

IMPLEMENTING LOWER SPEEDS IN NEW ZEALAND

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ABSTRACT

In many Western countries, particularly in Europe, speed limits less than our conventional 50 km/h (urban) and 100 km/h (rural) defaults are commonly used. There is also a significant take-up in road treatments that encourage slower speeds (e.g. “self-explaining roads”, shared spaces and traffic calming devices), with or without the presence of supporting speed limits. Although there have been a few positive initiatives in recent times, New Zealand has generally been rather slow in adopting these practices, to the detriment of its road safety record. This is a particular concern when considering the safety of walking and cycling and encouraging a greater use of both modes.

This paper looks at the current state of practice in New Zealand, both in terms of existing low speed implementations around the country and the technical guidance available to support such initiatives. In particular, it examines the existing “Setting of Speed Limits” guidelines and possible ways to bolster their ability to more pro-actively support lower speed limits. Existing guidance and research on implementing speed reduction treatments is also examined, with a view to identifying recent developments in this area and topics for future New Zealand research.

INTRODUCTION

Speed has been identified as one of the five high-priority areas in New Zealand's latest *Road Safety Strategy to 2020* (MOT 2010a). It was notable however that it was the only one of the five not to have any immediate "first actions" taken to Cabinet this year for implementation. This is disappointing when there are a number of relatively obvious speed management methods that could be rolled out and encouraged.

A range of user, vehicle and road/environment factors have been identified in the literature as having an influence on driver speeds. The latter category includes speed limits, enforcement levels, lane widths, sight distances, and traffic management/calming devices. These are of particular interest in this paper, as these are the ones that can be directly influenced by transportation engineering professionals.

In many Western countries, particularly in Europe, speed limits less than our conventional 50 km/h (urban) and 100 km/h (rural) defaults are commonly used. There is also a significant take-up in road treatments that encourage slower speeds (e.g. "self-explaining roads", shared spaces and traffic calming devices), with or without the presence of supporting speed limits.

Although there have been a few positive initiatives in recent times, New Zealand has generally been rather slow in adopting these practices, to the detriment of its road safety record. This is a particular concern when considering the safety of walking and cycling and encouraging a greater use of both modes. This paper looks at the current state of practice in New Zealand, both in terms of existing low speed implementations around the country and the technical guidance available to support such initiatives.

THE EFFECTS OF TRAFFIC SPEED

Motor vehicle speed is a major factor in the amenity and safety of our road network for all road users. MOT (2010b) identifies undesirable speed as including both "excess speed" (travelling faster than the posted speed limit) and "inappropriate speed" (travelling too fast for the prevailing road and environmental conditions). In both cases, this is likely to lead to a greater chance of being involved in a collision and a greater chance of higher severity injuries as a result.

The OECD/ECMT (2006) found that reductions in average speed of approximately 5% would yield a reduction in fatalities of as much as 20%. Nilsson (2004) confirmed earlier studies of his that found that the injury accident rate changes with the square of the change in mean speed, with even higher exponents valid for serious and fatal injuries.

It is not surprising therefore that speed factors are cited in a large proportion of crashes; Between 2007-09, "driving too fast for the conditions" was cited as a factor in 31% of fatal crashes, and 17% of other injury crashes in New Zealand (MOT 2010b).

However when considered in the context of pedestrian and cyclist crashes however, it is likely that the safety effect of speed is underestimated. For example, between 2005-09, of the 1840 fatal and serious injury crashes in 50km/h areas involving a pedestrian or cyclist, only 4.1% had a speed-related ("too fast") factor attributed to the driver (MOT 2010c). Clearly however the vehicle was travelling fast enough to cause serious harm (or death) to the person concerned, whereas the same situation in a lower speed environment may have yielded a much lesser injury (if any collision at all). It is also concerning that the proportion of pedestrian/cyclist crashes with a speed factor recorded is considerably lower than the average for all road crashes, suggesting a reporting bias.

A number of official publications over the years have quoted the relative effects of motor vehicle impact speed on the survivability of pedestrians and cyclists struck by them (e.g. ACC/LTSA 2000, MOT 2010a). Some past studies have suggested that, at impact speeds of 70 km/h and above, the chances of survival are less than 10%. However, more recent research by Rosén et al (2011) has identified methodological flaws in the earlier work that resulted in a bias to more severe injuries; also modern motor vehicle designs and medical care are now somewhat better at minimising the injuries of externally struck people. Table 1 summarises some of the key studies in this area over the last few decades.

Table 1: Comparison of Studies into Vehicle Impact Speed vs Adult Pedestrian Injury Severity

Study	% of Fatalities for Given Impact Speed					Comments
	30 km/h	40 km/h	50 km/h	60 km/h	70 km/h	
Ashton (1982)	5%	18%	50%	79%	90%	Interpolated from mph
Pasanen (1992)	6%	16%	40%	72%	94%	Same data as Ashton
Anderson et al (1997)	10%	25%	84%	100%	100%	Australian/Swiss data
Davis (2001)	1%	4%	10%	24%	50%	Same data as Ashton
Rosén & Sander (2009)	<2%	4%	8%	19%	38%	German data

Although the absolute percentages are quite different between the various studies, it is clear that the relative fatality risk as speeds go up is still a considerable increase. This is particularly evident when considering typical urban impact speeds between 30-60 km/h. For example, even in the latest analysis from Rosén & Sander (2009) the risk of pedestrian fatality if struck at 50 km/h is still twice that at 40 km/h and five times that at 30 km/h.

Although no similar study has been undertaken in New Zealand, a similar kind of analysis can be considered by reviewing the posted speed limits for all crashes involving pedestrians or cyclists. Figure 1 summarises the relative severity of injuries for all reported pedestrian/cyclist crashes over the past 5 years (over 12,900 reported crashes) in comparison with the posted speed limit; for fatal crashes the data has also been separated out into each mode separately.

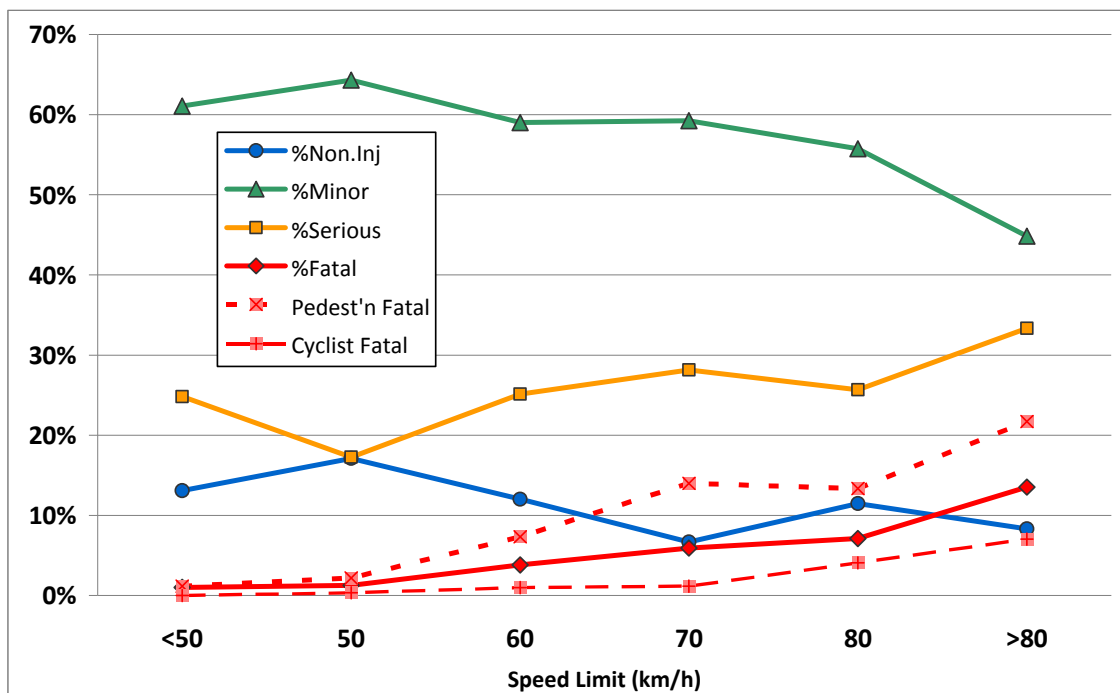


Figure 1: Effect of Posted Speed Limit on Severity of Pedestrian/Cycle Crashes 2005-10

It needs to be acknowledged that there are a few caveats and limitations with the data in this

study (at least without a more detailed study of the crash records):

- The posted speed does not directly correlate with the actual impact speed that the pedestrian or cyclist would have suffered in each case; if the motorist was identified as having been speeding then it may have been higher, if the motorist had started to brake then it may have been lower. To partly account for this, any crashes where speed was cited as a factor have had their speed increased by 10 km/h.
- It is also accepted that in many instances, the posted speed limit does not correlate with the typical speeds driven at a particular site; this may be a consequence of an inappropriate choice of speed limit, or local geometric constraints.
- A small number of the lower speed limits will be associated with a temporary speed limit during construction works (only 69 crashes were coded as being "under construction"). Depending on the site layout, motorists may have been observing the temporary speed, or they may have not seen fit to adhere to it.
- The reporting rates of pedestrian/cyclist crashes are known to be fairly low (Turner et al 2006, Langley et al 2003), particularly those of lesser severity. Therefore not much should be inferred from the relative proportions *between* severity levels.
- The relative rarity of some of the less common speed limits has necessitated combining some speed limits together. For example, only 11 crashes were identified with a 40 km/h speed limit. All other speed categories presented have over 180 crashes each, but the overwhelming majority (85%) were in the 50 km/h category.

Despite these limitations, a clear pattern can be seen in the proportions of fatal pedestrian/cyclist crashes as the posted speed limit increases. Although these proportions are lower than those identified in the overseas studies, these studies focused on impact speeds. One suspects that the typical impact speeds involved here were probably lower than the posted speed in many cases.

It is also interesting to see a clear distinction between the fatality rates for pedestrians and cyclists. Most overseas studies have focused on pedestrian impacts and the findings have then been assumed to translate to other similarly vulnerable road users like cyclists. The findings here however suggest that this is not correct, possibly due to the different relative speeds of cyclists, the types of collisions, the ages of the two road user groups, and the mechanics of impacts with bicycles. Further research into this issue would be worthwhile.

Speeding traffic can also have significant effects on traffic noise experienced by nearby residents and other road corridor users (e.g. Dravitzki *et al* 2006 found a 4-6 dBA increase in noise as light vehicle speeds increased from 50 to 70 km/h and again to 100 km/h). Traffic speed is also cited by many people as a reason for not walking and cycling as much as desired (e.g. Jacobsen *et al* 2009). Reduced traffic speeds can also reduce vehicle operating costs, particularly at open road speeds.

Overseas Speed Treatments

Western Europe has been a long-time haven for the implementation of traffic calming treatments and lower speed limits. It is perhaps no surprise that these have played a strong role in the high support for walking and cycling found in many European cities. Although specific facilities like separated cycleways are often touted as the mechanism behind greater use of active modes, what is forgotten is that for much of the urban environment in Europe no such facilities exist because they are not needed - traffic volumes and traffic speeds are reduced instead. For example, 80% of the street network in Munich, Germany, is now part of 30 km/h zones; when streets are reconstructed and the speed limit reduced, the city's policy to *remove* existing cycle paths or cycle lanes (if these are present).

The safety benefits of lower speed limits, such as 30 km/h (20 mph) zones have been well

proven. Elvik et al 2009 reviewed a variety of studies and estimated that lower speed zones across Europe reduced injury accidents by an average of 27%.

One policy aspect that has helped the acceptance of lower speeds in Europe is the concept of "self-explaining roads". As described by Charlton *et al* (2010), the general concept is to clearly differentiate different road functionality groupings by means of consistent design elements, e.g. roadway widths, intersection controls, crossing types. In this way, it is potentially possible to create a road network where, even in the absence of different speed limits, motorists generally travel at a speed appropriate to the class of road they are driving on. The Netherlands and the UK have been particularly notable in pursuing the self-explaining roads philosophy.

In Europe, another increasingly common approach to road safety is to match speed limits and road environments, based on the potential damage and survivability of a situation (Wrangborg 2005). For example:

- where pedestrians and cyclists are present (e.g. residential areas): 30 km/h
- where side-on crashes could occur (e.g. at-grade intersections): 50 km/h
- where head-on crashes could occur (e.g. overtaking, roadside poles): 70 km/h
- where traffic is fully protected from the above dangers (barriers, interchanges): 90 km/h+

These so-called "forgiving roads" ensure that, whether drivers erred through bad choice or bad luck, they (and other road users) will still have a good chance of surviving the result of that error.

Although rural environments typically provide 70km/h and higher speed limits, this is not always the case. For example, in The Netherlands and Scandinavia so-called "2-minus-1" roads are common, whereby a relatively narrow road is marked with shoulders for cyclists and a single traffic lane in between (Erke & Sørensen 2008). Motorists are able to use the shoulders to pass each other when clear of cyclists. Typically these roads have a 60km/h speed limit. Such an application could be useful in New Zealand for quieter rural locations where cycling is common, e.g. popular training ride routes.

EXISTING SPEED LIMIT LEGISLATION AND GUIDELINES IN NZ

It is pertinent here to summarise the existing legislation and policy guidance in New Zealand on speed limits. Since 2004, all road controlling authorities (RCAs) are responsible for setting speed limits on their roads, under the *Setting of Speed Limits* Rule (NZ Govt 2003, referred to hereafter as "the Rule"). Previously speed limits were set by central Govt (via LTSA) under various Acts. Speed enforcement and fines are still controlled by central government.

Under the Speed Limit Setting process, default urban (50 km/h) and rural (100 km/h) limits are still enshrined. It is also possible to set other speed limits in multiples of 10 km/h between 10 and 90 km/h, as well as holiday (seasonal), temporary, and variable speed limits. The urban boundaries and all other limits must be specifically noted in a Speed Limits Register held by each RCA and enacted via a local Bylaw.

The Rule has set procedures for determining and changing speed limits. *Speed Limits NZ* is the standard process to be used assessing suitable speed limits; this is described further below. Public consultation is also necessary and specific groups such as NZTA, the NZ Police, the Automobile Association and the Road Transport Forum must be informed of any proposed changes (it is perhaps symptomatic of our traditional motoring background that no pedestrian or cyclist groups are listed for mandatory consultation, and inspection of submissions to Councils around New Zealand finds these motoring groups regularly against the introduction of lower speed limits).

Under the *Speed Limits NZ* process, practitioners need to consider the following:

- Adjacent land use and developments
- Presence of side roads and nearby development along them.
- Roadway characteristics (cross-section and alignment)
- Usage and position of on-street parking
- Traffic control devices (islands, intersection controls, crossings)
- Pedestrian/cycle activity
- Mean / 85th percentile operating speeds
- Crash history

A series of rating tables for “development factors” (adjacent land uses and side roads) and “roadway factors” (alignment and cross-section, parking, pedestrians, cyclists, traffic controls) are used to score each 100m section of road within the study length. These scores are then used to determine average section ratings. A flowchart (example shown in Figure 2) then determines what the most appropriate speed limit is (known as the “Calculated Limit”); for example, an average rating of between 6-11 would suggest a 70km/h speed limit.

As well as the Calculated Limit, practitioners should also consider existing operating speeds along the route and the crash history. As a general rule, observed mean speeds should roughly match the posted speed limit, with 85th percentile speeds typically no more than ~15% higher. While a high crash rate may be one motivation for wanting to reduce a speed limit, generally additional engineering/education/enforcement actions will also be required. It is also important that proposed speed limits are of suitable lengths to be credible to road users and enforceable.

Rural Speed Zoning

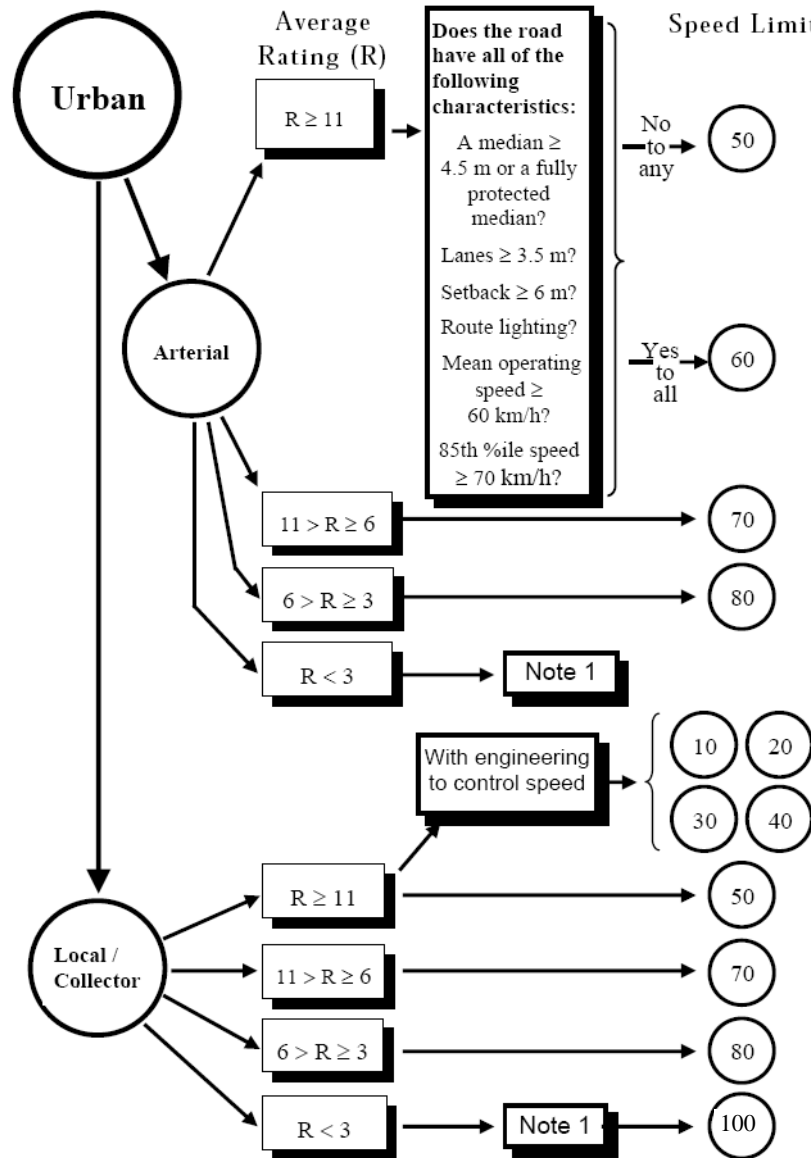
Rural speed zones are designated stretches of road where the speed limit is set for the constrained operating conditions and physical characteristics of the road (for example a narrow, winding mountainous section). Typically speed limits of 70/80/90 km/h are used instead of the 100 km/h suggested by the *Speed Limits NZ* process, but they could be lower. Ideally rural speed zones should be no less than 10 km long, although some circumstances permit them to be as short as 2 km.

In rural areas, speed zoning has been developed since before 2004. However there appears to have been no finalisation of rural speed zoning guidelines since a revised draft Policy was produced in early 2005 (LTSA 2005).

In setting rural speed zone limits, both spot speed and speed profile (floating car) surveys are required to be considered. The site survey should also consider the width of road & shoulders, median barriers, roadside hazards, whether the road is straight or curved, and the presence and safe provision of active transport users. A different roadway survey procedure to *Speed Limits NZ* is used, which also takes into consideration factors such as the proportions of heavy, agricultural or tourist traffic, lane/shoulder widths, and the presence of passing facilities.

A range of various trial sites have been set up around the country, initially on State Highways, but increasingly on local roads too. Although its development has been somewhat slow, the intent of the process (to provide a wider range of speed limit options in rural areas) is encouraging.

Figure 2: Speed Limit Rating Flowchart from *Speed Limits NZ*



Note 1. The level of development is not consistent with the location of this road. Please check you have used the correct flow chart for the location (see Fig. SLNZ1)."

School Speed Zones

Developed in Christchurch a decade ago (Osmer 2002), school speed zones are a form of variable speed limit, whereby the default speed limit around a school is lowered (typically from 50/60 km/h to 40km/h) during the start and end of school days. Usually these sites are supplemented by some form of active signage, such as variable-display flashing speed signs.

LTNZ (2005) describes the process for selecting and implementing such school zones. It is desirable that a school has a minimum number of children travelling on or near the roadside in question and that either observed traffic speeds are high or there have been speed-related crashes in the past 5 years. Police enforcement is encouraged, although anecdotally they seem to be reasonably well observed by motorists.

Given the above discussion about the relative safety of active transport users versus speed,

one wonders whether 30 km/h school zones might be more appropriate in many locations, particularly if accompanied by suitable street treatments such as islands, platforms, thresholds, etc.

Lower Speed Limits (<50km/h)

Aside from the above-mentioned school speed zones, the Rule also allows the possibility of using 10 - 40km/h limits. Here is the relevant clause:

- 3.2(6) *A road controlling authority may propose to set a speed limit of less than 50 km/h... if:*
- (a) the calculated speed limit for the relevant road is 50 km/h; AND*
 - (b) the proposed speed limit would be likely to increase the safety of pedestrians, cyclists or other road users; AND*
 - (c) safe and appropriate traffic engineering measures are installed so that the measured mean operating speed is within 5 km/h of the proposed speed limit.*

Meeting requirement (a) is not likely to be difficult for locations where a lower speed limit is being proposed. The earlier discussion about speeds and safety make requirement (b) fairly redundant. All that remains therefore is for the road environment itself and the traffic behaviour to be assessed and if necessary adjusted to satisfy requirement (c).

A number of potentially suitable locations for such limits occur around schools and tertiary institutions, residential areas, parks and playgrounds, and urban CBDs and shopping streets. The 10 km/h speed limit was introduced for shared zones only, where motor vehicles must give way to pedestrians, e.g. street malls and car-parks.

To ensure that there is good credibility with lower speed limit zones, *Speed Limits NZ* requires that observed mean speeds must be within 5 km/h of the posted limit. If the existing street does not enable this then the guidelines recommend applying "*appropriate and safe traffic engineering techniques*".

There is little guidance available on implementing such techniques; LTSA (2004) seems to be the only formal guidelines and, other than a brief list of possible engineering treatments (but with no guidance on their implementation or effectiveness), this is relatively bereft of practical information. Indeed, it seems designed to put people off implementing a lower speed limit because of the additional steps required to do so. It is also concerning that it states "*The urban speed limit in New Zealand is 50 km/h. This is the most appropriate speed limit... where there are vulnerable road users.*" More useful guidance was actually suggested in a draft Advisory Circular produced as part of the development of the Setting of Speed Limits Rule (LTSA 1997); this included some guidance on the use of lower speed zones over an area instead of a single street, and some suggested signage.

Current Lower Speed Initiatives in New Zealand

It should be noted that it is at present very difficult to get a full understanding of the extent of lower speed initiatives across New Zealand. Local Councils vary in the ease of finding the information in a readily accessible format (e.g. public website). Even harder to find is consistent information on traffic-calmed street locations; although most Councils keep records of assets such as signs, carriageways, etc, the recording of traffic calming devices is often only reflected in terms of data on surface treatments and carriageway widths.

Councils are required to maintain a Speed Limits Register; however the public provision of this is variable. Some provide a detailed list of locations, some provide a map of locations, and some, despite making available their relevant Speed Limits (or Traffic) Bylaw, fail to provide any useful information about what their actual limits are, referring for example to a Schedule or Plan that is not similarly available.

There appears to be no similar publicly available register for such speed limits on all State Highways; instead one is required to search through past issues of the *New Zealand Gazette*. These amendments are made to the *New Zealand Transport Agency (Speed Limits on State Highways) Bylaw* (NZ Govt 2010); however this is not easy to come by.

Nevertheless, there are some good NZ speed reduction initiatives so far, for example:

- **Auckland:** Trials of self-explaining roads have been introduced in Point England, using a variety of street calming treatments to influence driver speeds without changing speed limits (Charlton et al 2010). Shared spaces (i.e. streets with pedestrian priority) are also beginning to be investigated in the CBD area and near Eden Park (Karndacharuk & Wilson 2010).
- **Hamilton:** As well as introducing a 30km/h speed limit in the CBD, over just three years Hamilton City has also introduced 40km/h school zones at all but seven of the city's 55 schools (HCC 2010).
- **Wellington:** 30km/h speed limits have been planned for 21 separate CBD and suburban "shopping street" areas (WCC 2009), with five already implemented.
- **Christchurch:** For some years, local street reconstructions typically included significant traffic calming as part of them (previously dubbed the "Living Streets" programme) (CCC 2000); more recently, such street-works have been grouped into neighbourhood "clusters" so that entire areas are treated similarly with a low-speed environment.

It is also encouraging to see that the new subdivision development Standards (Standards NZ 2010) acknowledge the ability of good street design to manage speeds and make them more pleasant environments for residents and active transport users. In particular, the Standard identifies the use of road widths and sight distance as key tools to manage speed.

What is quite concerning however in reviewing the speed limits around the country is the wide range in their implementation. Many councils have very few roads that are not the default 50/100 km/h urban and rural limits, usually some "peri-urban" roads at 70 or 80 km/h. Like the shopping streets in Wellington or school zones in Hamilton, there is probably at least one similar deserving location in every other significant urban centre. This variation seems to be very much dependent on the pro-active level of staff and Councillors within each jurisdiction; which is unfortunate for the citizens of the less-inclined Councils. In line with the LTSA Road Safety Surveys of old, it seems an opportune time for an audit to investigate the level of speed limit usage across all Councils and the reasons for and against their use of the non-conventional tools.

Issues with the Current Setting Speed Limits Guidelines

Examination of the current *Speed Limits NZ* process identifies a few flaws with respect to introducing lower speed limits:

- The pedestrian and cyclist roadway ratings are somewhat based on the numbers of these users that are currently present. However, if the current road environment is not very inviting for pedestrians and cyclists and the purpose of a lower speed is to encourage more of them, then the existing ratings won't be particularly relevant.
- Although flush medians and narrower traffic lanes are sometimes used as speed management devices, this effect is generally not allowed for in the geometry roadway ratings (but they are considered in rural speed zoning calculations). It is also somewhat vague what "open/average/limited" visibility mean in these ratings; given the ability of reduced sight distance to control speeds, some distance ranges would be useful.
- Under "use of the road", curiously a local industrial street warrants a higher rating than a local commercial street (where more pedestrians and cyclists are likely to be). Neither however warrants any rating if the road is a collector or higher in the roading hierarchy.

- Roadway ratings for traffic control don't take account of locations where a high demand for crossing the road exists but no physical facilities exist. In some lower speed situations, such as commercial districts, it may be impractical to provide pedestrian crossings at particular locations if there is a widespread demand to cross at a variety of locations; this may be one reason behind wanting a lower speed limit.
- The guidelines state that speed limits below 50 km/h should not be used on roads with a collector or arterial function. This however ignores the fact that in New Zealand many of these streets are (unfortunately) providing a mixed-use function of both access and mobility. It is precisely because of this mixed use that many of them require speed management as an important road safety tool.
- It is not clearly stated whether observed speeds should measure free speeds only or all traffic speeds. In busier areas there may be quite a difference between the two, unless there is sufficient engineering of the road environment to suggest the most appropriate operating speed.
- Unlike speed limits of 50 km/h and above, there is no explicit rating that *recommends* a lower speed limit. It is hard to know therefore at what point a lower speed limit might be much more suitable.
- The guidelines for a 60 km/h urban limit recommend a range of physical attributes, including medians, wide lanes, good lighting, etc. However there is no requirement to also provide adequate provision for cyclists on such roads, despite the fact that they are likely to be using these routes.
- For both the conventional Setting Speed Limits process and the rural speed zoning policy, very little guidance is available if RCAs wish to reinforce a new lower speed limit with some engineering measures.
- The school speed zone process is very much based around the use of 40 km/h zones in urban areas; there is little guidance on its application in other settings. For example, a number of rural schools have questioned why they are not able to implement a similar treatment. This pressure has now led to a trial of 50 km/h school zones around seven Selwyn District rural schools.

It also appears that a number of Councils are focusing strongly on the *Speed Limits NZ* Calculated Limit rating, to the detriment of other input factors. For example, the following are taken (anonymously) from Council officer reports:

"Staff acknowledge that the school and Community Board support the speed limit on this section of [...] Road to be reduced to 50 km/h. However the Speed Limits NZ rating does not support the reduction of the current speed limit of 60 km/h to 50 km/h."

"Unfortunately, the rules are quite stringent and are set out in the speed limits policy."

Both politicians and the general public seem to be (sometimes grudgingly) accepting of this outcome, and one suspects that many staff also believe that this is the case. However this ignores the fact that the Rule allows for departing from the Calculated Limit:

3.2(5) A road controlling authority may propose to set a speed limit that differs from the calculated speed limit... only if:

- (a) a speed limit different from the calculated speed limit is the safe and appropriate speed limit for a road with regard to the function, nature and use of the road, its environment, land use patterns and whether the road is in an urban traffic area or a rural area; OR
- (b) the proposed speed limit is less than 50 km/h and 3.2(6) applies.

A key problem however is that no real guidance is provided on how to evaluate these factors listed in clause (a).

It would be instructive to consider from first principles what a suitable lower speed environment might look like and what rating that would subsequently attract. For example, such an environment might have the following features (with equivalent *Speed Limits NZ* ratings shown):

	<i>Rating/100m</i>
• High use by pedestrians (with adjacent footpaths), or expected high use following a lower speed limit	<i>1 unit</i>
• A close grouping of small businesses (at least one every 20m) or houses (at least one every 10m) or a reasonable sized primary school (e.g. 300 pupils with 200m frontage)	<i>10 units</i>
• Frequent on-street parking for customers, parents, etc, close to moving traffic	<i>2 units</i>
• Single-carriageway (one lane each way) with good visibility	<i>3 units</i>
TOTAL RATING	<i>16 units</i>

This conservative assessment ignores the possibility that there is also side road development demand, reasonable cycling use, traffic control devices (e.g. pedestrian crossing, intersection), or busier adjacent developments. Even without these the above analysis suggests that an Average Rating of ≥ 16 should warrant a speed limit of 40 km/h or less. It may even be possible to determine a similar cut-off for 30 km/h speed limits.

IMPLEMENTING SPEED REDUCTION TREATMENTS

As identified a number of times above, speed limits alone are not the only speed management tool. An important part of encouraging drivers to choose a lower speed is to ensure that the road environment matches their expectations for that speed. It is important therefore to understanding what physical measures can be made to influence this behaviour.

There are three main contributors to higher vehicle speeds:

- Street **Length** (visual and physical)
- Road **Width** (perceived and actual)
- Smooth **Surfaces**

These factors therefore suggest some key methods for limiting vehicle speeds:

- Limit physical street lengths (or at least the straights) or perceived length (via visibility). This could include curvilinear alignment via a "tributary" instead of a "grid" network.
- Limit forward sight distance, via plantings and realignment.
- Reduction in visual or actual width, via kerb extensions, plantings, road markings, narrower lanes.
- Vertical deflections, via humps, speed cushions and platforms.
- Alignment deflections, via chicanes and islands.
- Cobbled/tiled pavements, textured surfacing or rumble strips.
- Perimeter (threshold) treatments with signage, surfacing, narrowings.
- Intersection treatments such as roundabouts, angled deflectors and street closures.
- Use of lateral and transverse road markings and delineators.

For the practitioner however, there is only limited guidance available locally with regards to the design of some of these aspects and even less guidance available on the relative effectiveness of different devices (which is likely to vary with the context e.g. urban street vs rural highway).

Research into the Effectiveness of Speed Reduction Treatments

There has been a wide range of international research into the effectiveness of different street treatments and traffic calming devices. For example:

- TRL (2007) identified the effects of forward visibility, road width and other parameters such as road surface and parking on 85th percentile speeds in the UK.
- DfT (2007) provides a very comprehensive overview of the effectiveness of various traffic calming measures on speeds, crashes, traffic volumes, etc. It also has considerable guidance on the implementation of low speed zones, such as 20 mph "home-zones".

While this research may provide a starting point for implementation in New Zealand, there is a question about whether it is equally applicable when applied to our streets and our drivers. It is therefore prudent to undertake similar research under New Zealand conditions. Unfortunately, historically New Zealand practitioners have collated relatively little data in this area; Minnema (2006) noted this paucity in his review of traffic calming devices for New Zealand.

More recently a number of studies have started to fill in a few gaps, for example:

- Wigmore *et al* (2006) reviewed a variety of engineering devices to improve school journey safety and compared their relative merits, including local perceptions of effectiveness.
- Charlton & Baas (2006) investigated speed management change treatments that would make roads more self-explaining, for both high and low speed environments. The work included a comparison of international literature against some local speed measurements, which suggested that it was not always directly transferable, especially in urban areas.
- Mao & Koorey (2010) studied the effects on traffic volumes, speeds and crashes following the installation of traffic calming devices on urban local streets in Christchurch. Reductions in all of these attributes were observed at most sites.
- Burdett & Nicholson (2010) examined the effect on speed of the presence of painted edgelines and centrelines on straight, single carriageway rural roads in the Waikato. Results showed a significant increase in speed on roads with a centreline, compared to no markings, and with a centreline and edgeline, compared to centreline-only.
- Charlton *et al* (2010) explored the use of traffic management features to create self-explaining roads in an Auckland suburb. Observations after implementation showed a significant reduction in vehicle speeds on local roads and increased homogeneity of speeds on both local and collector roads.
- Daniel *et al* (2011) considered the development of a method to estimate speed profiles along traffic calmed streets. Observations at and near a variety of calming devices in Christchurch enabled the development of relationships for the relative effectiveness of each device in reducing speeds and the zone of influence further away.

Chasing after all the various studies locally and internationally is hard work, however. What is needed is a central repository of the key information so that practitioners can access information on particular treatments (assuming that there has been some research). While a national guideline document might be a convenient way to capture this information, for the time being when the available information is rather sporadic and developing all the time, it may be more sensible to have an electronic resource, e.g. online website. Such a repository would also help to target future research into areas that require more information.

Areas requiring Further Investigation

The following are some suggested areas for further investigation in New Zealand (some have been investigated overseas and, in the interim, they could provide a starting basis for knowledge here):

- Although there is a reasonable amount of local data on "conventional" calming devices

such as humps and narrowings, more research is required to investigate the relative effectiveness of less common devices, including various chicane and central island treatments, as well as intersection treatments.

- Some equivalent research to that in the UK on the effects of road widths and sight distances would help to establish typical speed patterns on many roads in the absence of more overt calming devices.
- Less work has been done on the relative effectiveness of rural speed management treatments, including pavement marking treatments and kerb/island treatments.
- There is a need to assess the effect of changing speed limits on driver travel speeds, in the absence of any other treatments. This would help identify the "enforcement effect" relative to the "engineering effect" of any changes to a road environment.

Over time, such information could add to the central repository of knowledge mentioned above.

COMMON CONCERNS WITH IMPLEMENTING LOWER SPEEDS

As well as the technical issues identified in the previous sections, there are also a number of more philosophical concerns that are often raised by the various stakeholders. Some of these are identified below, with responses:

- *"Reduced speeds will mean longer travel times"* - In practice, most studies have found such differences to be negligible in comparison to intersection and traffic delays en route. In fact, some studies have found that travel times for side road traffic have improved because it has been easier to find a suitable gap in the main road traffic when it is travelling at slower speeds (Elvik et al 2009). Perhaps more importantly, a key philosophy in speed management is that we're trading a little mobility for vastly improved safety and sustainability.
- *"The average speed is already well below the speed limit"* - This would seem even more reason to reinforce that with a true speed limit! If it is desired that people respect an increasing range of different speed limits then they must all be credible to them. Lower speed limits also send a clear message to those who wish to walk or cycle that the road environment is safe for them to do so, even in the absence of specific facilities for them.
- *"The public don't want reduced speeds"* - The answer to this tends to depend on who you are asking the question of: those driving through the area may not want reduced speeds; but those living, working and riding there invariably do. If the lower speeds are being applied to local streets, where the access function should override the mobility function, there is even less justification for this concern.
- *"What about the effects of calming devices on emergency services"* - Rather like the first concern above, this issue is often negligible in comparison with the other route and traffic delays encountered by these services. Any relative cost of such delays also has to be weighted against the considerable health and safety benefits that the lower speed environment presents to other users.
- *"What if the proposed treatment isn't effective enough or people don't like it?"* - Given our relative inexperience with some speed management treatments, this is an understandable concern. However that shouldn't stop RCAs from trialling particular treatments (indeed, a "trial" may be more palatable to some stakeholders). With many physical measures there are also ways to use semi-permanent tools like paver block kerbs that can be adjusted as required to test the effectiveness of a particular layout.
- *"Traffic will still travel faster than the proposed speed limit, especially during off-peak times"* - If this is considered a concern, then it is always possible to add some additional traffic management features to get the speeds down a bit, even in the absence of other traffic. It is important to remember however that most pedestrians and cyclists who stand to benefit from a lower speed limit are likely to be present during the key peak times (e.g.

to/from work and school).

- "We're not like Europe, lower speeds won't work here" - One wonders whether we're a different species of human to the Europeans, as we appear to get injured just the same at high speeds! However, if we want other examples, one only has to look at North America, where increasingly a wide variety of lower speed limits are routinely implemented.

It is acknowledged that every place is different and hence, different solutions will probably need to be applied (and perhaps trialled). That however is no excuse for doing nothing, just because of "fear of the unknown".

CONCLUSIONS

Speed (whether "excess" or "inappropriate") continues to be a problem in New Zealand. Whilst education and enforcement certainly have an important role to play, driver speeds are greatly affected by the road environment.

This review has identified that, while the necessary physical and legal tools are currently available to implement lower speeds in New Zealand, there is little technical guidance easily available for practitioners on when it is appropriate to use them, and equally little positive encouragement to ensure their greater uptake. The net effect is that in many places the status quo of 50km/h and 100 km/h speed limits has proven to be easier to maintain (although it is acknowledged that there are some good local examples of lower speed limits in New Zealand).

Recommendations

It is recommended that the following actions be undertaken:

- Official information on the effect of traffic speeds on pedestrian/cyclist crash severities should be updated to reflect the latest research and further local research undertaken on this.
- Investigation into the reporting of pedestrian and cycle crashes should consider whether there is any procedural bias with respect to reporting speed-related factors.
- The current draft Rural Speed Zoning Policy needs to be updated and brought up to full operational status (or brought into the *Speed Limits NZ* process).
- The *Speed Limits NZ* process needs to be reviewed to make it procedurally easier to implement a lower speed limit. Such measures could include changes to the rating system, introducing a specific rating level above which a speed limit below 50 km/h is recommended, and more clarity about the ability to depart from the Calculated Limit.
- More specific official guidance should be provided on physical measures that may assist with the introduction of a lower speed limit, both in urban and rural areas.
- Guidelines for introducing school speed zones with speeds other than 40 km/h need to be developed, including more guidance on physical measures to support such zones.
- Consideration should be given to having a central register of all non-standard speed limits; that would allow for better national monitoring and follow-up between RCAs of practical implementation issues.
- A national audit should be undertaken to investigate the range of speed limits practice across all RCAs and the reasons for and against their use of the non-conventional tools.
- A central repository of information and research related to speed management treatments should be developed to provide a "one stop shop" for RCAs considering speed-related initiatives. Such a repository could also provide the basis for identifying current gaps in the knowledge base that require local research and trials.

In this way, the full benefits of lower traffic speeds might be realised soon in New Zealand.

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REFERENCES

- ACC/LTSA (2000). *Down with Speed: A Review of the Literature, and the Impact of Speed on New Zealanders*. Accident Compensation Corporation & Land Transport Safety Authority.
- ANDERSON R.W.G. et al. (1997). Vehicle Travel Speeds and the Incidence of Fatal Pedestrian Crashes, *Accident Analysis and Prevention*, No. 29, pp.667-674, Elsevier.
- ASHTON S.J. (1980). A preliminary assessment of the potential for pedestrian injury reduction through vehicle design. *SAE Technical Paper 801315*, SAE Inc., Warrendale, PA.
- BURDETT B., NICHOLSON A. (2010), Speed Management on Rural Roads: The Effect of Pavement Markings, *IPENZ Transportation Group Conference*, Christchurch, Mar 2010, 15pp.
- CCC (2000). Transformation to "Living Streets", *Report to City Services Committee*, Christchurch City Council, Dec 2000.
- CHARLTON S.G., BAAS P.H. (2006). Speed change management for New Zealand roads. *Land Transport New Zealand Research Report 300*. 144pp.
- CHARLTON S.G. et al. (2010). Using endemic road features to create self-explaining roads and reduce vehicle speeds, *Accident Analysis and Prevention*, No. 42, pp.1989-1998, Elsevier.
- DANIEL B., NICHOLSON A., KOOREY G. (2011), Investigating Speed Patterns and Estimating Speed on Traffic-Calmed Streets, *IPENZ Transportation Group Conference*, Auckland, Mar 2011, 14pp.
- DFT (2007). Traffic Calming, *Local Transport Note 01/07*, (UK) Department for Transport
- DRAVITZKI V., WALTON D.K., WOOD C.W.B (2006). Road Traffic Noise – Determining the Influence of New Zealand Road Surfaces on Noise Levels and Community Annoyance. *Land Transport New Zealand Research Report 292*. 76 pp.
- ELVIK R. et al (2009). *The Handbook of Road Safety Measures*. 2nd Ed., Emerald Publishing.
- ERKE A., SØRENSEN M. (2008). Extended shoulders on rural roads: A measure for cyclists and pedestrians? *TOI Report 961/2008*, Transport Economics Institute, Norway.
- HCC (2010). *Speed Limit Bylaw Amendment 2010*, Hamilton City Council, May 2010.
- JACOBSEN P.L., RACIOPPI F., RUTTER H. (2009). Who owns the roads? How motorised traffic discourages walking and bicycling, *Injury Prevention*, No.15, pp.369-373, BMJ Publishing.
- KARNDACHARUK A., WILSON D.J. (2010). Development of Performance Evaluation Framework for Shared Space Schemes in New Zealand, *2010 NZTA & NZIHT Annual Conference*, Christchurch, Nov 2010.
- LANGLEY J.D. et al (2003). Missing cyclists. *Injury Prevention*, No.9, pp.376-379.
- LTNZ (2005). 40 km/h variable speed limits in school zones - Guidelines. *Traffic Note 37*, revision 1, Jun 2005, Land Transport New Zealand.
- LTSA (1997). *30km/h Speed Limits*. Draft Advisory Circular, Dec 1997, Land Transport Safety Authority.

LTSA (2004). Speed limits less than 50 km/h - guidelines. *Traffic Note 43*, Jun 2004, Land Transport Safety Authority.

LTSA (2005). *Draft New Zealand Speed Zoning Policy*, Version 0.4.0, Feb 2005, Land Transport Safety Authority.

MAO J., KOOREY G. (2010), Investigating and Modelling the Effects of Traffic Calming Devices, *IPENZ Transportation Group Conference*, Christchurch, Mar 2010, 15pp.

MINNEMA, R. (2006). The evaluation of the effectiveness of traffic calming devices in reducing speeds on "local" urban roads in New Zealand, *Master of Engineering in Transportation (MET) Research Report*, Department of Civil Engineering, University of Canterbury, Christchurch, New Zealand.

MOT (2010a). *Safer Journeys: New Zealand's Road Safety Strategy 2010-2020*, Ministry of Transport, Mar 2010.

MOT (2010b). Speeding. Crash Statistics for the Year Ended 31 December 2009. Prepared by Research and Statistics, Ministry of Transport.

MOT (2010c). CAS (Crash Analysis System) data for crashes involving pedestrians or cyclists, 2005-10. Ministry of Transport, accessed 10/12/10.

NILSSON G. (2004). Traffic safety dimensions and the power model to describe the effect of speed on safety. *Bulletin 221*, Lund Institute of Technology, Lund, Sweden.

NZ GOVERNMENT (2003). Land Transport Rule: Setting of Speed Limits. *Rule 54001* and subsequent amendments (2005/2007/2009), Wellington.

NZ GOVERNMENT (2010). New Zealand Transport Agency (Speed Limits on State Highways) Bylaw 2010/10, *New Zealand Gazette*, 1/09/10, Issue No.112 and subsequent amendments, Wellington.

OECD/ECMT (2006). *Speed Management*. Organisation for Economic Cooperation & Development & European Conference of Ministers of Transport, Paris, France.

OSMERS W. (2002). The Warrant for 40 km/h School Zones (Electronically-Signed Part-Time Speed Limits at Schools), *IPENZ Transportation Group Technical Conference*, Rotorua, Sep 2002.

ROSÉN E., SANDER U. (2009). Pedestrian fatality risk as a function of car impact speed. *Accident Analysis and Prevention*, No. 41, pp.536-542, Elsevier.

ROSÉN E., STIGSON H., SANDER U. (2011). Literature Review of Pedestrian fatality risk as a function of car impact speed. *Accident Analysis and Prevention*, No. 43, pp.25-33, Elsevier.

STANDARDS NZ (2010). Land Development and Subdivision Infrastructure, *New Zealand Standard NZS4404:2010*, Wellington.

TRL (2007). The Manual for Streets: evidence and research, *TRL Report 661*, prepared for Traffic Management Division, (UK) Dept for Transport, Transport Research Laboratory, UK.

TURNER S.A., ROOZENBURG A.P., FRANCIS T. (2006). Predicting accident rates for cyclists and pedestrians. *Land Transport New Zealand Research Report 289*. 180 pp.

WCC (2009). Lower Speed Limits in Suburban Shopping Centres. *Strategy and Policy Committee Report 2 (1215/52/Im)*, Wellington City Council, 11 June 2009.

WIGMORE B.J. et al. (2006). School journey safety: a comparative study of engineering devices. *Land Transport New Zealand Research Report 271*. 118 pp.

WRAMBORG P. (2005). A New Approach to a Safe and Sustainable Road Structure and Street Design for Urban Areas. *13th International Road Safety on Four Continents Conference*, Warsaw Poland, Oct 2005.