Kong Society for Transportation Studies*, pp15-25.
9. Zito R and Taylor M A P (1996). Speed profiles and vehicle fuel consumption at LATM devices. *Proceedings of the 18th ARRB Conference*, 18(7), pp 391-406.
10. McLean, J R *et al* (1994). *Vehicle travel speeds and the incidence of fatal pedestrian collisions*. Report CR146. Federal Office of Road Safety, Canberra.
11. AUSTROADS (2000). *50km/h speed limit on local streets – community opinions and anticipated effects*. AUSTROADS Report AP –R161/00.
12. Walsh D (1999). The 50km/h Speed Limit in NSW: A joint partnership between councils, their communities and the NSW Roads and Traffic Authority. *Proceedings of the Research Policing Education Road Safety Conference*, Canberra, Volume 2, pp695-707.
13. RTA (1998). *50km/h Urban Speed Limit Trial – Evaluation Report*. Roads and Traffic Authority, Sydney.
14. Walsh D and Smith M (1999). Effective Speed management the next step forward: saving lives by decreasing speeds in local streets. *Proceedings of the Research Policing Education Road Safety Conference*, Canberra, Volume 2, pp685-694.