Guideline

Bicycle lane separation devices

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Queensland Government

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1 Purpose and scope of this guideline

This guideline has been prepared to provide guidance on preferred treatments and design characteristics of bicycle lane separation devices.

Austroads *Guide to Road Design* Part 6 *Roadside Design, Safety and Barriers*, Section 5.1.3 *Road Safety Barriers for Vulnerable Road Users* addresses road system barriers but adjacent to off-road shared paths rather than for on-road bicycle lanes. Austroads *Guide to Road Design* Part 3 *Geometric Design* Section 4.9 *Bicycle Lanes* discusses separated bicycle lanes, protected bicycle lanes and supplementary treatments but does not provide specific safety design details about the separation treatment. Section 4.9.5 *Separated Bicycle Lanes* states *'Designers may also refer to road agency publications that may provide additional information, including local requirements and examples of treatments*'. Transport and Main Roads guideline *Selection and design of cycle tracks* also discuss separation treatments, including widths but does not provide guidance on separation device design considerations.

1.1 Background

Transport and Main Roads supports the implementation of on-road separation between people riding bikes and motorists. There is currently limited design guidance, however, on how to best implement these separation treatments and to ensure new hazards are not created for people riding bikes. A number of incidents have been reported (refer to Section 4.1 *Case studies*) that emphasise the importance of ensuring separation treatments are not hazards in their own right.

While separation devices increase the lateral separation between people riding bikes and motorists, research confirms that some devices and/or treatments are more effective than others.

The degree and type of separation varies, with separation being provided through road markings, vertical separation, physical barriers, and a combination of devices. This guideline provides a recommendation of preferred separation devices which are suitable for use alongside on-road bicycle lanes.

1.2 Related documents

This guideline should be read in conjunction with the following:

- Austroads *Guide to Road Design:*
  - Part 3 *Geometric Design*
  - Part 6 *Roadside Design, Safety and Barriers*
  - Part 6A *Pedestrian and Cyclist Paths*
- Austroads *Cycling Aspects of Austroads Guides*
- Queensland *Manual of Uniform Traffic Control Devices:*
  - Part 2 *Traffic Control Devices for General Use*
  - Part 9 *Bicycle Facilities*
- Transport and Main Roads guideline *Selection and design of cycle tracks*.

2 Preferred separation device

2.1 Device configuration

The preferred separation device configuration is a **vertical delineation device on a separation kerb, within a pavement marked buffer**. The design aspects of the preferred separation device are detailed in Figure 2.1(a) and Table 2.1.

Figure 2.1(a) – Key features of preferred treatment

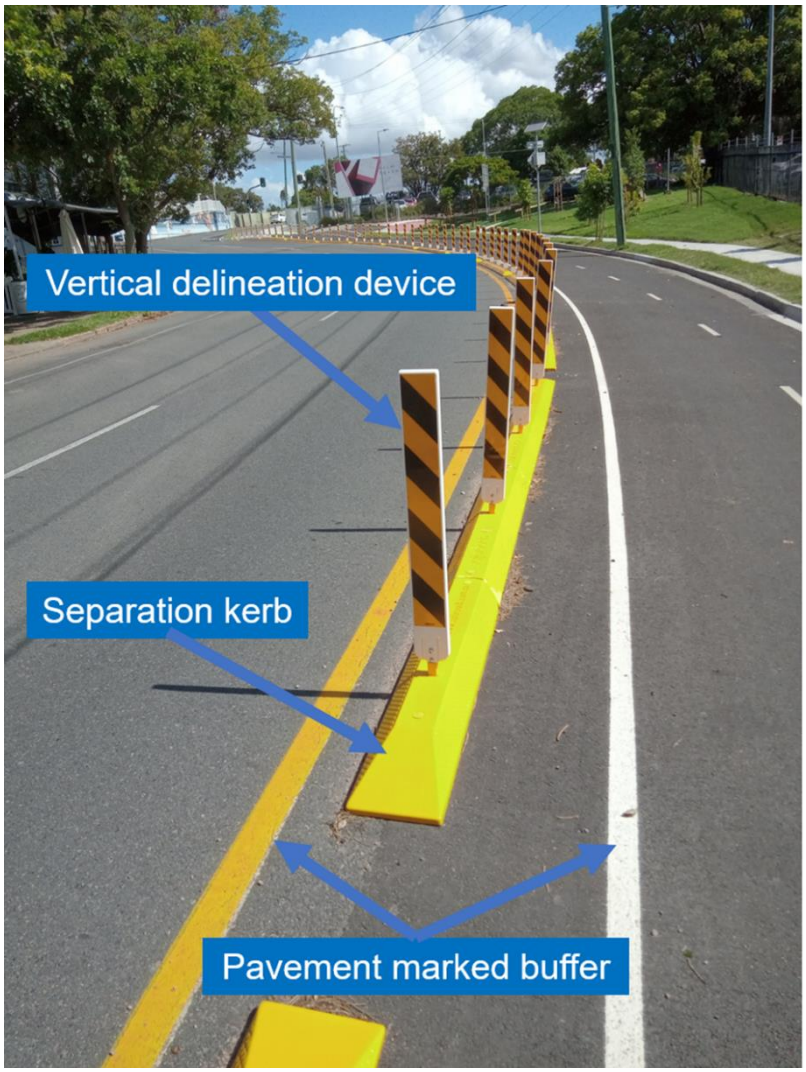

Table 2.1 – Preferred separation device design attributes

Preferred safety design features	Function	Considerations
Separation kerb	Provides a safe mounting for vertical delineators and a tactile deterrent to vehicle encroachment. To optimise safety outcomes, the preferred separation device must have the following characteristics: • conspicuous through use of contrasting colours and inclusion of fluorescent and retroreflective elements • slip-resistant wet pendulum >65 BPN • semi-mountable on the bicycle side, not incorporating a vertical lip (refer Transport and Main Roads Standard Drawing 1033); a barrier profile may be appropriate on the motor vehicle side to reduce motor vehicle encroachment • continuous treatments are preferred compared to short sections of discrete devices; they should be sufficiently long that they are legible on approach (for example, install the kerbs on the approach to corner of conflict zone such that they reinforce to motorists the desired travel path in their own lane).	• Breaks in the device should be included to remove a 'debris trap' and overland flow / road drainage should not be significantly affected. • Drainage gaps shall incorporate sloped ends no steeper than 1 in 4 on the leading edge. • Avoid short sections of separation kerb as it may appear unexpectedly to people riding bikes. • Regular monitoring and clearing of debris build-up in the bicycle lane and near the device is required. • The vertical height of the device makes it difficult for vehicles to mount it at reasonable speed and/or comfort and is therefore only suitable where there is no demand for vehicles to cross the device (for example, to access car parking or driveways). • Where access to driveways needs to be maintained, fully-mountable separation kerbs may be used in these sections only (as illustrated in Figure 2.1(b).
Vertical delineation device	Improves conspicuity, reduces the likelihood of bicycle wheel strikes and complements the vehicle encroachment deterrent provided by the separation kerb. Improves visibility and raises awareness of the separation kerb to pedestrians crossing the road, reducing the trip and fall risk.	• These are effective in improving the legibility and visibility of the installed physical separation kerb. • These are very effective in improving safety of people riding bikes. They are more effective when installed with other devices (for example, separation kerb) rather than directly into the road surface. • The height should be the equivalent of a road edge guide post. • The device should be installed at the front face of the treatment and at regular intervals. • Additional / more frequently spaced devices may be required based on site characteristics such as horizontal alignment or where there is a lack of or limited street lighting. • Larger gaps in spacing may be considered where there is a need for vehicles to cross the device. • A disadvantage of this device is the potential for impact damage and associated frequent maintenance / replacement costs.
Pavement marked buffer around the separation kerb	Improves delineation and provides the required offset to vehicles and bicycles from the separation device.	Refer to offset requirements to travel lanes specified in the *Road Planning and Design Manual* and Austroads guides.

Figure 2.1(b) – Example of mountable separation kerb for driveway access

2.2 Site design considerations

Site design aspects to be considered when installing bicycle lane separation devices include:

- bicycle lane width and the potential for the device to hinder passing or overtaking within the bicycle lane
- the type of people riding bikes likely to use the bicycle lane:
  - groups or individuals
  - children or adults, and
  - level of experience
- the likelihood of motor vehicle encroachment, especially at:
  - feeder bicycle lanes to advanced storage areas or advanced stop boxes
  - horizontal curves
  - weaving situations, and
  - intersection auxiliary lanes
- traffic volumes and proportion of heavy vehicles / buses
- locations where there is high vehicle or pedestrian demand across / through the bicycle lane:
  - strong desire line of people walking along or across the bicycle lane
  - kerbside bus stops (consider bus frequency)
  - kerbside car parking (consider turnover rates and if it is reconfigurable), and
  - driveways at high vehicle trip generators.

Guidance on these issues can be found in:

- Austroads *Guide to Road Design* Part 3, Section 4.8 *Bicycle Lanes*, and
- Transport and Main Roads guideline *Selection and Design of Cycle Tracks*.

3 Historical applications

Figure 3 – Example of historical concrete barrier kerbs

Use of concrete barrier kerbs or 'wheel stops' are common on historical separation treatments, as shown in Figure 3. These treatments are appropriate only if the risk of vehicle encroachment into the bicycle lane is greater than the risk of crashes by people riding bikes and motor vehicles with the device. If used, they must incorporate colour contrast, retroreflection, a pavement marked buffer and vertical delineation devices similar to that detailed in Table 2.1. They must also have a semi-mountable profile facing on the bicycle lane side with ramped ends at the drainage cuts combined with increased width at the entry and distinct delineation on the ends.

4 Background

4.1 Case studies

4.1.1 David Low Way, Bli Bli, North Coast District

Transport and Main Roads' North Coast District was subject to a personal injury claim in December 2016.

As part of a roundabout construction, a developer installed a small concrete island which was struck by a person riding a bicycle.

The images following show a concrete island separating the bicycle lane from the road. There are two gaps in the concrete for driveways accessing David Low Way across the bicycle lane. The last photo in Figure 4.1.1 shows the same treatment at the other legs of the roundabout. This continuous separation treatment design was adjusted due to the driveways on the approach to this leg of the roundabout where the incident occurred.

The smaller concrete island was hit by a person riding a bicycle who was injured, and subsequently made a personal injury claim against Transport and Main Roads. The concrete island has now been removed.

Lessons learnt: Smaller non-continuous sections of separation devices can be hazardous, particularly when installing next to minimum-width bicycle lanes. It is preferable to not install short sections of separation; however, if these are to be installed, further delineation of the potential hazard should be incorporated into the design.

Figure 4.1.1 – David Low Way: Showing concrete islands separating the bicycle lane from the road

(Source: Google Street View)

4.1.2 Captain Cook Highway, Cairns, Far North Queensland region

A bicycle lane separation treatment was funded by the *Safer Roads Sooner* program on the Captain Cook Highway in Cairns. It sought to provide a physical separation between people riding bikes and vehicles on a road with high traffic volumes and speeds and a high proportion of heavy vehicles. The funding business case drew upon a Coroner's findings into a death that had occurred at this location.

The initial treatment (2009) used a low-height plastic kerb and is shown in Figure 4.1.2(a).

Figure 4.1.2(a) – Captain Cook Highway: 2009 separation treatment (plastic kerb with vertical delineators)

Brisbane City Council has used this profile at the separated cycle facility in George Street (Figure 4.1.2(b)), and Transport and Main Roads has installed it on Gympie Road at Kedron Park Road southbound (Figure 4.1.2(c)).

At all locations, and specifically at the Captain Cook Highway, there have been maintenance issues with vehicles striking the kerb (the pinning mechanisms failed on repeated occasions) and the delineator posts were frequently damaged.

Figure 4.1.2(b) – George Street, Brisbane (plastic kerb with vertical delineators)

Figure 4.1.2(c) – Gympie Road at Kedron Park Road southbound, Kedron Park (plastic kerb with vertical delineators)

Considering the maintenance issues and the need to further discourage heavy vehicles from entering the bicycle lane, the Far North Queensland region submitted a *Safer Roads Sooner* funding case to replace it with a concrete, back-to-back barrier kerb, which is still in place (Figure 4.1.2(d)).

Figure 4.1.2(d) – Captain Cook Highway: current separation treatment (concrete kerb)

Design changes included amending the bicycle lane openings to assist in smooth bicycle flow paths and 300 mm vertical delineation devices were installed; however, as per the 2009 project, these were also struck by heavy vehicles' rear wheels and became a maintenance issue (see Figure 4.1.2(d) image with marker lying flat on the ground in front of kerb).

While this has been considerably more effective in achieving the primary goal of preventing vehicles from entering the bicycle lane, there are design elements that could be improved to make it more 'cycle friendly', notably the steep leading edges at the drainage breaks, the entering / exiting alignment, the width at the entry and improved delineation of the end (which would benefit both people riding bikes and drivers).

The challenge at the Captain Cook Highway roundabouts is to keep vehicles out of the bicycle lane but ensure any new risks for people riding bikes are not introduced. The barrier kerb on the traffic side appears to have effectively reduced the 'hit by truck' risk but has introduced other hazards that should be able to be mitigated with some design modifications.

Lessons learnt: The plastic kerb was not suitable for the high traffic and truck volumes (and in particular, the B-double sugarcane hauling trucks) experienced at the Captain Cook Highway roundabouts. A more robust treatment was necessary to keep vehicles out of the bicycle lane. Further improvements could still be considered to reduce risks to people riding bikes by introducing a semi-mountable profile on the side of people riding bikes with ramped ends at the drainage cuts, combined with increased width at the entry and distinct delineation on the ends, colour contrast, retroreflection, and a pavement marked buffer and vertical delineation devices. In addition, a rail / post for people riding bikes could be included to assist people riding bikes checking for turning vehicles from behind at GIVE WAY locations.

4.2 Separation device audit

The following table details separation devices currently in place and the findings of the assessment of their suitability as separation treatments for on-road bicycle lanes. This assessment informed the definition of the preferred bicycle lane separation treatment outlined in Section 2.

Table 4.2 – Types of separation devices and suitability audit

<table>
<tr><th>Device</th><th colspan="2">Examples</th><th>Assessment findings</th></tr>
<tr><td rowspan="2">Pavement markings
Painted buffer (various line marking arrangement and widths)</td><td>  </td><td>  </td><td rowspan="2">• Provision of RRPMs also assisted with this improved perception of safety.
• Limited effectiveness in reducing vehicle encroachment.</td></tr>
<tr><td>Painted 1 m chevron traffic island with rumble bars (Chinderah Bay Road)</td><td>Painted 2 m chevron traffic island with raised reflective pavement markers (RRPMs) at bend (Bennetts Road)</td></tr>
</table>

<table>
<tr><th>Device</th><th colspan="2">Examples</th><th>Assessment findings</th></tr>
<tr><td rowspan="6">Discrete high-profile devices
armadillos
wheel stops
half wheels
moulded rubber</td><td>  </td><td>  </td><td rowspan="6">Concrete devices were noted as having poor visibility in low light and at night.
All concrete device options, regardless of the angle of the leading and trailing edges, were noted as introducing risk to all road users.
Separation between devices varied but did not appear to reduce or eliminate the build-up of debris compared to continuous installations.
There was a lower perception of comfort when driving or riding next to these treatments. Concrete devices, particularly the leading edges, introduced a risk that may have been more significant than that which was being addressed via the installation.
The device, when installed with treatments to address these issues (that is, vertical delineation devices and pavement marked buffers around separation kerbs), provide improved sense of separation compared to being installed by itself.</td></tr>
<tr><td>Low visibility of older concrete devices</td><td>Low abruptness discrete concrete (Helensvale Road)</td></tr>
<tr><td>  </td><td>  </td></tr>
<tr><td>Rounded discrete rubber (Somerset Drive)</td><td>High abruptness discrete concrete (Somerset Drive)</td></tr>
</table>

<table>
<tr><th>Device</th><th colspan="2">Examples</th><th>Assessment findings</th></tr>
<tr><td rowspan="6">Discrete low / medium profile separators
audio tactile line markings (ATLMs)
retroreflective pavement markers
Riley kerb
low profile rumble bars</td><td>  </td><td>  </td><td rowspan="6">Studies found that a significant proportion of vehicles travel over the ATLM devices and into the adjacent bicycle lane.
Typically, the ATLM device is not an effective deterrent for motorists travelling at low speeds (approx. 60 km/h) and does not reinforce or increase separation between vehicles and people riding bikes.
Some versions of rumble bars have a relatively high edge and could potentially destabilise people riding bikes, should they meet the device.
In some instances (for example, low-profile longitudinal humps), the low vertical profile could be almost indistinguishable in look or function to surface paint. These devices may prove ineffective as a deterrent to motorists given the very low profile. Additionally, people riding bikes may not be able to distinguish the device as being slightly raised and may inadvertently ride over it, not expecting there to be a difference in level or surface texture.
Overall, these devices had a limited effect in reducing the number of vehicle encroachments into an adjacent bicycle lane and were not conspicuous enough.</td></tr>
<tr><td>Vehicle encroachment over ATLM (Bennetts Road)</td><td>Low profile rubber rumble bar with RRPM (Chinderah Bay Road)</td></tr>
<tr><td>  </td><td>  </td></tr>
<tr><td>Low profile longitudinal humps (Bridge Street, Mackay)</td><td>High profile rumble bar (creating a medium profile separator)</td></tr>
</table>

<table>
<tr><th>Device</th><th colspan="2">Examples</th><th>Assessment findings</th></tr>
<tr><td rowspan="6">Vertical separators
flexible guide posts
lane divider flap
traffic cones
low impact smart bollard
plastic flexible bollards</td><td>  </td><td>  </td><td rowspan="6">Guide posts can be prone to regular and major damage depending on their location, proximity to the edge of traffic, and fixing / mounting type. Guide posts installed on top of concrete barriers or as an integrated component of a separation kerb are better alternatives based on consideration of the following:
They appear less prone to initial damage compared to isolated guide post installations.
When damaged, any remnant part of the guide post fixed to the surface (including the mounting plate) will not be located at-grade, itself becoming an unintended hazard for people riding bikes.
When damaged, there appears an improved chance that some parts of the device mount may be contained within the longitudinal separator.
Plastic bollard devices are retrofittable and relatively cheap, short enough to not catch on the handlebars of people riding bikes and are reflective; however, they can be more prone to vandalism and regular damage by collision.</td></tr>
<tr><td>Damaged delineation post (Tweed Valley Way)</td><td>Plastic bollard device (Grey St)</td></tr>
<tr><td>  </td><td>  </td></tr>
<tr><td>Damaged (leaning) bi-directional guide posts (George Street)</td><td>Delineation post on top of concrete barrier (Helensvale Road)</td></tr>
</table>

<table>
<tr><th>Device</th><th colspan="2">Examples</th><th>Assessment findings</th></tr>
<tr><td rowspan="4">Separation kerbs
caterpillar safe cycle kerb (new product and as yet untested)
rubber separation kerb
rubber lane maker
pre-cast concrete</td><td>  </td><td>  </td><td rowspan="4">The rubber devices were robust and generally did not suffer catastrophic failure. Longer-term issues including UV degradation, device separation and cracking are common within an approximate four–six year post-installation period, depending on site exposure and traffic characteristics.
The continuous concrete kerb device is very robust; however, as these treatments age, their visibility becomes limited, particularly in low light or darkness. The dimension of the vertical face from the road surface is higher than the rubber device. The profile of the concrete kerb is likely required to reduce edges chipping off. There is the potential for the more significant edge dimension to destabilise people riding bikes if they were involved in an acute collision with the device.
Skid resistance needs to be verified.</td></tr>
<tr><td>Caterpillar kerb</td><td>Rubber separation kerb (George St)</td></tr>
<tr><td colspan="2">  </td></tr>
<tr><td colspan="2">Pre-cast concrete (Maryborough Street – 20+ years old)</td></tr>
</table>

<table>
<tr><th>Device</th><th colspan="2">Examples</th><th>Assessment findings</th></tr>
<tr><td rowspan="2">Safety barriers
(>150 mm height)
• pre-cast concrete
• water filled</td><td>  </td><td>  </td><td rowspan="2">• Concrete barriers >150 mm high are typical installations on higher speed road environments, designed to redirect out-of-control vehicles. In this situation, a higher level of separation is preferable.
• The devices are installed as interconnected modules which make them difficult to locate within an existing road cross-section in a retrofit situation.
• They are also less likely to conform to medium-high radius turns, given their fixed characteristics.
• Water-filled barriers are typical installations in temporary road works situations and are designed to be used as containment fences or as delineation devices. Similar to the pre-cast concrete barriers, these devices are installed as interconnected modules. Their width would make them difficult to locate within an existing road cross-section in a retrofit situation. The devices can be connected to form medium radius curves, unlike concrete barriers.
• A smaller form of device with a lower risk profile is preferred for retrofit situations and lower speed and traffic volume situations.</td></tr>
<tr><td>Pre-cast concrete with safety fencing</td><td>Water filled safety barriers</td></tr>
</table>

<table>
<tr><th>Device</th><th colspan="2">Examples</th><th>Assessment findings</th></tr>
<tr><td rowspan="2">Planter boxes
plastic / rubber
pre-cast concrete
raised gardens</td><td>  </td><td>  </td><td rowspan="2">Planter boxes are large non-frangible devices where the mass and scale of the treatment could represent a hazard to motorists and people riding bikes on roads that have posted speed limits of 60 km/h or higher.
The size (width) typical of planter boxes would also make it difficult to locate them within an existing road cross-section in a retrofit situation.
The available research does not specifically reference planter boxes. The research is clear that any form of separation would deliver perceived and objective benefits to / for people riding bikes; therefore, a smaller form of a separation device that has a lower risk profile is preferred. FEMA 430 Section 4.4.2 discusses the use of crash-rated bollards concealed in planters.
Advantages of these treatments is that they are much more aesthetically pleasing and can be preferable when installed as part of an overall streetscaping / greening / calming project for a particular precinct.</td></tr>
<tr><td>Plastic / rubber planter box</td><td>Pre-cast concrete planter box</td></tr>
</table>

5 Further information

For further information on this guideline, please contact:

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