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# VISIBILITY OF ROADSIDE BARRIERS AND KERBS IN NEW ZEALAND

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## INTRODUCTION

The issue of the marking of roadside furniture along its length has been difficult to unravel because of ambiguities in language and uncertainties of intent. The terms “hazard marking” and “delineation” can both have different interpretations, and often they are (incorrectly) used interchangeably. While the nature of hazard marking and delineation are prescribed and are to be of different forms, their roles can often blend together, as, for example, when a row of marked hazards (e.g. power poles) can become also a de-facto delineation of the route ahead, but displaced from the true carriageway. The devices used to mark hazards are often termed “delineators” - a generic description for small reflective devices which can be used for either hazard warning or for delineation.

The term “hazards” is applied to objects beside the road, which would cause significant damage and injury if struck. These objects are either marked, or the motorist shielded from them by guardrails that are themselves often not marked, as a guardrail is intended to be a structure capable of being impacted without serious injury occurring. But, if guardrails are struck, damage and minor injury often occurs and in some circumstances serious or fatal injury is still possible. The term “hazards” is also often applied to both geographical features along the route that would be dangerous if the car left the road (such as cliffs, rocky foreshores, or rivers), and geometric features of the route (such as sharp curves). Strong delineation of the route should guide drivers around and past these hazards and guardrails near the road edge should prevent the vehicle from leaving the road.

At a local level, road safety practitioners are responding to a perceived driver-need and are developing ad hoc solutions. For example, markers are often fixed onto these guardrails but it is often not clear whether the intent was to mark the hazard potentially posed by the guardrail or to strengthen the delineation around the hazard which the guardrail is providing additional protection from.

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Apart from bridge ends and sides, most of the furniture that is the subject of this report is confined to major roads. For these roads in New Zealand there is a clear and well implemented policy to mark the safe carriageway (where to go). There is also a clear but less well implemented policy to mark dangerous objects in the “clear zone” away from the road (where not to go). It is the transition between these two zones in the road shoulder area, where most of the road furniture is placed, that both policy and practice are the most ambiguous as to where it is safe to go and where there is furniture that may be difficult to see. Currently there is no crossover between delineation and hazard marking. That is, in New Zealand use there is no official dual purpose marker for delineation and hazard marking. The regulations specifically state that delineation devices should be used strictly for route guidance, never for hazard marking.

This paper picks through these two main issues: of how to illustrate the objects near the road to avoid; and how to mark the safe route ahead, with a view to developing a recognised national approach. While not providing conclusive solutions it does identify a set of potential solutions for further evaluation.

### **The Potential Hazard of Unmarked Furniture**

Longitudinal road furniture is generally installed for road safety purposes. Barriers are typically used to reduce the severity of a crash by reducing the chance of a vehicle either crossing the centre line (median barriers) or leaving the road (roadside barriers), where it is hazardous to do so. Kerbs are used for more varied purposes, including separating pedestrian and vehicular traffic, for drainage, and as a tidy edge around traffic islands and bordering medians.

This furniture, such as guardrails and kerbs, are often positioned very close to the traffic lane, even within the roadway. They are usually grey in colour and can be difficult to see, particularly at night and in the wet, because they tend to blend in with the road environment. They can therefore also be a hazard to traffic, though usually a much lesser hazard than the one they are intended to protect drivers from.

Although difficult to see, the furniture is often marked only in part. Hazard markers are placed on bridge ends; on the approaches to traffic islands; and medians and frequently at the start of crash barriers. In addition, delineation in the form of continuous painted lines may also be used to define the edges of the intended vehicle pathway, and if not traversed, drivers would safely pass the furniture.

However furniture is not required to be marked along its length even though it can be long, extending up to several hundred metres and even for kilometres. The unmarked length can still present a hazard because:

- After passing the end with the hazard marker, the driver receives only poor information of his position relative to the furniture, which can be difficult to distinguish in the dark. Drivers may be unaware that the furniture is still present.
- New Zealand has no minimum standards of visibility of painted delineation, nor requirements for markings to remain visible in the wet. Marking brightness is low compared to international standards and painted edge lines become difficult to see in wet weather, weakening route delineation and increasing the chance of the motorist straying from the travelled way and towards road furniture.

- There are no rules that state that a motorist cannot cross the painted edge line, and in some cases this is even encouraged. For example, slow vehicles are encouraged to “pull off to the left” to let faster traffic through in holiday advertising campaigns, urban traffic is required to clear the roadway to let emergency vehicles through, and tired drivers are encouraged to pull well off the road and rest.
- Current delineation practice is for it to be consistent along its length, yet the road shoulder beyond the edgeline can be variable with either clear shoulder, or guard rails and kerbs in place. Drivers at night therefore can receive a message of an apparently consistent road environment, which could be misleading.

There appears to be two issues in marking longitudinal furniture:

- How to continue the same standard of delineation through the affected road section, when the presence of the furniture may make including or mounting the delineation difficult.
- How to provide warnings to the driver where longitudinal roadside hazards exist and the distance of the hazard from the road, but that do not interfere with existing delineation.

### Indications of Contribution to Crashes

The LTSA’s Crash Analysis System (CAS) shows that longitudinal road furniture was associated with crashes in New Zealand - over a six-year period from 1994 - 1999 this type of road furniture was associated with 1,796 injuries and 164 fatalities. At present the crash reporting would not enable an assessment of the contribution that lack of hazard marking along the length may have had on the crash cause so no analysis of the value of improving the visibility of the furniture is possible.

Crash statistics from 2001 of injury-causing crashes recorded to involve objects being struck are shown below. The statistics give an indication of the type object struck and the influence of the dark. Care is needed with this data as more than one object may be struck in (and therefore recorded against) an individual crash. In addition, many crashes involving only a single vehicle may not be reported and therefore not feature in the database. However, the data still indicates that nearly half of the crashes involving objects being struck occurred in the dark, yet only a quarter of the VKT are in the hours of darkness. This provides a quite strong indication that poor visibility of the furniture at night may be a contributing factor.

#### Injury-causing crashes involving striking of objects on urban and rural roads in 2001

Object Struck	Urban roads (<70km/h)		Rural roads (≥70km/h)		Total
	Total	In dark	Total	In dark	
Bridge end or approach rails	18	9	69	30	87
Guard Rail	27	17	171	67	198
Traffic Island or median	83	52	21	8	105
Kerb	82	44	17	9	99
<b>Total</b>	<b>210</b>	<b>122</b>	<b>278</b>	<b>114</b>	

## NEW ZEALAND REQUIREMENTS FOR MARKING OF HAZARDS AND ROAD FURNITURE

### General

The Manual of Traffic Signs and Markings (MOTSAM) sets out the policy and location requirements for road markings, delineators and hazard markers. It gives mandatory

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requirements for state highways and is strongly recommended to all local authorities to encourage consistent marking practices nationally (MOTSAM Preface 1997). New Zealand requirements relevant to the visibility of roadside furniture are described in MOTSAM, Part 2, Section 5 (1994). This states that objects within or immediately adjacent to the road can constitute a hazard to traffic.

Hazards<sup>1</sup> include the ends of furniture within the road, or objects within nine metres of the roadside<sup>2</sup>.

MOTSAM states that the ends of guide rails, guardrails, handrails, and vertical, or near-vertical, kerbs may constitute a hazard to traffic. It also provides details of how “isolated hazards” should be marked: painted white up to 1.7m above ground and marked with two reflectorised white discs.

Furniture ends must be marked except when the furniture is an approved guardrail or a guardrail protects the end. Marking typically comprises, painting the ends white and affixing a hazard marker, or bridge end marker if applicable. Other than in some circumstances, approved guardrails on the roadside are not needed to be marked.

The aim of delineating the start of furniture is to alert the road user to the presence and proximity of this potential hazard within the clear zone.

Delineation refers to long range route guidance, which is normally provided by edge marker posts chevrons, road markings and pavement markers. Another document “Guidelines for Rural Road Marking and Delineation: 1992 (RTS5)” advises on marking delineation of local authority roads, which extend to very low daily traffic volumes.

An important concept, indicated in MOTSAM, is that route delineation, and hazard marking are to be treated independently. Delineation is provided to mark the road alignment so the route is clearly visible. Hazard marking is provided to make hazards visible so that the driver is aware of their presence and can take the appropriate care. MOTSAM states that edge marker posts should be used only for route delineation, and never for hazard marking.

This implies that marking the **hazard** of road furniture along its length should be done with hazard markers (possibly a new form of marker) and not with markers normally used for delineation.

## **Furniture Within the Road**

Additional signs and delineation are placed on, or prior to, the hazard itself to guide the road user around it. For example: keep left/keep right (RG17), or diverging traffic (PW5) signs, and height restriction signs (for overpasses).

## **On-road Markings and Delineation Associated with Hazards**

A process of providing delineation to show the safe path supplements warning drivers of hazards. Markings and delineation on the road and adjacent roadside are used to guide the

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<sup>1</sup> “Objects which may constitute a hazard to traffic include bridge end posts and bridge end kerbs, ends of guide rails and hand rails, piers and abutments at underpasses, ends of vertical or near vertical kerbs, soffits of underpasses with less than 4.4m clearance, service poles and lighting columns, ends of medians and safety zones and trees with trunk diameter of more than 150mm” (MOTSAM 5.01.02)

<sup>2</sup> Within 9m from the road if there is no kerb, and within 600mm if there is a kerb (MOTSAM 5.02.02)

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road user past the furniture where it impinges on the roadway, and may start in advance of the furniture to divert the road user around the furniture. The on-road markings are lines, of either paint or specialised products, occasionally supplemented with raised pavement markers. Roadside markers are edgemarker posts. The posts are spaced and placed so as to provide a “smooth flowing pattern of delineation, which defines the trafficable portion of the carriageway” (MOTSAM 5.05.04). They are placed no further than 3m from the side of the adjacent traffic lane.

Often the roadside furniture can make the normal placement of the edgemarkers difficult. Little guidance is provided in MOTSAM on continuing the delineating edgemarker posts along the furniture with the exception of across one-lane bridges, where it suggests the optional use of edgemarker posts continued at a 20m spacing (MOTSAM figure 5.6). In practice this same treatment is often applied to guardrails in general. (It is probably this issue of continuing the edgemarker post type delineation along the furniture that is a major driver for practitioners to seek to mark the furniture along its length, especially guardrails.)

MOTSAM requires advance delineation for the two situations:

- (a) Furniture within the roadway: “All objects located within the roadway and constituting a hazard to traffic require (on road) approach markings to guide the traffic past the object...the markings shall take the form of reflectorised yellow lines and stripes”. (MOTSAM 5.04.01) This is re-iterated in Section 2.08 in the context of raised islands separating opposing traffic. For islands separating diverging traffic, white lines and bars are used.
- (b) One-lane bridges (where the road narrows to cross the bridge), where the preceding route is delineated with edge marker posts. Here MOTSAM (Figure 5.6) requires the edgemarker post system to taper into the start of the bridge or if protected by guardrail to the start of the guardrail, (before the guardrail tapers in).

MOTSAM requires ongoing edgelines beside central medians.

- (c) MOTSAM (2.03.04) advises edgelines be fitted to roads with a raised median, one edgeline on the shoulder the other near the central median. These edgelines are permissible on urban roads, recommended for rural roads and are specified for rural median divided roads. These edgelines can be supplemented with red RRPM in extreme cases (2.03.08).

MOTSAM does not specify any performance level of the road markings other than that they are to be reflectorised.

MOTSAM Section 5 was last revised in 1994, and RTS5 in 1992. Since then the use and range of available road furniture, in particular guardrails and kerb extensions, has increased, as has the availability of high performance materials and the use of reflectorised devices. For example, it is now Transit New Zealand’s intention to reflectorise all state highway road lines, to ensure good levels of dry-night visibility.

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## SOME METHODS BY WHICH ROADSIDE FURNITURE IS MARKED ALONG ITS LENGTH IN NEW ZEALAND

### General Overview of Practice

An informal telephone survey of about 35 road safety practitioners which include consultants, Transit and LTSA personnel, was undertaken to identify current New Zealand practice.

The common perception of the road safety groups was that many barriers, particularly concrete barriers, were hard to discern at night. This was perceived as a problem, even when overhead lighting was present. In wet conditions the problem was seen as especially acute, as painted road markings become significantly less visible, thus route guidance becomes correspondingly poorer.

Raised pavement markers, and profiled line markings are touted as possible solutions within existing accepted practice. However, it was noted that for roadside furniture located on the left hand side of the road, these treatments may interfere with the safety of cyclists, an area of concern in recent times.

The majority of practitioners consulted considered that the minimum MOTSAM practice provided an inadequate level of visibility of roadside furniture and gives insufficient advice for the treatment of roadside furniture. Most practitioners stated that there were situations where they were doing more than the minimum requirements of MOTSAM, and had improved night-time visibility of barriers and kerbs along their length. Their rationale for doing so was not based on quantitative crash data, but rather on an intuitive assessment of the need to better mark the route and its potential hazards. Some conflicts were identified between consultants, who wished to mark the barriers, and road controlling authorities who sought to comply with MOTSAM.

Some practitioners expressed concerns regarding the overall variety of delineation used around furniture, and the national inconsistency that this is likely to lead to. Concerns were also raised about the misuse of delineation and hazard marking; some treatments were over-dominating, causing glare or an imbalance with other delineation. This was commonly due to the treatment being too bright, too large, or too frequently spaced. There is considerable demand for better guidance within documents for the marking of, and delineating along, roadside furniture.

It is also believed that roading authorities and consultants are not clear in their intent in marking this furniture. That is, it is not clear if they are trying to better indicate the hazard of the presence of furniture, or whether they are trying to strengthen the delineation of the route by for example marking the guardrail to give better emphasis to a tight curve. This intent is significant because hazard marking and delineation differ in their purpose.

Some specific treatments were as follows.

### Barriers

These treatments are primarily attempts to keep the continuity of delineation through the area. They both strengthen delineation of the geometric feature, and their placement on the furniture helps to highlight the presence of the furniture. However, they do not do this unambiguously and the driver may not perceive the section of roadway with guardrail marked in this way as any different from the rest of the road where there is a clear roadside.

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Placing standard delineation features on the furniture could be construed as contravening MOTSAM, especially if the intent is to warn of the furniture, not strengthen the delineation of the route past the furniture.

- Painting Guard Rails using either reflectorised or non reflectorised paints.
- Fixing delineators or hazard markers (edgemarker posts, reflectors, reflectorised sheeting) onto the barrier either:
  - (a) In front of, or flush with, the roadside face of the road furniture, using reflectors as sheeting. For example, chevrons were either placed on to or attached to the face of the barrier. Chevrons placed on the face of the barrier appeared to give a better indication of both the curvature and the proximity of it to the road. However, chevrons are a delineation (curvature defining) device, and as such may not be suitable as a part-delineation/part-hazard-marking device.
  - (b) On top of the barrier, using chevrons or raised pavement markers: Standard (red, white, or yellow) raised pavement markers are attached to the top or face of concrete and w-section barriers
  - (c) Edgemarker posts above but behind the roadside face of the furniture - so that the furniture face is between the edgemarker post and the road (for example, on the support posts of metal guard rails, or behind a vertical kerb face). MOTSAM states that edgemarker posts should define the edge of the trafficable portion of the carriageway. Clearly, when placed behind a barrier on the left hand side of the road, this is not the case, and there is the potential to mislead motorists to believe that they have more shoulder available than is actually present.

Other treatments are:

- (d) An ad hoc treatment is to use small triangular sections of standard edgemarker posts applied with a reflector are attached into the cavity of w-beam railing using a single bolt.
- (e) The 3M Linear Delineation System (LDS). This consists of one metre long strips of corrugated reflective sheeting, and is mounted to the face of barriers by bolts at each end. This system is particularly bright under headlights. Concerns have been raised that a balance needs to be maintained:
  - geographically before and after treatment by LDS to avoid migration of crashes, and
  - with other delineation and markings present, to avoid LDS "Overpowering" them.
- (f) A circular reflector which is attached to a flexible base. This is inserted into the cavity of w-beam guardrails at 20 to 50 metre spacing. The aim is to provide delineation and an indication of the proximity of the guardrail to the traffic lane, while not posing a threat to pedestrians and cyclists.

### **Treatments for Wire Rope Barriers**

Wire rope barriers can present some particular difficulties. Unmarked they are difficult to see but the nature of the product limits the opportunity to fix reflective material to them.

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Small single yellow reflectors are currently fixed to the posts of this system at about 100 metre spacing. These are of low effectiveness but there is the opportunity to increase the density by marking many more of the posts and to select a reflector that will not be confused with edgemarker posts.

## **Kerb Treatments**

Kerbs pose a particular visibility problem because of their very low profile and are generally made of grey concrete and unmarked. This can make them blend into the roadside, especially at night, or in visually “busy” intersections.

The most common treatment for kerbs is to paint them white with non-reflectorised paint. However continuous marking of kerbs has the danger of appearing to be a road edge line, indicating to the driver that it is part of the traversable portion of the road, therefore consideration should be given to kerb marking which should be discontinuous: for example, dashed or dotted.

## **Edge Marker Posts on Kerb**

Edge marker posts are attached flush with the right hand side edge of the kerbing. This is intended to provide delineation along a section of kerbed road, which conveys the true trafficable width of the roadway.

However, this treatment restricts the width of the footpath (if present) for pedestrians. Furthermore, there are potential dangers for cyclists when they get as far left as possible to avoid passing-traffic. Posts that have been knocked out of alignment can pose a specific hazard to both cyclist and pedestrian traffic.

## **INTERNATIONAL PRACTICE FOR IMPROVING THE VISIBILITY OF ROADSIDE FURNITURE**

Practices for improving the visibility of roadside furniture in Australia, the USA, Canada, England, Sweden, and Denmark were reviewed.

It appears that there are generally two types of treatments in use in these countries.

- Pure delineation, where the only goal is to indicate the route ahead.
- Mixed delineation and hazard warning, where the goal is to indicate the presence and proximity of the longitudinal roadside furniture, as well as to assist with delineation along its length. Often these objectives are not separated in the guidelines or by the practitioner, and the term “delineation” is often used where “hazard marking” would be more appropriate. In the following summaries, these terms have been changed, where appropriate, as inferred from their context.

## **Australia**

State Road authorities in New South Wales, South Australia, and Victoria indicated that they have their own requirements that incorporate the principle of AS1742.2 in requiring markers to be attached to guardrail installations that are within 4 metres of the running lane. For roadside furniture situated greater than 4m from the nearest lane edge, no markers are used in order to minimise driver distraction.

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The typical treatment where the guardrails and concrete barriers are within 4m of the running lane, delineators are attached at the appropriate interval. These devices are intended to serve the dual purpose of providing alignment information to the road user and also informing them of the presence of road side furniture.

The treatment comprises of a circular or rectangular reflector, which is made of either sheeting or acrylic material - red on the left hand side and white/yellow on the right hand side. This is attached to the guard rail/barrier/guide-post at a height that (usually) corresponds to the eye-level of the driver (approx 1m above the road surface).

Inclined faces of the median kerbs are normally painted white. All pavement markings are reflectorised using glass beads. Care is taken to use pedestrian- and cyclist-friendly devices.

## **USA**

The United States Department of Transportation, Federal Highway Administration (FHWA) have national requirements for delineation and hazard marking in their Manual of Uniform Traffic Control Devices (MUTCD 2000, Chapter 3). The manual states that “Delineators are considered guidance devices rather than warning devices”. As this implies, the regulations for delineation along guardrailing follow closely to the standards for road delineation in general. Curves, and un-illuminated road sections may be delineated, as can barriers lying within 2.4m of the roadside. The delineators are to be mounted behind the guardrail, and have a reflective element with a minimum dimension of at least 75mm, visible from 300m away when viewed under high beam.

In practice, the different states within the USA handle delineation along roadside furniture in a variety of ways. Some states use a reflective tab that fastens to the head of the guardrail bolt as a delineator on guardrails, while others drive a standard delineator post behind the guardrail next to the guardrail post.

## **United Kingdom, Canada, and Sweden**

The situations in the United Kingdom, Canada, and Sweden are very similar to New Zealand’s current situation, where there is no formal treatment for longitudinal furniture. Some practitioners in these countries have attempted to remedy the perceived shortfall of their respective marking guidelines by applying their own visibility treatments, as is the case in New Zealand.

## **Denmark**

Current practice is to continue delineation along the length of longitudinal roadside furniture using the same reflectors used for standard route delineation (90x150x200mm white fronted/yellow backed). The reflectors are spaced every 100m on straights, and at less than 50m intervals on curves.

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## PROPOSED METHODS FOR NEW ZEALAND USE

### General

The presence of longitudinal furniture, either in, or to the side of the road, causes difficulties for continuing delineation along the route. Roadside barriers, bridge railing, tunnel walls, and kerbing, generally cause a narrowing of the traversable roadside area available to the road user. According to the national road marking guidelines (in MOTSAM), edge marker posts must be placed within the trafficable width of the road. Clearly then, to continue edgemarker post delineation where longitudinal roadside furniture exists, it is necessary to mount the posts on the near side of the furniture. This certainly may pose a safety hazard for pedestrians and cyclists, and may not even be possible in many situations (such as narrow bridges, tunnels, etc). Therefore, to safely provide adequate route guidance along roadside furniture, another method of delineation may be necessary.

A closely related, yet distinct, concept is that drivers should be aware that the longitudinal furniture exists, so that they can take the appropriate care (perhaps lowering speed) and so that no confusion exists as to where it is safe, and when it is not safe, to pull off the road. In this respect, barriers and kerbs themselves can be considered hazards, and should be marked as such along their length.

It should be possible to provide adequate solutions to both problems with a single treatment. The treatment would have to indicate to the road user:

- that roadside furniture is present,
- its proximity to the road,
- route guidance, at least to the standard of delineation that would otherwise have existed without the furniture in place.

Thus the design of the treatment must be distinct from the standard delineation devices (such as edge marker posts) to clearly indicate that roadside furniture is present. This distinction is even more necessary now that edge marker posts are made of flexible impact resistant material. The replacement rate of 10 to 15% per annum shows that they are often hit, and because most drivers now know that the posts are flexible they may make less effort to avoid them. (This excludes those who hit them deliberately.)

### Guiding Principles

This review has identified that there is no defined "International Best Practice" that we can recommend to be used directly in New Zealand. There are a number of examples that are worth pursuing further, but often some specific trials should be undertaken to evaluate the effect of the treatment in the New Zealand context. However the need for guidance on how to mark roadside furniture was clearly apparent from the review of current New Zealand practice.

In formulating guidance we have first identified some general principles to form the basis of recommendations. These are a distillation of current New Zealand practice and our view of how international practice could be included and improved on and fitted to the New Zealand road environment. These general principles are:

- Markings and warnings along the route should illustrate the variability of the close-in roadside environment, that is about 3-4 metres from the edge of the left hand lane, so

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that a driver at night time has a similar appreciation of this variability in this zone as would a driver in the day time.

- Roadside furniture close to the road edge should be marked along its length to indicate its presence.
- The safe path on the road should be marked where it would be hazardous to stray from the safe path, and this marking should be visible in all weather conditions.
- Delineation of the safe route should be given prominence i.e. the brighter markings, with hazard markings on the periphery being of a lesser brightness so as to be readily discernable without being distracting.
- Markings and warnings should be simple and uncluttered, that is a multiplicity of lines of markers should be avoided.
- There needs to be a balance in the brightness of the markers and road markings also along the road.

### Specific Treatments Proposed

- There should be consistency in marking the start of guardrails. At present only some are marked. This should be extended so that all guardrails are marked at their ends.
- The markings that are currently used to mark the safe route beside roadside furniture should be upgraded to markings which are brighter and which still function in wet night conditions. This will address the problem of many markings being of poor visibility to older drivers and of almost all current New Zealand road markings not being visible in the wet.
- A marking is needed to advise that it is hazardous to cross over the left hand edge line. This is particularly for kerbs in rural areas, and on bridges. The current white line does not have this role in New Zealand unlike Australia where the solid left hand edge line is not to be crossed.

The two candidates line types are:

- A continuous yellow line. This line type already exists for the centre line but its use to the left hand side may require education as to its purpose. The yellow line has the advantage of being effective both in day light and night time and, if appropriately specified, would not require RRPM's for night or wet night effectiveness. However its use would require other changes to maintain consistency, for example with approaches to medians.
- Red reflective pavement markers fixed onto the left hand edge line. This treatment almost has the "no crossing intent" in rural areas already but this is not explicit and this meaning is corrupted by alternative uses in urban areas.

This "no-crossing" line type should also be used on the right hand edge line where there is a low profile median adjacent to the lane. In the "RRPM on white line" option, a number of areas in New Zealand are already using red on the left hand edge and yellow RRPM against the median and this appears suitable for a national approach.

- Only furniture close to the road should be marked along its length with hazard markers. Australia marks guardrails up to 4 metres back from the road edge, the USA about 2-4 metres back. New Zealand roads do not always have such wide shoulders. Marking furniture that is 1 metre behind the line of the edge marker posts is proposed, as the EMP positions will already be determined relative to the actual shoulder width at that location.

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- A new marker type is needed which can fulfil both functions of marking the hazard of the furniture along its length such as guard rails or sight rails and which continue the route delineation currently provided for the rest of the route by edge marker posts. This type of marker would be used mainly in rural areas where the furniture is intermittent and the roadside environment is therefore variable rather than on urban motorways where generally the guard rails are continuous, there are generous shoulders marked with diagonal lines, and the roadside environment very consistent.

There are several candidate devices, which include readily available commercial products and some home grown trial devices. Circular prismatic reflectors are used in both Australia and some states in the USA. These are coloured red and so continue, for Australian at least, the use of red reflectors on the left hand side. They are usually fixed to the top of the guardrail posts or concrete barriers.

The alternative approach in New Zealand would be to taper the edge marker posts towards the barrier and continue the posts along the top of the guardrail. We propose that an alternative reflective device be identified for New Zealand use; first because the use of end marker posts at the guardrails does not signal the changed road side environment; and second because the edge marker post is difficult to apply to concrete barriers or bridge sides. These markers need to be balanced with markings on the road, and with the rest of the delineation both before and after the hazard. Specific trials will be needed to identify appropriate devices.

Delineation of the **safe** road should be given priority with respect to the brighter markings and hazard markings should be less intrusive. Where the furniture is close and parallel to the road edge then it can be used to reinforce the delineation around, for example, a tight curve. This could be achieved by increasing the marker density and if necessary the brightness, or size.

## SUMMARY OF RECOMMENDATIONS FOR MARKING ROADSIDE FURNITURE

- (a) The current practice of marking the end of some guardrails should be extended to the ends of all guardrails.
- (b) Roadmarking used to mark the safe route beside roadside furniture in rural areas should be brighter and function in wet conditions (Retroreflectivities, based on 100mm wide lines, of  $100\text{mcd}\cdot\text{m}^{-2}\cdot\text{Lux}^{-1}$  in the dry and  $50\text{mcd}\cdot\text{m}^{-2}\cdot\text{Lux}^{-1}$  in the wet are recommended).
- (c) A new marking type that denotes “do not cross” is recommended for the left hand lane edge line (equivalent to the yellow centre-line), for use where it would be hazardous to do so such as kerbs in rural areas and against kerbs on bridges. Possible markings that should be further investigated are; a solid yellow line or a solid white line with coloured reflective raised pavement markers.
- (d) Furniture within 1 metre of the line of edge marker posts should be marked along its length with hazard markers.
- (e) A new marker type that can fulfil both functions of marking hazards and providing delineation should be further investigated for use in rural areas where the furniture, such as road edge guardrails or sight rails, is intermittent, and marking it warns both of the hazard and strengthens the delineation of the road.
- (f) Delineation of the safe route should be a priority and be brighter than for hazard marking.

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