NSW bicycle guidelines

NSW Bicycle Guidelines

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Contents

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These updates will be reflected in future published versions of the document.

Version Number	Page	Description	Issued
1.1	42	Section 7.1 - Updated Figure references	March 2004
	84-85	Index - Updated page references	
1.2	14	Figure 3.5 - Line S5 units amended	July 2005
	66	Figure 8.3 - Line S5 units amended	

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1. Introduction

These guidelines are designed to assist road designers, engineers and planners to design and construct high-quality bicycle transport facilities for the people of New South Wales. The document is intended to provide technical assistance on a range of conditions particular to the State and should be read in conjunction with: *Austroads Guide to Traffic Engineering Practice, Part 14 – Bicycles* and *Australian Standard AS1742.9 – Manual of Uniform Traffic Control Devices, Part 9 Bicycle Facilities* both of which apply in NSW. Where there are differences between these guidelines the advice in this document will prevail.

1.1 A best practice guide

This manual is provided as a guide to practitioners on how bicycle network facilities should be developed as part of the wider New South Wales transportation network. The information contained in this document is intended to be used as a guide to best practice. Discretion and professional judgement should always be exercised by practitioners in the application of these Guidelines to ensure that the many factors which may influence the eventual choice, design and construction of traffic management treatments are fully taken into account.

1.2 RTA Policies

Cycling is supported by the NSW Government as a healthy, low cost, environmentally friendly form of transport. It offers a flexible and low-impact alternative to the use of private motor vehicles. The Roads and Traffic Authority policy on bicycles is set out in *Action for Bikes – Bikeplan 2010* (RTA 1999a).

Action for Bikes – Bikeplan 2010 lists the four strategies the NSW Government is adopting to improve the cycling environment across the State. These strategies are:

1. To improve the bike network by making comprehensive provision for bicycles on all new major road infrastructure projects with a strong preference for off-road cycling;
2. To make it safer to cycle by improving road safety and security while riding;
3. To improve personal and environmental health by promoting the benefits of cycling within the community; and,
4. To raise community awareness of the importance of cycling by educational and promotional methods and encourage community involvement in the ongoing process of planning for and providing bicycle facilities.

It is NSW Government policy to make appropriate provision for cyclists on all new major roads constructed by and for the RTA. In practice, on major new roads, comprehensive provision for bicycles both on- and off-road can be included.

On arterial roads where new major work is being carried out, provision can be made for bicycle facilities either on-road, off-road or both. The off-road facilities may be through parks, drainage easements, public utility easements or similar sheltered areas, or along shared paths, which are suitable in width and alignment for cyclists and pedestrians to travel in safety. The on-road facilities enable experienced cyclists to use the road in separate lanes without having to be in the same lane as fast-moving motor vehicles.

Public transport facilities may also incorporate cycleways. Where the RTA is planning bus transitways, they feature a parallel off-road cycleway. The 17km Parramatta to Liverpool Rail Trail is an example of providing for regional bicycle access by utilising public transport corridors outside of traditional road easements.

In the design and construction of major road projects signposting, linemarking and traffic rearrangements are implemented which give consideration to the needs of cyclists.

Photo 1.1: The RTA includes bicycle facilities as part of its infrastructure projects. Southern access ramp to the Anzac Bridge, Pyrmont.

1.3 How to use these guidelines

The Australian Road Rules (ARR) define the "road", the "shoulder" and the "road related area". The rules shown in the ARRs and local NSW Regulations for the road do not cover the shoulder of the road but the rules for road related areas do. However, unless expressly stated otherwise, any reference in the ARRs to road would also include road related area. These guidelines are consistent with the Australian Road Rules (ARRs) at the time of publication. The ARRs operate in NSW and no practitioner should design or install any facility that requires or encourages road users to contravene an Australian Road Rule.

The RTA has published a number of Technical Directions over the past years relating to the provision of bicycle network facilities. These guidelines incorporate all Technical Directions issued up to the date of publication. Practitioners are advised to check on the availability of any Technical Directions published subsequent to this document.

Local bicycle user groups (BUGs) can be a valuable source of local information to aid the practitioner in the planning, design and implementation of bicycle facilities. Local user groups are made up of riders who can have a detailed knowledge of the local cycling environment along with its problems and opportunities. BUGs can be contacted through the NSW peak cycling organisation Bicycle New South Wales.

The RTA publication *How to Prepare a Bike Plan* is a useful planning guide for practitioners on systematically developing bicycle facilities within a council area or region. This publication is available from the RTA Bicycle and Pedestrian Section or on-line from the RTA's Website.

The *NSW Bicycle Guidelines* document has been designed to provide a logical path through each of the design phases with a layout that is compatible with *Austroads – Part 14*. This methodology is outlined in brief in Figure 3.1 at the beginning of Section 3. This Figure also provides a checklist for developing bicycle facilities.

Section 2 introduces the major terms used in this manual and pays particular attention to definitions of the major facility types.

Section 3 explains the design principles and the philosophy which underpins the document. In particular, it outlines a methodology for designing high quality bicycle network facilities. This methodology is mirrored in the progression of sections which make up this document. Sections 3 to 9 cover the major issues in the design process in a logical sequence.

Section 4 provides an introduction to the nine main types of bicycle route facilities available to the designer and provides guidelines to their appropriate use.

Section 5 describes bicycle route facilities within the road reserve and provides detailed recommendations on the application and variation of the facilities listed in Section 4.

Section 6 deals with bicycle route facilities in off-road situations.

Section 7 describes methods of designing bicycle network facilities into intersections and other types of roadway crossings.

Section 8 provides information and recommendations for a range of design issues relating to the finish of cycleways including: surface treatments and materials; linemarking; landscaping, drainage and barrier fencing.

Section 9 deals with the signing of bicycle network facilities and covers regulatory, warning and direction signage and network mapping.

Sections 10 to 12 deal with specific bicycle transport issues such as: maintenance (10); parking facilities and public transport linkages (11); and audits and evaluation processes (12).

Sections 13 and 14 provide reference material to further assist practitioners: a bibliography consisting of the documents used in the compilation of these Guidelines; and, an index.

Photo 1.2: This bicycle shoulder lane treatment can be used on streets built to the old 12.8 metre road standard and is an example of how bicycle network facilities can be integrated into the transport system. Bourke St, Surry Hills.

2. Definitions of words and terms

Bicycle – a vehicle with two or more wheels that is built to be propelled by human power through a belt, chain or gears (whether or not it has an auxiliary motor). For the purposes of this manual 'bike' and 'cycle' mean the same thing.

Bicycle facility – a public facility especially constructed for bicycle traffic. This term has broad use and can refer to any part of a *bicycle route*, *bicycle path*, *bicycle lane*, associated signage or parking equipment.

Bicycle lane – is a marked lane, or the part of a marked lane beginning at a bicycle lane sign applying to the lane; and ending at the nearest of the following:
(a) an end bicycle lane sign applying to the lane;
(b) an *intersection* (unless the lane is at the unbroken side of the continuing *road* at a T–intersection or continued across the intersection by broken lines); or
(c) if the *road* ends at a dead end — the end of the *road*.

Bicycle network – a defined set of *Bicycle routes* which make it possible to travel around a region by bicycle in a safe and connected manner. In bicycle networks there is a three level hierarchy consisting of:

- **Regional routes** provide the quickest and most direct means of travelling between regional centres (the road hierarchy equivalent is the State road). These routes offer the highest priority bicycle travel through an area with few delays and a high level of consistency and quality of construction;
- **Local routes** link regional routes to local mixed traffic streets and provide a collector distributor function in the network. These routes also provide radial access to major sub-regional centres and parallel alternative access to regional routes;
- **Mixed traffic streets** provide door to door access to places where people live. They are usually residential low-volume, low-speed streets where bicycles operate within the traffic stream and dictate the traffic flow.

Bicycle path – means a length of path for the exclusive use of bicycle riders. This facility begins at a 'Bicycle Path' sign or bicycle path line marking, and ends at the nearest of the following:
(a) an 'End Bicycle Path' sign or end bicycle path linemarking;
(b) a 'Separated Path' sign or separated path linemarking;
(c) a *road* (except a *road-related area*); or
(d) the end of the path.

Bicycle rider – (for the purposes of this manual) a person who is riding a *bicycle*. Other words used in this manual (cyclist, rider, bike rider) mean the same thing. The ARR also defines rider as a motorcycle rider or the driver of an animal drawn vehicle but these definitions do not apply within this manual.

Bicycle route – any marked route which forms part of a *bicycle network*. The route may utilise different types of *bicycle facilities* and may be *on-road (bicycle lanes and bicycle shoulder lanes)*, or *off-road* (*bicycle paths, separated paths* and *shared paths*) in the road related area paralleling roads or through parks and reserves.

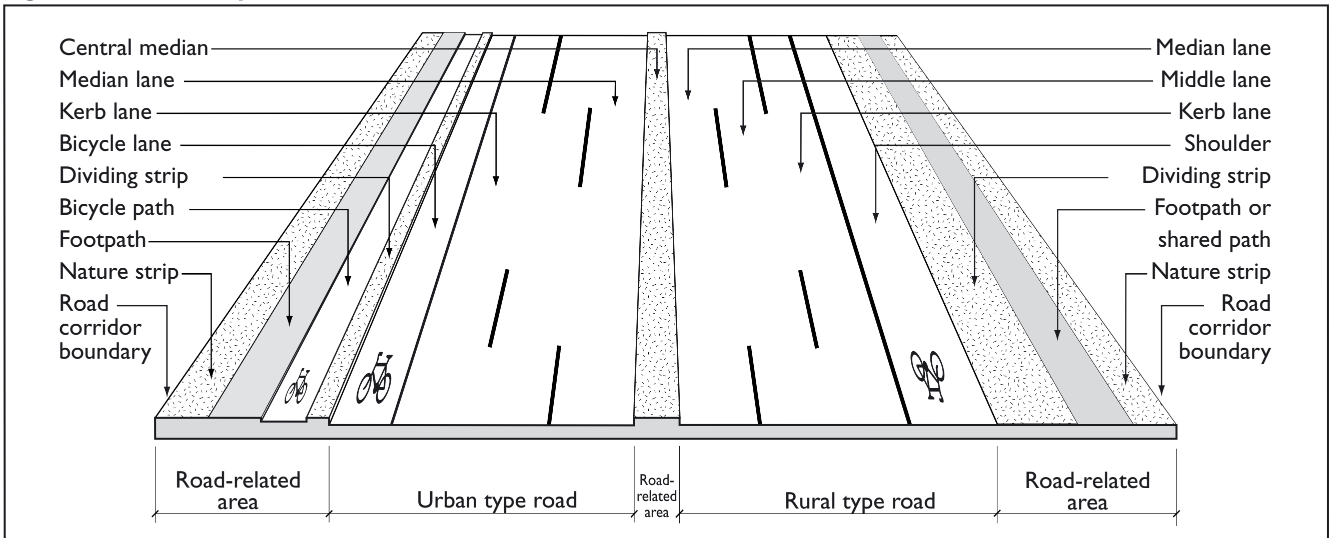
Bus lane – is a marked lane, or the part of a marked lane, beginning at a bus lane sign and ending at an end bus lane sign. Bus lanes may be used by bicycle riders unless they are signed "BUSES ONLY".

Carriageway – a term no longer used within the Australian Road Rules but still in use within road transport engineering practice. This term generally refers to the road area as defined in the ARR.

Contra-flow bicycle lane – a *bicycle lane* used in a one-way street to provide bicycle riders with two-way use of the road.

Cycleway – a generic term used to describe a *bicycle route*, *bicycle lane*, *bicycle path* or that part of a *separated path* used by riders.

Figure 2.1: Commonly used road terms.



Design operating speed – a concept used by designers to coordinate, sight distance, curve radius, superelevation and friction demand for elements of the road or path so that riders and drivers negotiating each element will not be exposed to unexpected hazards. For bicycle paths and roads the design speed chosen should be such that it is unlikely to be exceeded by most riders or drivers as appropriate and not less than the 85th percentile speed.

Dividing strip – part of the *road-related area* between the road (or parking lanes) and a facility not located on the road such as a *bicycle path*, *separated path*, *footpath* or *shared path* not designed for use by motor vehicles.

Edge line – for a road, means a line marked along the road at or near the far left or far right side of the road (except any *road-related area* of the road).

Footpath – an area open to the public that is designated for, or has as one of its main uses, use by pedestrians.

Intersection – an area where 2 or more roads (except any *road-related area*) meet, and includes any area of the roads where vehicles travelling on different roads might collide; and the area of any slip lane where the roads meet but does not include any *road-related area*. In these Guidelines an intersection is also the area where an off-road bicycle path or shared path intersects with a road or other bicycle path, shared path or footpath.

Off-road – a *bicycle path* or *shared path* is said to be off-road when it is located on a *road-related area* paralleling a *road*, or through parks or reserves or within public transport corridors and other public or private land not open to motor vehicle traffic.

On-road – a *bicycle facility* is said to be on-road when it forms part of the road such as a *bicycle lane* or a *shoulder* shared with parked vehicles.

Road – an area that is open to or used by the public and is developed for, or has as one of its main uses, the driving or riding of motor vehicles.

Road network – the road transport planning professions recognise several different road classification systems and road types. For the purposes of this manual these road types are important:

- **Motorways and freeways** are the major urban or rural roads which provide the quickest most direct access through a region or across an urban area. They have limited access to the surrounding road network and have grade separated *intersections* and higher speed limits.
- **State roads** provide the quickest and most direct means of travelling between regional centres and to major centres within the State. These routes offer a high priority means of travel through an area with fewer delays and a high level of consistency and quality of construction.
- **Regional roads** link *State roads* and *highways* to *local roads* and provide a collector distributor function in the network. These routes also provide radial access to major sub-regional centres and connections to other regional centres.
- **Local roads** provide door to door access to places where people live. They are usually low-volume, low-speed roads.

Figure 2.2: Commonly used path terms.

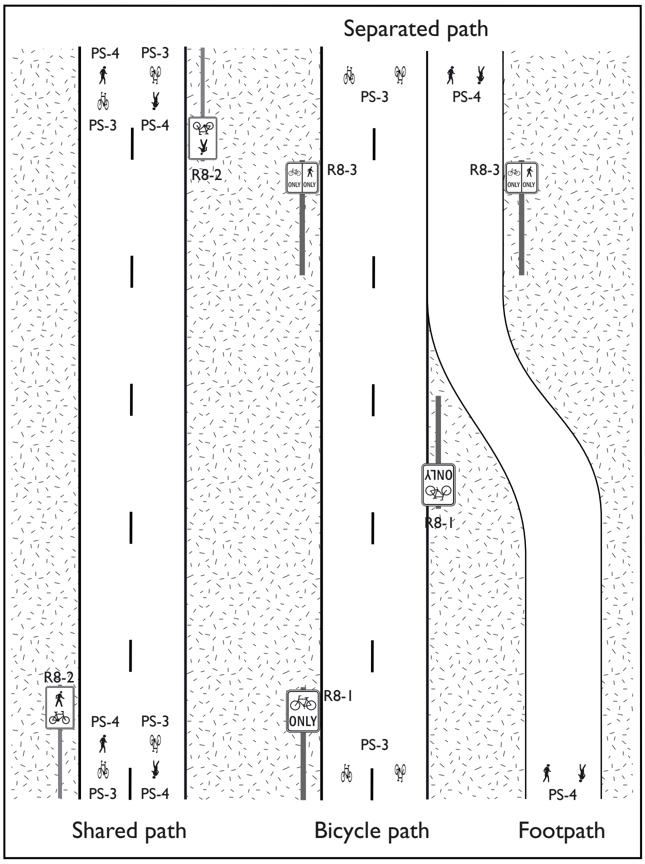
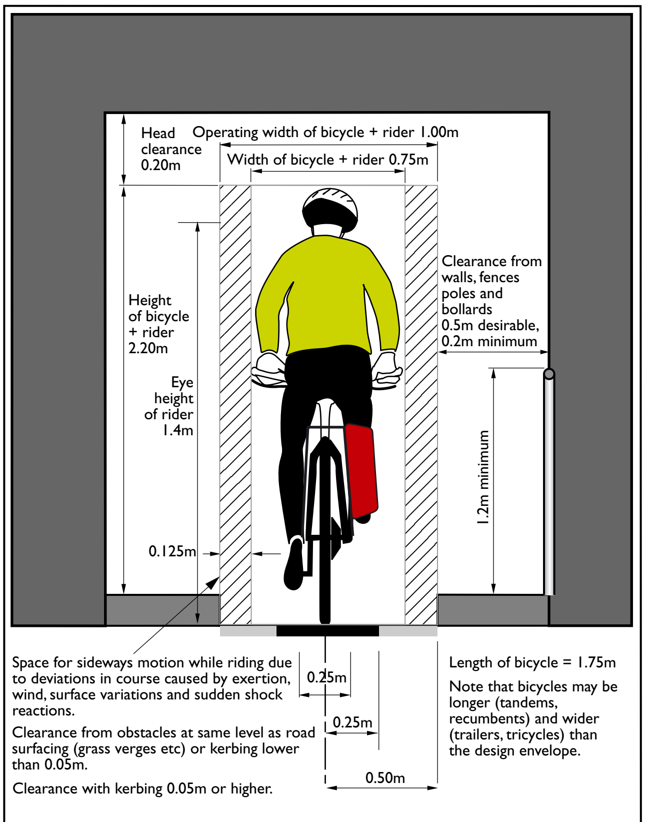


Figure 2.3: The bicycle rider design envelope & clearances.



Source: Austroads - Part 14, 1999 and CROW 10, 1993

Road related area – is any of the following:
(a) an area that divides a road;
(b) a footpath or nature strip adjacent to a road;
(c) an area that is not a road and that is open to the public and designated for use by cyclists or animals;
(d) an area that is not a road and that is open to or used by the public for driving, riding or parking vehicles.

This can include the area that divides a *road* (median), the *footpath* or nature strip or an area designed for exclusive use by bicycles (*bicycle paths*).

Rules that apply to roads generally apply to *road-related areas* in the application of the Australian Road Rules.

Road reserve or road corridor – the total parcel of public land on which the *road* and *road-related areas* are located.

Separated path – a length of path where an exclusive bicycle path is laid adjoining a footpath. The separation may be visual (painted line) or physical (dividing strip or raised median). The facility begins at a separated path sign or separated path linemarking, and ends at the nearest of the following:

(a) an 'End Separated Path' sign or the end of the separated path linemarking;
(b) a 'Bicycle Path' sign or bicycle path linemarking;
(c) a 'No Bicycles' sign or no bicycles road marking;
(d) a road (except a *road-related area*); or
(e) the end of the path.

Shared path – area open to the public (except a *separated path*) that is designated for use by both bicycle riders and pedestrians. The shared path begins at a 'Shared Path' sign and ends at the nearest of the following:
(a) an 'End Shared Path' sign;
(b) a 'No Bicycles' sign or no bicycles road marking;
(c) a 'Bicycle Path' sign;
(d) a *road* (except a *road-related area*); or
(e) the end of the path.

Shoulder – includes any part of the road that is not designed to be used by motor vehicles in travelling along the road, and includes:
(a) for a kerbed road — any part of the kerb; and
(b) for a sealed road — any unsealed part of the road, and any sealed part of the road outside an *edge line* on the *road*; but does not include a *bicycle path*, *footpath* or *shared path*.

Transition – a facility which makes it possible to travel between an *on-road bicycle lane* and a *bicycle path* or other *off-road bicycle facility*.

Photo 2.1: An example of a separated path through a public park. This type of facility is very useful when volumes of walkers and riders is high. Separation (from motor vehicles and walkers) is an important issue both for the safety and level of service of all transport users. Marine Pde, Wollongong.

3. Planning and engineering concepts

Figure 3.1: Bicycle facility design checklist.

Policy (Section 1)
- ☑ Identify all existing state, regional and local plans and policies relevant to the provision and promotion of cycling

Location of cycle routes (Section 3)
- ☑ Position cycle routes to be as direct and as short and as safe as possible
- ☑ Limit the impact of motorised traffic with consideration of vehicle speed and volume
- ☑ Provide sufficient crossing opportunities to overcome the barrier effect of major roads
- ☑ Avoid steep slopes and grades
- ☑ Offer alternatives to routes which are considered socially unsafe
- ☑ Avoid one-way cycle facilities and detours

Cycleway/road profile (Sections 3 - 4)
- ☑ For new facilities determine the most suitable type of profile (see Figure 3.2)
- ☑ For existing facilities check if the existing type of profile is suitable (see Figure 3.2)
- ☑ If a mixed-use on-road profile is selected, limit the speed difference between cyclists and cars
- ☑ Determine actual width of facility (including access for maintenance vehicles)

Design of facilities (Sections 4-6)
- ☑ Ensure adequate curve radii and manoeuvring width on tight curves and good sightlines
- ☑ Design for adequate grades on bridge ramps
- ☑ Ensure adequate head height at underpasses and tunnels
- ☑ Ensure smooth kerb ramps, lipless driveways, appropriate landscaping with good sightlines
- ☑ Include social safety considerations in the design of underpasses, tunnels and sections between fencing or through remote areas
- ☑ Ensure seamless route connectivity and continuity through good design

Intersections and traffic signals (Section 7)
- ☑ Determine the profile type for intersections (this may differ from the mid-block profile)
- ☑ Explore all alternative design possibilities to traffic lights
- ☑ Ensure bicycle rider operating space is designed into the intersection for approach, transition, waiting, through travel and departure movements
- ☑ Ensure minimum green signal time to allow cyclists enough time to cross large intersections
- ☑ Design in-road detectors to pick-up cycles
- ☑ Pay particular attention to right turning cyclists

Pavement, surface treatment and linemarking Section 8
- ☑ Ensure the cycleway surface is smooth, even and well drained
- ☑ Ensure the joints (transverse and longitudinal) are smooth and even
- ☑ Ensure all drainage grate covers are cycle-friendly
- ☑ Where there is a bicycle path paralleling a major road make sure that the pavement is as even as possible across side road openings
- ☑ Ensure that all line marking is clear and unambiguous
- ☑ In special circumstances consider using green surface colour to delineate path of cyclist

Signage and network info Section 9
- ☑ Ensure adequate lighting,
- ☑ Ensure that a comprehensive route/destination signage system is provided for the network

Other issues Sections 10-12
- ☑ Provide adequate parking facilities

This section explains the design principles and the philosophy which underpin this manual. Figure 3.1 provides a simple checklist which can be used to follow the decision process through the various sections of this document.

3.1 Principles of bicycle network provision

The needs of bicycle users and their requirements for an efficient and useable bicycle network can be best summed up in five key principles listed below. Table 3.1 provides criteria and design considerations for implementing these principles.

Coherence: Bicycle network infrastructure should form a coherent unit by linking popular destinations with local residential streets via regional routes and local routes. The network should be continuous and it should be very clear to the user where the facility leads. Intersections should seek to provide a clear path for bicycle riders as well as for other modes. The quality of network facilities should also be consistent throughout the length of the route regardless of whether the facility uses a separated or shared road profile. Routes should be easy to find from local streets and the network should be of such a density that there is always a choice of nearby routes available to the user.

Directness: Network infrastructure should be as direct as safely practicable. Long detours should be avoided as human energy is required to propel the vehicle. This should always be balanced against the problems of topography – a slightly longer route may work better because it contours around a hill rather than tackling it at its steepest climb. Regional route design should take into account both the slowness in operating speed of bicycles up-hill and the relatively high speeds when descending. Delays due to prolonged crossing times of major barriers should be avoided and the aim of the designer should be to ensure that riders are able to maintain a safe, comfortable and consistent operating speed throughout the length of the route.

Safety: Well designed bicycle network infrastructure improves and enhances the road safety of riders, pedestrians and motorists. Intersections should be designed to explicitly include bicycles as well as other categories of road users. Special intersection designs that include a path for cyclists are an important element of integrated network design. Mid-block treatments need to provide safe and easy major roadway crossings for riders. The design of bicycle routes past bus stops should be designed for safe accommodation of riders, bus passengers, other pedestrians and vehicles.

Attractiveness: Community support exists for cycling provided it is an enjoyable activity. Enjoyable cycling requires attractively designed and located facilities. Bicycle network infrastructure, such as regional and local routes, should be fitted into the surrounding environment so that the enjoyment of the experience is enhanced. Clear well-placed signposting should indicate major destinations, while centrelines and edgelines should indicate the serious

Table 3.1: Key design principles of the bicycle transport system.

Principle	Criteria	Design considerations: Regional routes	Design considerations: Local routes	Design considerations: Mixed traffic streets
Coherence	Continuity of routes	No breaks in route	Connect to regional route	Easy access to local routes
	Consistent quality of routes and facilities	Minimal quality changes	Minimal quality changes	N/A
	Easy to follow	Regional route signage	Local route signage	All street signs visible
	Freedom of choice of routes	Choice of at least two	Choice of at least two	Less than 250m to a route
Directness	Efficient operating speed	50 km/h design speed	30 km/h design speed	Consistent with street design
	Delay time	15 sec/km	20 sec/km	20 sec/km
	Detour factor * Detour factor is the relationship between the most direct distance between origin and destination and the distance taken by the actual route taken. A detour factor of 20% means that the route will be 20% longer than the distance as the crow flies.	20%*	30%*	40%*
Safety	Minimum risk of accident on routes Minimum risk of conflict with car traffic Minimum risk of unsafe infrastructure	Monitor use of facility and investigate any links between accidents and design.	Monitor use of facility and investigate any links between accidents and design.	Monitor use of facility and investigate any links between accidents and design.
Attractiveness	Support for the system	Public support and ownership	Public support and ownership	N/A
	Attractiveness of environment	Well lit and open appearance	Well lit and open appearance	N/A
	Perception of social safety	Minimum reports of vandalism & harassment	Minimum reports of vandalism &harassment	N/A
	System attractiveness	Coordination of all supporting system elements (maps, fittings, signage etc)	Coordination of all supporting system elements (maps, fittings, signage etc)	N/A
Comfort	Smoothness of ride *(Refer to Austroads - Part 14 Section 8.5)*	Smooth riding surface	Smooth riding surface	Smooth riding surface
	Comfortable gradient	Steep climbs minimised	Steep climbs minimised	N/A
	Minimum obstruction from vehicles	Minimise illegal parking	Minimise illegal parking	N/A
	Reduced need to stop - number of stops (average per km)	0.5	1.0	1.5
	Protection from adverse climate	Shade trees and wind	Shade trees and wind	N/A

transport intent of the off-road sections of routes. New housing developments should provide easy to use and attractive bicycle transport facilities. Bicycle routes should also feel safe and offer good personal security. The community prefers well-lit pathways and open-to-view routes rather than dark and dingy alleyways.

Comfort: The bicycle network has to be easy to use for all types of riders. A smooth well maintained riding surface is essential both for comfort and operating safety. Depending on the speed and volume of other traffic (motor vehicles or pedestrians), some level of separation is often needed. Clearly marked bicycle facilities that allocate operating space to bicycle users are the most appropriate types of facilities on all but low traffic volume and low speed roads. Effective intersection treatment is a critical factor in joining streets to a coherent route or network, as well as providing safe and comfortable crossings of major arterial roads.

3.2 Locating bicycle route facilities

A network approach is recommended in order to create an efficient system of facilities to best serve the bicycle riding public. The following parts of this section outline the fundamental principles and issues relating to bicycle network provision. All new facilities should be considered in relation to their function and importance to the network as a whole. The relationship with the existing road network will also need to be carefully considered.

The major aims of the cycling network facilities designer are to:

Reduce encounters between cyclists and high-volumes of fast-moving traffic. The best-practice method of achieving this is by separation. This can be by marked lanes or by bicycle paths. Figure 3.2 shows the relationship between the degree of separation provided and the prevailing traffic speed and volume.

Treat every crossing by a bicycle facility of a street or road as an intersection. Crossings should be designed following normal intersection traffic management principles:

- There should be an explicit assignment of priority to specific legs of the intersection. This should be indicated by regulatory signage (STOP or GIVE WAY) or traffic signals. The priority should be allocated in accordance with normal traffic management methods.
- Intersection layouts should be simplified and marked on approaches to show each road user where they are to position themselves in order to safely negotiate the intersection.

Treat all bicycle facilities as serious transport facilities. An off-road cycleway is a transport facility and should be built and managed similar to streets and roads ie: centrelines to separate and regulate bi-directional flows; proper side and head clearances; adequate warning of potential hazards.

Design for efficiency and comfort as well as safety to suit a wide range of user types. In past years a high emphasis was placed on designing facilities to suit either the very experienced or the very inexperienced rider. World best practice designs bicycle facilities for a broad range of riders in the community by providing efficient, well-connected facilities that offer consistent quality throughout. This approach focuses on the comfort of the rider and aims to create a riding environment which allows the maximum possible mobility with the minimum stress and risk.

3.3 Function, priority and speed

Three important overriding issues in the bicycle network design process which need to be considered are: road/cycleway function; the priority assigned to both the cycleway and any adjacent roadway; and, the prevailing speed environment. These factors are seldom in balance and can be influenced by good engineering design as well as by management measures such as additional regulation and enforcement programs.

Road and cycleway function

One of the first considerations in the design of any bicycle facility, is the relationship between the bicycle network hierarchy and the prevailing road hierarchy. Where bicycle routes parallel or cross the road network, the design of route and intersection facilities should reflect the network functions for both the road and the cycleway.

If the function of the bicycle facility is for regional through route access, then the cycleway should be designed to provide the highest level of continuity, consistency, and connectivity with other major intersecting routes. Where major State or regional roads are crossed, the network function of the roadway should be maintained. For example, in a situation where a regional bicycle route crosses a state road or highway, a grade separated crossing may provide the best solution in order to preserve the network function of both facilities.

Priority

A primary aim of the bicycle transport network designer is to reduce travelling times by minimising delays. This can often be achieved by the assignment of priority to the bicycle route. Sound traffic management practice aims to assign explicit priority to various elements of the road network in order to maintain a safe and efficient operating environment. Traffic signals and stop and give-way signs are the most commonly used devices to assign priority and these and other measures are also available to the bicycle facilities designer.

In instances where the bicycle and main road networks intersect, priority will usually be allocated according to the status of the road and the bicycle facility within each hierarchy. For instance in the case of a local bicycle route crossing an arterial road the latter would obviously have priority and give-way signage or traffic signals would be fitted to the cycleway approaches.

Speed difference between riders and other modes

Good bicycle network facilities, like roadways should be designed to reduce the seriousness of accidents and conflicts and cater for all members of the community. In places where separation is impossible or undesirable the most effective means of crash prevention is to reduce the speed difference between bicycle riders and cars. This can also apply to paths shared with pedestrians.

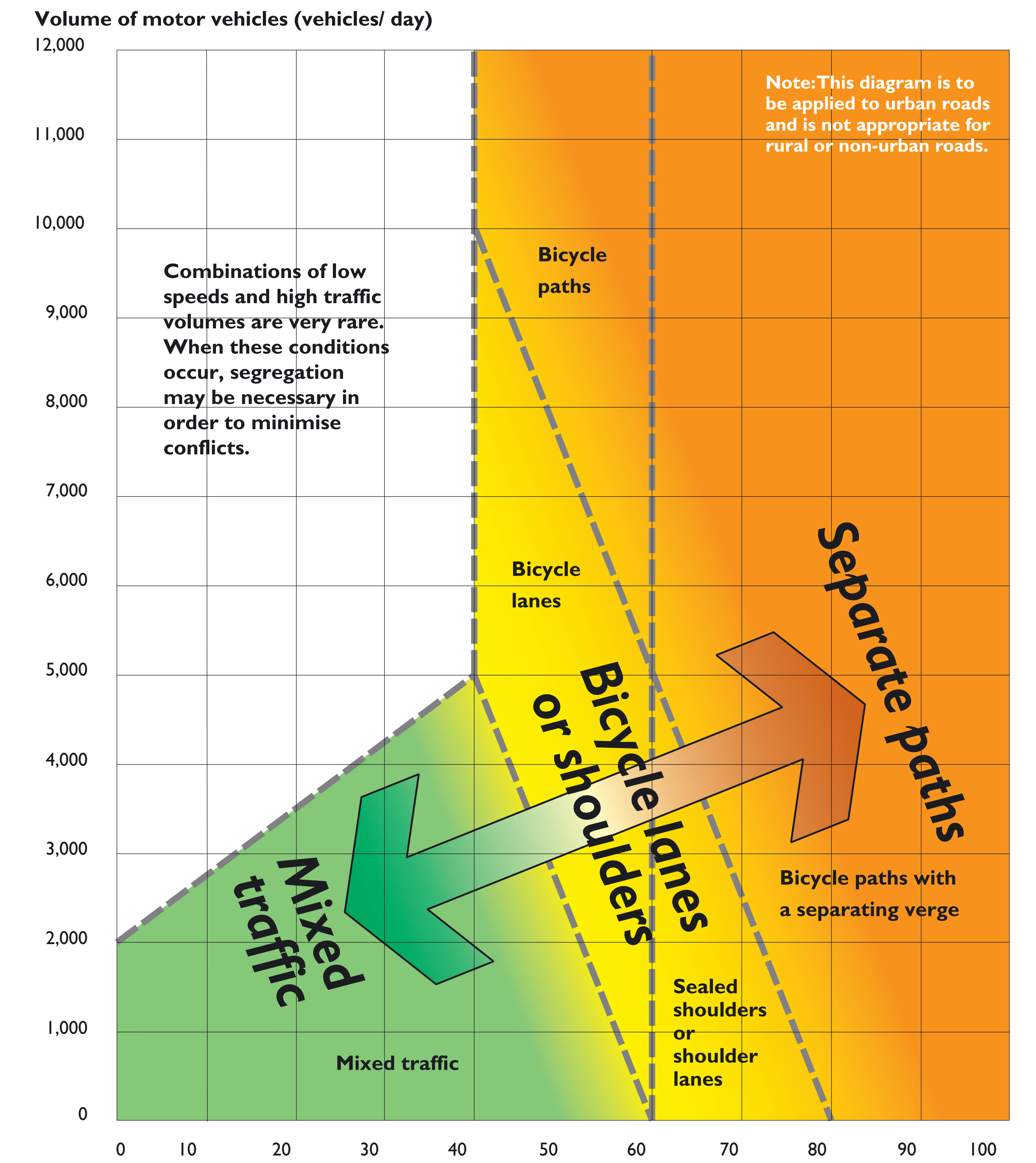
3.4 Separation or mixed traffic

The issue of physical separation is one of the most important considerations in designing bicycle facilities and may result in high levels of acceptance and possibly a reduction in accident rates. The application of on-road bicycle lanes and road shoulders is a recognised part of the NSW road environment. A network approach requires that

Table 3.2: Bicycle network functions and details.

	Network function	Planning/development	Funding
Regional bicycle routes	High-quality, high-priority routes to permit quick unhindered travel between the major regions of cities, towns or urban areas	RTA Regional Bicycle Network *(Action for Bikes - Bikeplan 2010)*	RTA and other partnership agencies
Local bicycle routes	High quality routes with seamless connections to regional routes. These routes connect the local street system to the major regional routes	Council bike plans in consultation with the RTA. (RTA's *How to Prepare a Bike Plan* publication)	RTA, Councils and partnership agencies
Mixed traffic streets (door to door access to all destinations)	The residential street system, though not a marked part of the network, is very important as it provides local access to residential destinations in a 'low stress' environment	Councils own and control this resource which provides local access and mobility.	Councils

Figure 3.2: Separation of bicycles and motor vehicles according to traffic speed and volume.



References: CROW10. 1993, DELG. 1999, DRD. 2000, SUSTRANS. 1997

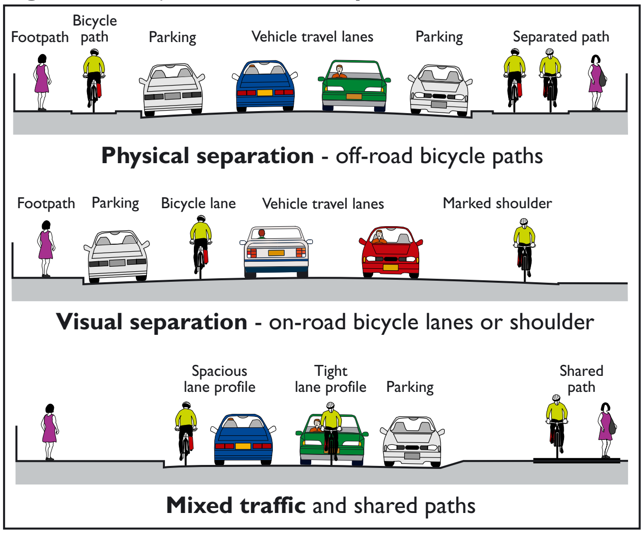
bicycle operating space also be included and designed into intersections in order for the network to function safely and efficiently as a coherent whole. Intersection treatments are covered in detail in Section 7.

Figure 3.2 provides guidance on the selection of separated or mixed facilities. The relationship between the prevailing traffic speed and volume is an important factor in the decision to provide physically separated facilities, mixed profile, or something in between.

Operating space in the form of lanes and marked crossing points should be designed to provide a clear indication to the bicycle rider as to where the road builders and managers would like them to safely and comfortably travel along any road. It is always important to consider the degree of separation, either visual (lanes or shoulders), or physical (bikepaths), to be provided.

In deciding on the need for separation for bicycles, it should be recognised that there are equally great benefits to motorists when this is done. Bicyclists normally travel much slower than motorised traffic and when they are required

Figure 3.3: Major methods of separation.



to share normal road lanes they often find themselves in a very stressful and unpopular position. This can also create disruption to the motor-vehicle flows and increase the risk to the rider. By allocating road space to bicycles, road designers/builders can improve safety for all users and increase the efficiency of the roadway.

At low traffic speeds and volumes it is possible, however, to plan and construct a successful shared road environment provided that the transitions from separated space to shared space are safely handled.

There are three main methods of separation:

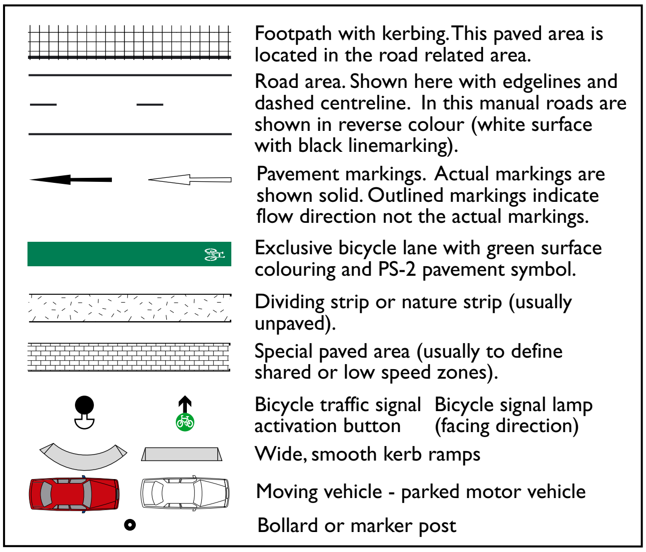
Physical separation

Riders cycle on bicycle paths or shared paths off-road. The widest section of the community prefers to cycle in environments without traffic.

Visual separation

Bicycle riders ride on the road but are separated from motor vehicles by either specially allocated space (bicycle lanes) or marked shoulders. This type of facility is suitable for use on regional bicycle routes for short distances

Figure 3.4: Legend of symbols used in diagrams throughout this manual.



(depending on the nature of the road) and for general use on local bicycle routes. Cycling on freeway or motorway shoulders and other high speed roads is only appropriate for experienced riders and such facilities cannot form part of the general bicycle network.

Mixed traffic

Bicycle riders share lane space on the road with motor vehicles and off-road with pedestrians. In road environments there can be a further sub-categorisation of shared space into tight and spacious profiles. A spacious profile road is where there is a consistently wide kerb lane to allow riders and drivers to comfortably share space according to the prevailing road speed. In very low speed environments such as residential areas and on very narrow inner-city streets, where the aim is to keep all vehicle speeds low, it is preferable to restrict the lane width so that all vehicles must follow each other in turn. This type of treatment can be used for bicycle network routes in low-speed, low volume environments where high visibility and a high level of network connectivity is necessary.

Figure 3.5: Signs, linemarking and pavement symbols most commonly used in this manual. For full details of all signs, linemarking and symbols for bicycle facilities see Sections 8 and 9.

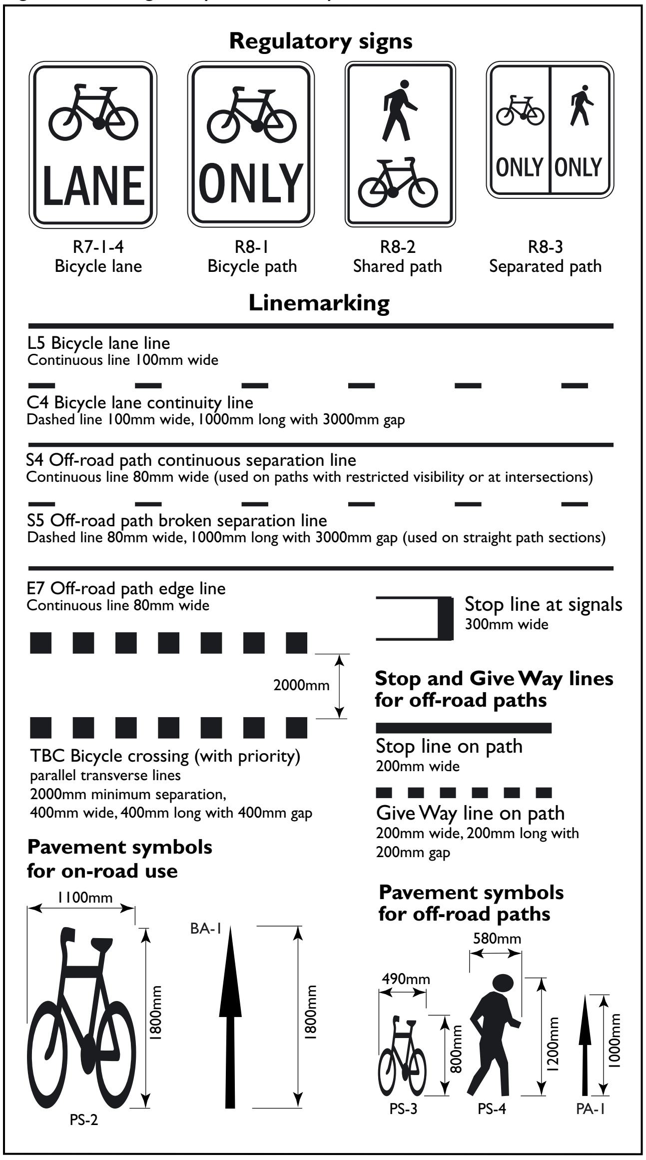


Photo 3.1: Regional town bicycle route utilising smooth sealed shoulders. Wellington NSW.

3.5 Including bicycle provision on streets

While these Guidelines address issues associated with the provision of effective bicycle network provision it should be remembered that bicycle riders will tend to use any street or road available to them if it lies along their desired route. On streets and roads and at intersections where bicycle network facilities are not present, it is current best practice to provide adequate road lane widths (particularly in the kerbside lane) to safely accommodate bicycle riders. *Austroads, Part 14* and the *RTA Road Design* guide provide detailed information and recommendations on lane widths and street profiles which include bicycle operating space. The table below lists the main methods of providing bicycle operating space to new or rebuilt streets.

3.6 Rural roads

Roads in rural areas can offer a wide range of cycling environments not unlike the suburban fringes of the major metropolitan centres. Though the principles of bicycle provision (as detailed in these Guidelines) are the same in rural areas the issues to be faced by the designer and builder of facilities can be quite different. Outside the more densly settled urban areas space is not usually a major issue and road lanes can often be of adequate width for comfortable sharing.

A major consideration in the provision of bicycle operating space on rural roads is the speed of other traffic. Where comfortable and safe sharing of roads is not achievable due to high speeds some form of separation is needed such as sealed shoulders or off-road paths. When creating links in a rural bicycle transport system which will make riding an attractive and desirable transport option it is sometimes more economical to build off-road connecting paths (designed to carry only bicycle and pedestrian traffic) rather than sealed shoulders which have to be constructed to bear the load of heavy vehicles. This has to be balanced with the other factors associated with separate off-road paths: remoteness of the facility; connectivity; maintenance etc.

In regional towns where street corridors are wide, sharing of road space is an easy option but careful attention must be paid to intersections. The main aim of the bicycle facilities designer is to guide the user along a clear and unambiguous path through all intersections along a route.

On high speed rural roads fitted with smooth sealed shoulders the continuity of this facility is a major issue for cyclists. Gaps in the facility and other potential squeeze points such as narrow bridges should be clearly marked to warn all road users of the changing road environment.

Table 3.3 Common methods for including bicycle operating space on streets

No	Method	Application	Comments
1	Removal or remarking traffic and/or parking lanes	Resizing road lanes to provide either visually separated bicycle lanes or kerbside lanes wide enough for sharing	Positioning of linemarking in relation to existing conditions (road joints, drainage, parking restrictions, sightlines etc)
2	Upgrading service roads	Marking service roads to include visually separated bicycle operating space	Special attention to parking, driveway access and entry/exit points to maintain bicycle facility continuity
3	Bicycle lanes on one side of road only	On uphill roads with limited width a bicycle lane is provided on the uphill side only	Bicycle riders need separated operating space when climbing but can easily share road space on downhills
4	Sealing shoulders	On rural roads and unkerbed urban roads	Bicycle shoulder lanes can also be fitted to kerbed urban roads with parking provision
5	Converting footpaths to shared paths	For off-road bicycle/pedestrian route within the road corridor	Suitable for off-road one-way pairs or two-way shared path on one side only
6	Indenting car parking	Where footpath space is available	Preserves parking and permits straight through kerbside bicycle lanes at intersections.
7	Car parking on one side of road only	By removing a parking lane from one side of road only to create bicycle operating space	Reduces parking. Can be used in conjunction with angle parking schemes in adjoining side streets to preserve existing parking space availability.
8	Road-widening at median	Where median space is available	Move other lanes in to median to create bicycle operating space at kerb
9	Road-widening at the kerb	To add bicycle operating space in the form of increased width of the kerbside lane or by adding a bicycle lane.	Best used where number of driveways and side streets is at a minimum to reduce overall costs.
10	Creating an off-road bicycle path	Two-way on one side only or one-way pairs	Recommended option where traffic speeds and volumes are high

4. Major types of bicycle facilities

Table 4.1: Facility location and degree of separation (numbers in table refer to the figures on the following pages).

	On-road Mixed traffic	On-road With separation	Off-road In road reserve	Off-road Not in road reserve
Visual separation	N/A	4.1 Bicycle lane	4.3 Separated path	4.3 Separated path
Physical separation	N/A	N/A	4.2 Bicycle path	4.3 Bicycle path
Shared with pedestrians	N/A	N/A	4.4 Shared path	4.5 Shared path
Shared with parked cars	Bicycle/parking lane (see *Austroads - Part 14* (Section 4.4.2)	4.6 Road shoulder	N/A	N/A
Shared with moving cars	4.7 Mixed-traffic road lane - tight profile	N/A	N/A	N/A

This section introduces seven major types of bicycle facilities located on-road and off-road for use in bicycle network routes. There can be many variations of these main types and these are detailed in Sections 5 and 6 and in *Austroads – Part 14*. Table 4.1 shows the relationship between the location of each type of facility and their degree of separation or sharing with other modes.

Selecting the most appropriate facility

If the bicycle facility is part of a bicycle network route, separation is advisable in order to provide an adequate level of service and safety. The degree of separation required largely depends on the prevailing speed and traffic volume of the road (see Figure 3.2). The amount of space available and the way existing space is distributed within the road reserve are other important issues to be considered. Where the facility is to be located in low-volume and low speed streets a mixed-traffic road profile can be safely considered. Where a road is to be fitted with bicycle facilities which are not part of the bicycle network, shared facilities are more commonly used.

Separated facilities offer the greatest priority for travel on bicycle network routes provided that intersections are designed to maintain this priority. Shared facilities always provide a degree of compromise to priority depending on the volumes of both riders and the mode sharing the particular facility. The designer should always aim to achieve a consistent priority on any route for its entire length to preserve the continuity and coherence of the network.

Photo 4.1: This two-way bicycle path is located on the road related area. Illegal parking intrusion from vehicles is prevented by bollards. Nelson Rd, Yennora.

4.1 Bicycle lane

Function: Separated, marked operating space for riders on roads. Suitable for regional and local bicycle network routes.

Design: Visual separation by means of continuous lines and regulatory sign R7-1-4. Additional clearance recommended between parking lane and edge of bicycle lane to allow for car door opening. See Figure 4.1.

Comments: Riders must ride in bicycle lanes unless it is impractical to do so; riders are better protected than in shared road lanes but less well protected than on a separated facility; motorists can easily pass riders; cycling is more comfortable; maximum visibility for bicycle network routes; if parking is allowed, drivers must cross bicycle lane to park; motorists sometimes double park across the bicycle lane; riders need to move out of and back into the lane when passing buses at stops, double-parked cars or other riders travelling two abreast; on narrow streets there may not be enough space to include bicycle lanes; large vehicles may use the lane for extra manoeuvring space.

Examples: See *Austroads - Part 14* (Section 4.4.1) for dimensions and examples. See Section 5 of this manual for details on variations.

4.2 Bicycle path (in a road reserve)

Function: Separated, operating space for riders on road related areas. Suitable for regional and local bicycle network routes.

Design: Physical separation by means of a verge, median strip or kerb. Indicated by regulatory sign R8-1. Additional separation recommended between parking lane and edge of bicycle path to allow for car door opening. See Figure 4.2.

Comments: Riders are better protected than by visual separation or in a shared environment; motorists are clearly separated from cyclists and can easily overtake; cycling is more comfortable; maximum visibility for bicycle network routes; freedom of access to the road network is slightly reduced; driving speeds on adjacent roads are often higher; bus stops must be carefully located to avoid conflicts; physical preventative measures are often needed to avoid illegal parking of motor vehicles or the placement of garbage bins and debris on bicycle paths; intersections need to have bicycle path crossings planned into their layouts; bicycle paths require a greater use of space; pedestrians may not respect this exclusive bicycle operating space; when located on one side of street only it offers fewer options for accessing destinations on opposite side of street.

Examples: See *Austroads - Part 14* (Section 6.6.3 and 4.4.5) for dimensions and examples. See Section 5 of this manual for details on variations.

Figure 4.1 Bicycle lane

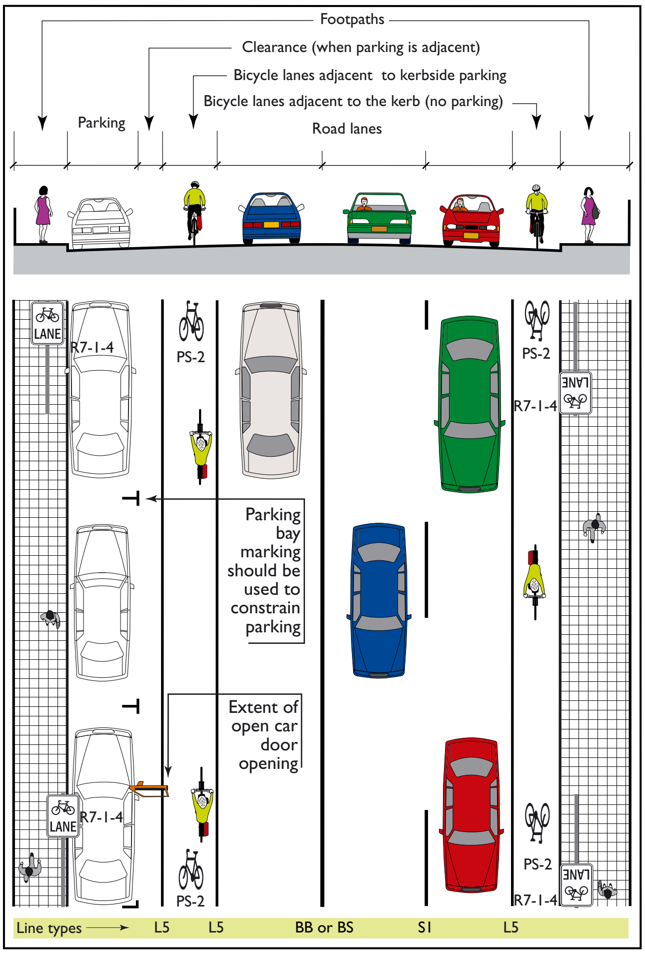
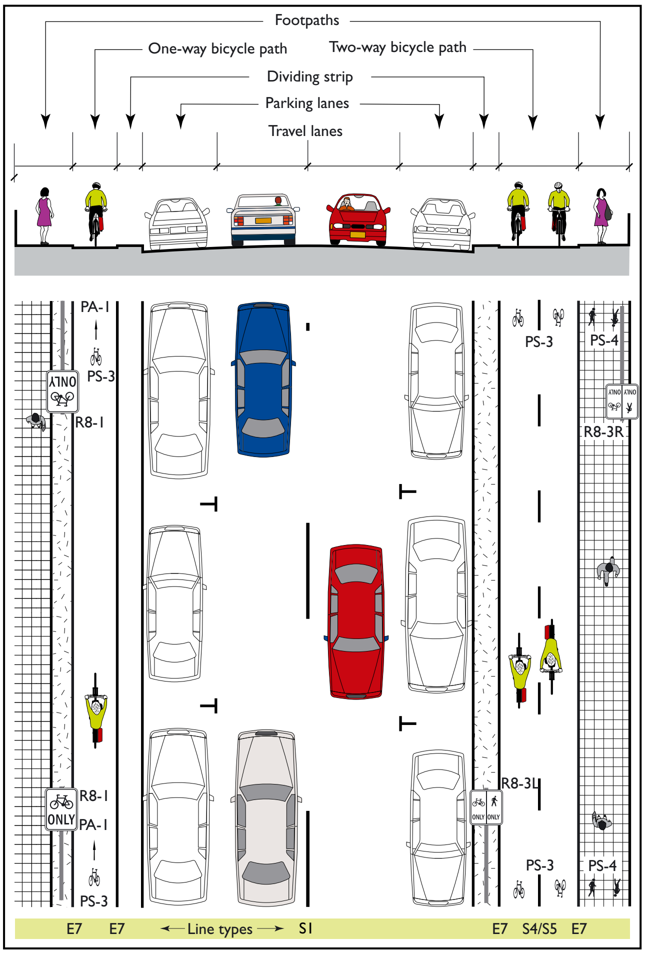


Figure 4.2 Bicycle path (in a road reserve)



4.3 Bicycle path (not in a road reserve)

Function: Separated, exclusive operating space for riders on off-road areas. Suitable for regional and local bicycle network routes.

Design: This facility is located outside a road reserve in areas such as a parks, drainage easements or reserves. Indicated by regulatory sign R8-1. A variation of this facility is the separated path which is a bicycle path abutting a footpath. This is indicated by the regulatory sign R8-3. See Figure 4.3.

Comments: Riders are better protected than by on-road lanes or mixed traffic; cycling is more comfortable; high visibility for bicycle network routes; freedom of movement around the road network is decreased; crossings of roads and pedestrian pathways must be carefully designed to prevent conflicts; physical preventative measures are often needed to avoid illegal parking of motor vehicles or the placement of garbage bins and debris on bicycle paths; bicycle paths require more space; pedestrians may not respect exclusive bicycle operating space; access by unauthorised motor vehicles may damage the path surface; special lighting may need to be installed in locations remote from the street system; bicycle paths used as bicycle network routes may offer unacceptable detours between key destinations.

Examples: See *Austroads - Part 14* (Section 6.6.3) for dimensions and examples. See Section 6 of these Guidelines for details.

4.4 Shared path (in a road reserve)

Function: Shared (with pedestrians) operating space for riders in road related areas. Suitable for regional and local bicycle network routes.

Design: Physical separation from motor vehicles by means of a verge, median strip or kerb. No separation from pedestrian traffic. Indicated by regulatory sign R8-2. Additional separation recommended between parking lane and edge of shared path to allow for car door opening. See Figure 4.4.

Comments: Riders are better protected than in a shared on-road environment but less well protected than on a separate facility such as a bicycle path; motorists are clearly separated from cyclists and can easily pass riders; cycling is more comfortable unless large numbers of pedestrians are present; maximum visibility for bicycle network routes; riders and pedestrians sometimes do not respect each other's use of the facility; physical preventative measures are often needed to avoid illegal parking of motor vehicles or the placement of garbage bins and debris on bicycle paths; road crossings need to be carefully planned; shared paths require a greater use of space – adequate width is critical; access by unauthorised motor vehicles may damage the surface.

Examples: See *Austroads - Part 14* (Section 6.6.1) for dimensions and examples. See Section 5 of this manual for details on variations.

Figure 4.3 Bicycle path (not in a road reserve)

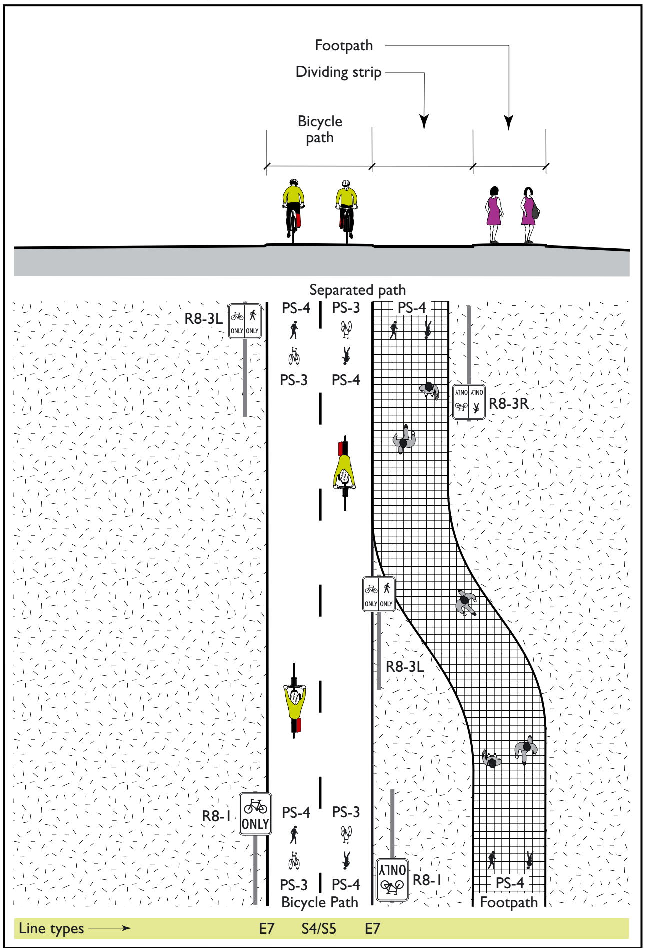
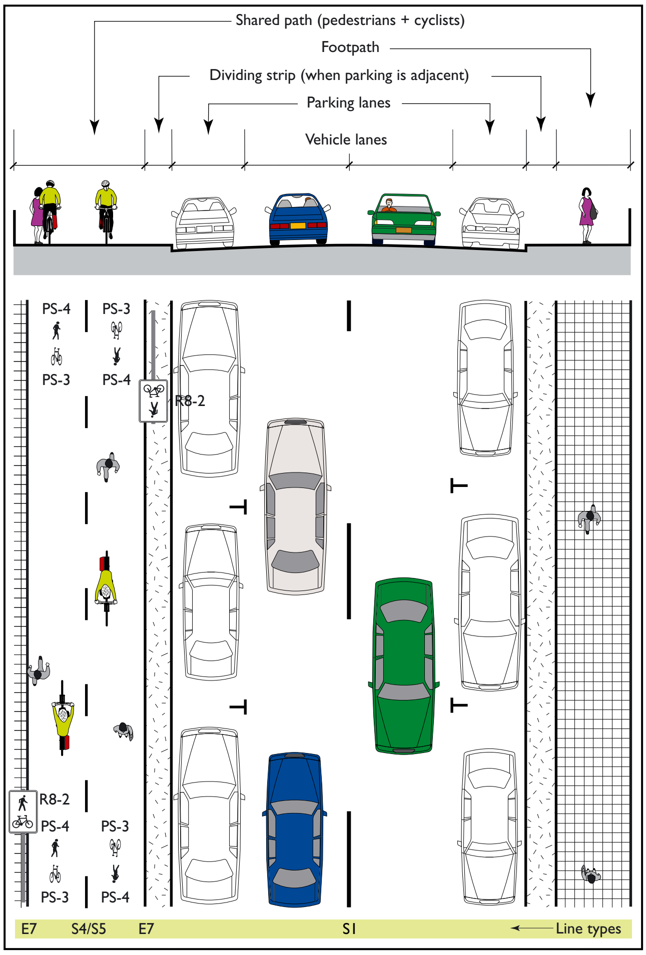


Figure 4.4 Shared path (in a road reserve)



4.5 Shared path (not in a road reserve)

Function: Shared (with pedestrians) operating space for riders and pedestrians on off-road areas. Suitable for regional and local bicycle network routes.

Design: This facility is located outside the road reserve in areas such as parks, drainage easements or reserves. Indicated by regulatory sign R8-2. See Figure 4.5.

Comments: Riders are less protected than by visual or physical separation; cycling is less comfortable when large numbers of pedestrians are present; maximum visibility for bicycle network routes; freedom of movement around the road network is decreased; physical preventative measures are often needed to avoid illegal parking of motor vehicles or the placement of garbage bins and debris on bicycle paths; road crossings need to be carefully planned; shared paths require a greater use of space – adequate width is critical; pedestrians and riders may not respect each other's use of facility; access by unauthorised motor vehicles may damage the surface; special lighting may need to be installed in locations remote from the street system.

Examples: See *Austroads - Part 14* (Section 6.6.1) for dimensions and examples. See Section 6 of this manual for details.

4.6 Road shoulder

Function: Shared (with stationary vehicles), marked operating space for riders on roads. Suitable for regional and local bicycle network routes in moderate to low speed environments (see Figure 3.2).

Design: Visual separation by means of a continuous line. Additional separation and ordering of parked cars by means of a broken lane separation line (C4). No regulatory signs are required. See Figure 4.6.

Comments: Riders are less protected than in a separated environment; motorists can easily pass riders; cycling is more comfortable than sharing road lanes; if parking is allowed, there is a hazard from unexpected opening car doors; drivers must cross the path of bicycles to park; motorists sometimes double park in all or parts of the shoulder area; riders need to move out of and back into the shoulder when passing stationary cars and other riders travelling two abreast; on narrow streets there may not be enough space to include shoulders; there is often minimal or inadequate clearance between riders and parked cars; where the shoulder is shared with parked cars these may not park sufficiently close to the kerb to allow for comfortable cycling; large vehicles may use the shoulder for extra manoeuvring space.

Examples: See *Austroads - Part 14* (Section 4.4.4 and 4.4.6) for dimensions and examples. See Section 5 of this manual for details on variations.

Figure 4.5 Shared path (not in a road reserve)

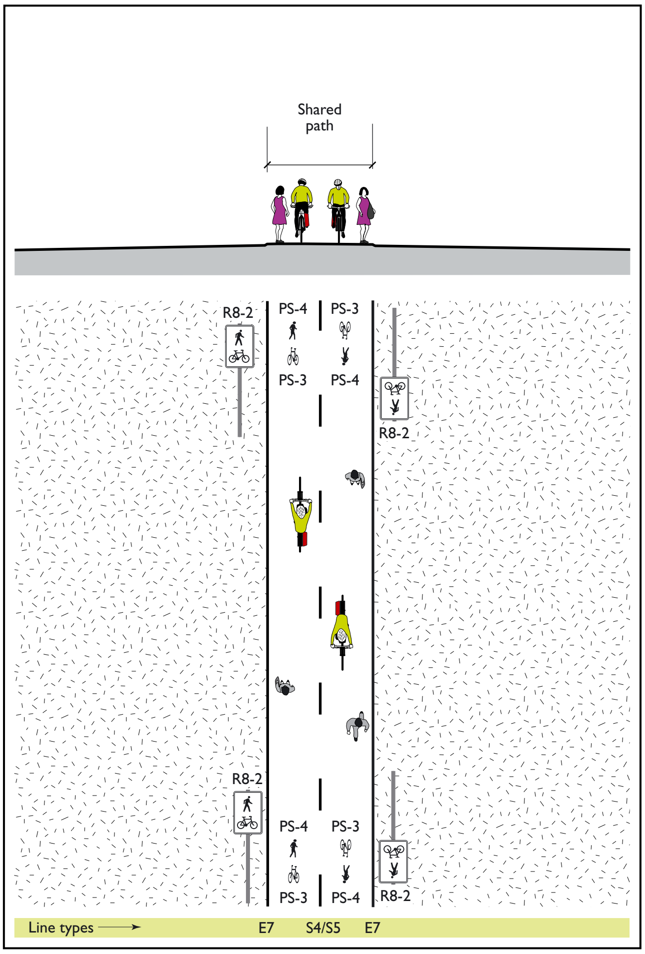
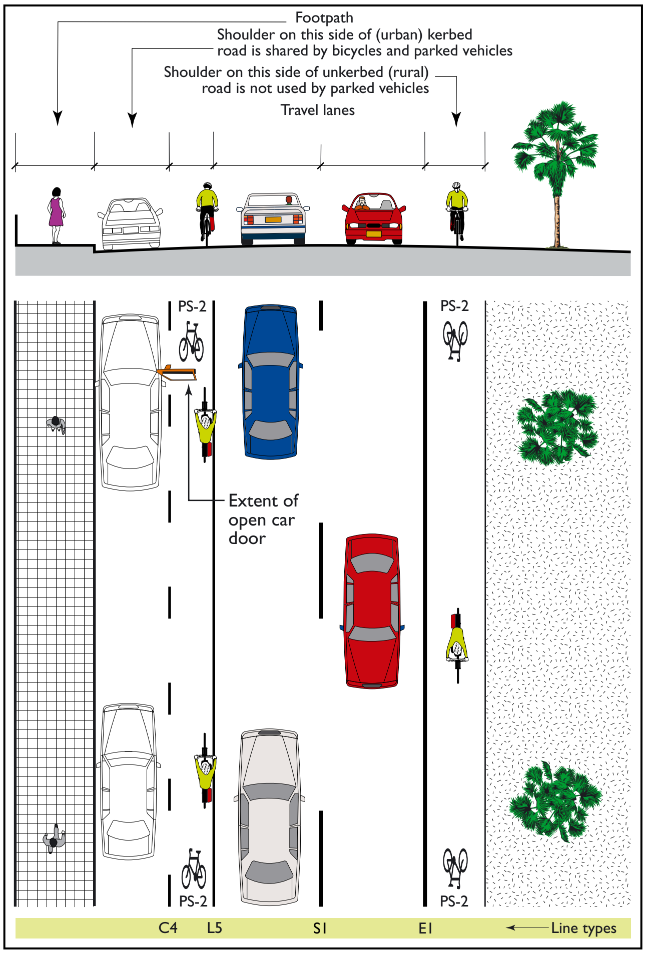


Figure 4.6 Road shoulder



4.7 Mixed traffic street (tight profile)

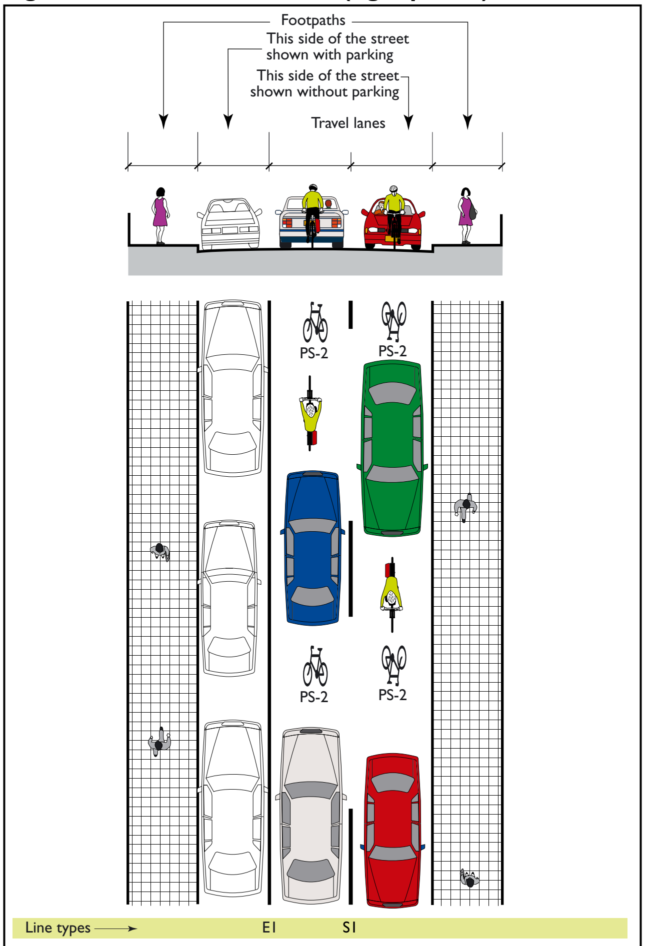
Function: Shared (with moving motor vehicles), unmarked operating space for riders on minor roads and residential streets. To provide bicycle access across the road network. Suitable in low-speed (less than 50 km/h), low-volume environments (see Figure 3.2).

Design: Riders share vehicle lanes which are designed tight enough so that it is not possible to pass riders. NB: shared road lanes with a tight profile are not recommended on major roads (above two lanes). See Figure 4.7.

Comments: Riders' full freedom of and access to the road network is preserved; safety at intersections with similar roads is increased; riders are less well protected than on separated or shared spacious-profile facilities; tight profile encourages lower speeds; physical methods to further reduce motor vehicle speeds are often necessary (LATM treatments); car parking in these streets can be a hindrance; the risk of illegal parking is high; motorists cannot pass riders and may pressure them to move faster or into lateral obstructions.

Examples: See Section 5 of these Guidelines for details on variations.

Figure 4.7 Mixed traffic street (tight profile)



4.8 Applying street treatments

The treatments outlined in this section can be applied to a range of street and road environments to create bicycle routes which satisfy the five principles of network provision detailed in Section 3.1 of these Guidelines. Successful bicycle provision always requires a more careful attention to finer details due to the operational characteristics of the bicycle as a vehicle.

Before deciding what type of bicycle facility treatment may be applied to a given street cross section, careful consideration should be given to the full range of physical and operational parameters:

- Function of the street within State and Council road hierarchies
- Function of the street within the bicycle network (see Table 3.2)
- Width and current operational allocation of the street corridor
- Motor vehicle volumes (See Figure 3.2)
- Motor vehicle speeds (See Figure 3.2)
- Use by heavy vehicles and buses
- Slope and grade
- Parking demand
- Location of blackspots
- Location of services and utilities
- Road drainage

Because the street environment can change greatly, even within the block, it is important to consider that a single solution may not be appropriate and the final bicycle route design may incorporate many different treatments in response to changing street conditions and opportunities. The table below provides an example of how different treatments can be applied in response to differing conditions.

Table 4.2: Options for bicycle provision on 12.8m streets

Street conditions	Treatment options
High traffic volumes	Re-route through traffic eg: creating a one-way paired street with a wide one-way bike lane in each Remove vehicle parking on one side to widen bicycle lanes
High traffic speeds	Lower speed environment Introduce bicycle compatible traffic calming measures
Moderate traffic speeds and volumes	Use bicycle shoulder lanes (see Section 5.1.2)
Low car parking demand	Remove parking from one side to widen bicycle lanes
Uphill slope	Wide bicycle lane on uphill side and mixed traffic on downhill side of street
Residential streets	Restrict vehicle street access with bicycle compatible LATM treatments

5. Bicycle facilities on- and off-road within road reserves

Table 5.1: Scope of Section 5.

Type of facility	Coverage in *Austroads - Part 14*	Coverage in these Guidelines
Bicycle lanes on roads	4.4.1 Exclusive bicycle lanes	5.1.1 Bicycle lanes on roads
Bicycle shoulder lanes	4.4.4 Sealed shoulders	5.1.2 Bicycle shoulder lanes
Bicycle lanes and bus lanes	4.4.8 Bus/bicycle lanes	5.1.3 Bicycle lanes and bus lanes
Bicycle contra-flow lanes	4.4.3 Contra-flow bicycle lanes	5.1.4 Bicycle contra-flow lanes
Bicycle paths within the road reserve	6.6.3 Exclusive use bicycle paths 6.6.1 Shared use paths 6.6.2 Separated paths	5.2.1 One-way and two way bicycle paths 5.2.2 Shared paths
Mixed traffic - tight profile Mixed traffic - spacious profile	4.4.2 Bicycle/car parking lanes 4.4.6 Advisory treatments 4.4.7 Wide kerbside lanes	5.3 Mixed traffic roads
Bicycle facilities and speed humps	4.7c Local area traffic management	5.3.3 Bicycle routes and speed humps
Freeway shoulders	4.6 Provision for cyclists on freeways	5.1.2 Bicycle shoulder lanes (Figure 5.4)
Bicycle path off-road to on-road transitions	4.5.3 Ramps	5.4 On-road to off-road transitions
Marked bicycle lanes through car parks		5.5 Bicycle routes through car parks

Bicycle facilities located on-road or off-road within the road reserve are the most important elements of the bicycle network as they provide the best integration with the general road network and thus can provide the most direct access to destinations.

This section provides detailed recommendations and treatment examples on the main methods of providing bicycle routes on, or related to roads: bicycle lanes on roads; bicycle paths off-road within the road reserve; and bicycle shoulder lanes and mixed traffic lanes.

When locating new bicycle facilities on existing roads it is essential to consider the entire road corridor between the property boundaries. *Austroads – Part 14* (Section 4.3.2) provides information on the various methods of finding bicycle operating space, trading space and rearranging existing space within the road corridor.

5.1 Bicycle facilities on-road

5.1.1 Bicycle lanes

Austroads – Part 14 (Section 4.4.1) provides detailed information about exclusive-use bicycle lanes.

Application

Bicycle lanes provide visually separated operating space for the exclusive use of riders on roads. They are used to define bicycle routes where the prevailing road speed and traffic volume requires a degree of separation. Riders are required to use these lanes unless it is impracticable to do so (*Australian Road Rules. Rule 247*).

Photo 5.1 (left): Bicycle lane adjacent to kerb (no parking). Elizabeth Dr, Bonnyrigg Heights.
Photo 5.2 (centre): Bicycle lane adjacent to parked cars. Campbell Parade, Bondi.

Design notes

Bicycle lanes are part of the road (usually the kerbside lane) and are defined by means of continuous white lines separating bicycle traffic from either moving traffic or parked vehicles. The lane is regulated by the sign R7-1-4 and two unbroken L5 lane lines. PS-2 pavement symbols are used in an advisory capacity at 75m intervals or adjacent to intersecting streets. L5 lane lines should be broken (C4 bicycle lane continuity lines) at minor side streets and exits. Start and finish of C4 lines should correspond with the signed or statutory prohibited parking zone adjacent to intersections. Green coloured pavement may be used in special circumstances to increase lane visibility (see Section 8.1.3 for permitted uses of green coloured pavement).

Comments

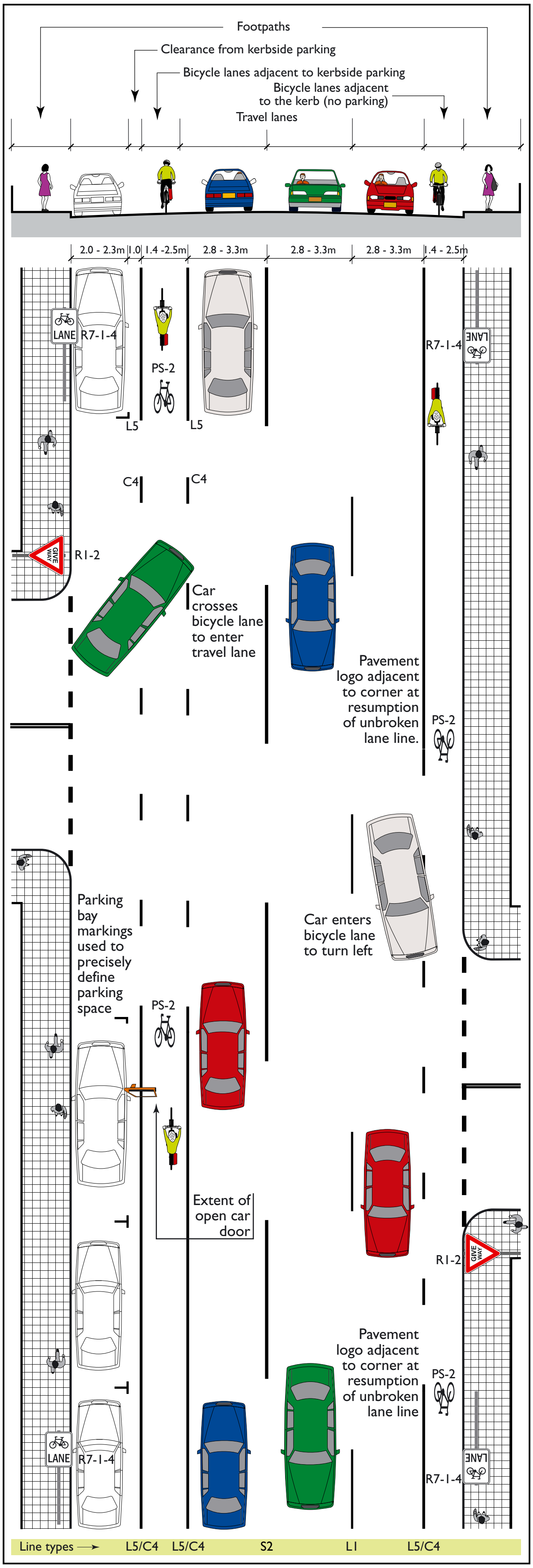
Riders must be able to keep a safe distance from opening parked car doors without deviating from the lane. To give riders some protection from opening car doors 0.4 – 1.0m clearance between the bicycle lane edge and parked vehicles is recommended. This space can be allocated to the parking lane or to the bicycle lane. Bicycle lanes can often be used illegally by motor vehicles either for double parking or for travel so door clearance space is best allocated to the parking lane. If both bicycle lane and adjacent travel lanes are very wide this may also increase motor vehicle speeds. Where space permits bicycle lanes should be wide enough for one rider to pass another without deviating significantly from the lane. Figure 5.1 shows bicycle lane linemarking treatment past minor side streets.

Example

Photos 5.1 and 5.2 show bicycle lanes in both mid-block and past minor side streets used in conjunction with car parking. Parking in the example shown in Photo 5.1 is indented and the bicycle lanes continue adjacent to the kerb up to the traffic signals. Left turning vehicles at this type of intersection need to carefully judge the speed of straight ahead riders in order to safely make their turn.

Photo 5.3: Bicycle lane marked past side street intersection. Birriga Rd, Bellevue Hill.

Figure 5.1: Bicycle lanes across minor side streets.



5.1.2 Bicycle shoulder lanes

On the older urban streets in NSW cities and towns there is often a need to provide marked bicycle operating space which is more flexible than bicycle lanes where the streets are narrow and vehicle speeds and volumes are moderate. This is often desirable when there is a heavy demand for kerbside car parking. Bicycle shoulder lanes have been successfully used in NSW by the RTA for a number of years and are recommended on low volume roads with speeds up to 80 km/h or moderate volume roads with speeds up to 60 km/h (see Figure 3.2). Bicycle shoulder lanes may also be appropriate in some situations where off-road paths are not achievable.

Application

Bicycle shoulder lanes provide a more flexible, visually separated operating space intended for use by riders on roads. They are used on streets to define bicycle routes where the prevailing road speed and traffic volume requires a degree of separation. They are primarily intended for use in tight situations on local roads within urban areas. See Table 4.2 for other options for use on 12.8m streets. Bicycle shoulder lanes can also be used in urban situations on roads without a centreline dividing the centre travel lanes.

Bicycle shoulder lanes can provide bicycle network connections on unkerbed rural type roads (see Figure 5.2). Urban and rural motorways can also accommodate bicycle shoulder lanes delineated by an E2 edge line (see Figure 5.4).

Design notes

Bicycle shoulder lanes are part of the road (usually adjacent to kerbside parking) and are defined by means of a solid white edge line, (a 100mm wide L5 bicycle lane line which defines the road shoulder) and a dashed white line (C4 type, 100mm wide) separating bicycle traffic from parked cars. PS-2 pavement symbols are used at 75m intervals and before and after intersecting streets. Green coloured pavement may be used in special circumstances to increase lane visibility particularly where parking demand is high and across complicated intersections (see Section 8.1.3 for permitted uses of green coloured pavement). No regulatory signposting is required.

Figure 5.2: Bicycle shoulder lanes.

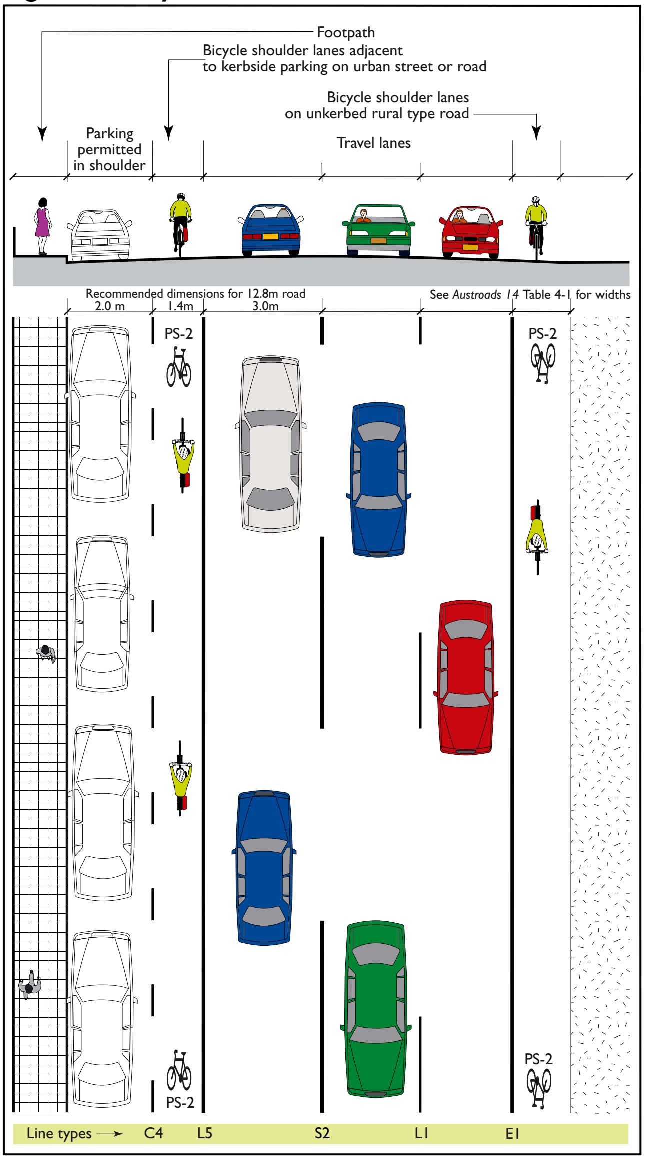
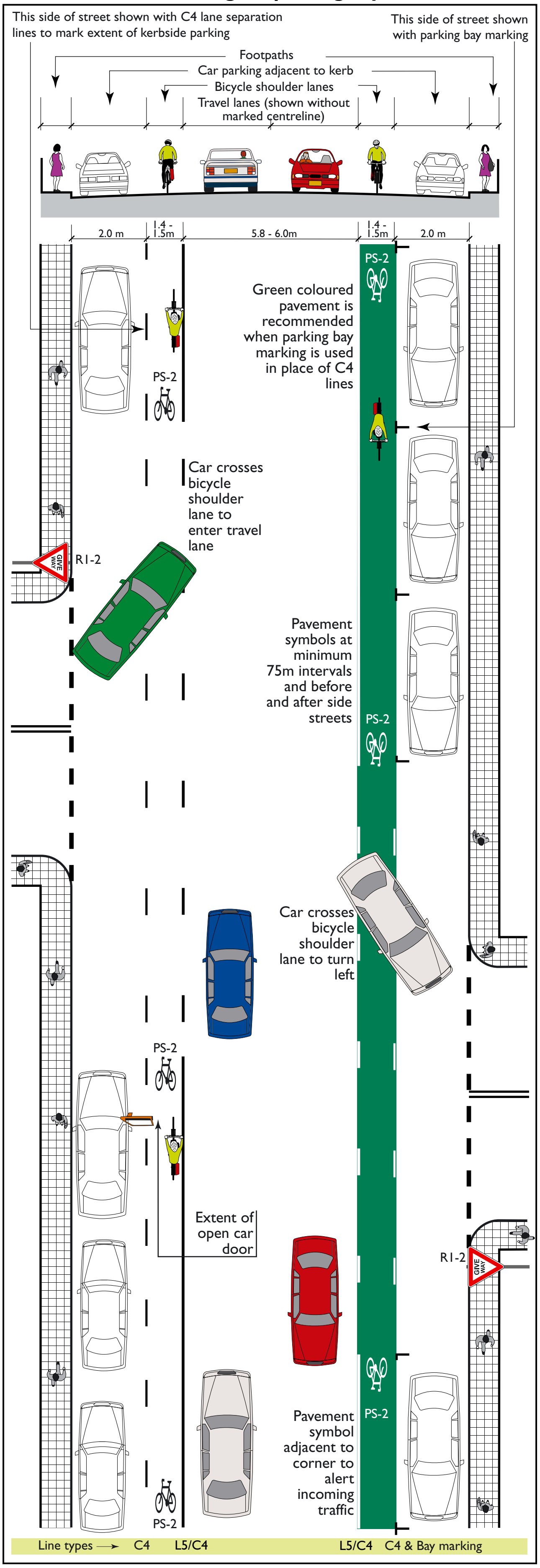


Photo 5.4 (above): Bicycle shoulder lane along an outer urban street. Englorie Park Dr, Ambarvale.
Photo 5.5 (below): Bicycle shoulder lane marking at minor side street. Moore Park Rd, Paddington.

Figure 5.3: Bicycle shoulder lanes across side streets with alternative marking for parking bays



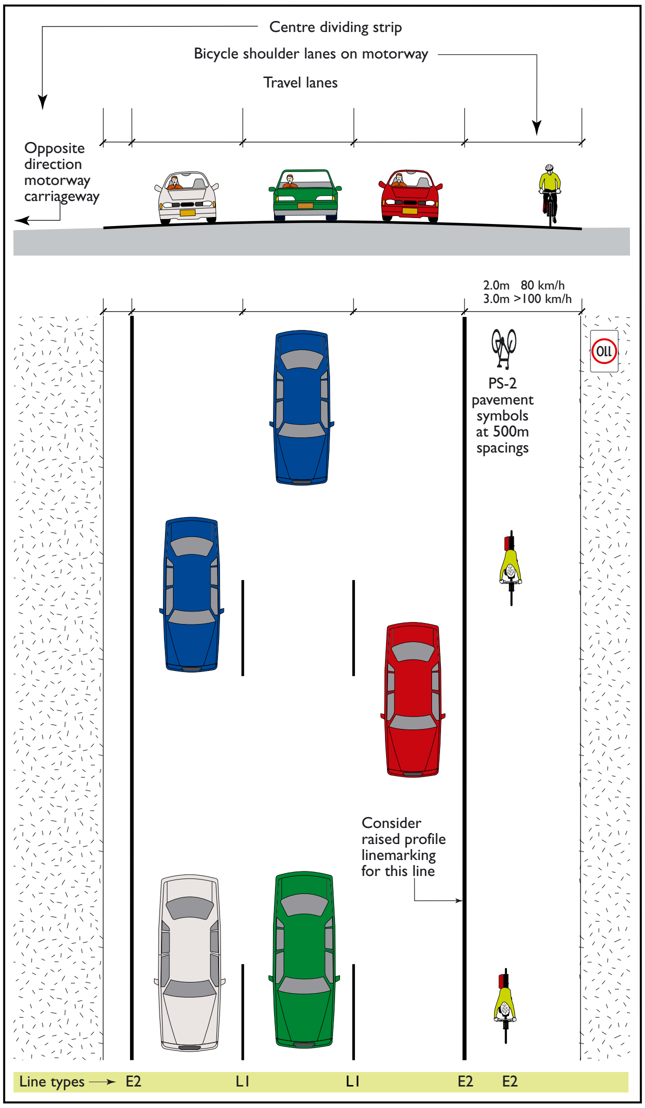
Comments

Bicycle shoulder lanes provide riders with a defined operating space but with tighter lanes and less clearance than with conventional bicycle lanes. Though they are separated from the main traffic lanes, riders still need to travel cautiously in the bicycle shoulder lane to avoid unexpected opening car doors, poorly parked cars and surface joint hazards. This type of treatment can also be used on lower speed roads (≤ 50 km/h) to define bicycle operating space when no centre line is used (this configuration is shown in Figure 5.3).

Drivers are encouraged to park close to the kerb by means of the dashed lane separation line or by 2.0m wide marked parking bays. When both bicycle shoulder lanes and adjacent travel lanes are very wide this may increase motor vehicle speeds. If bicycle shoulder lanes are wider than 1.5m, instances of double parking and use of these lanes by motor vehicles are more prevalent. Figure 5.3 shows bicycle shoulder lane linemarking treatment adjacent to minor side streets and using parking bay markings.

Figure 5.4 shows the use of bicycle shoulder lanes on high speed roads such as motorways and State Highways. The recommended widths of these shoulders are necessary to minimise the impact on riders of wind from passing heavy vehicles travelling at speed.

Figure 5.4: Bicycle shoulder lanes on motorways.



5.1.3 Bicycle lanes and bus lanes

Austroads – Part 14 (Section 4.4.8) provides basic information about bus lanes shared by riders.

Application

In NSW bicycles may be ridden in bus lanes but not in "Buses Only" lanes. As bus lanes are usually installed as the kerb lane, riders will usually use this lane in preference to other road lanes. Shared use of bus lanes is desirable for general bicycle access to all destinations. For network route purposes separate abutting bicycle and bus lanes or physically separated bicycle paths are preferred.

Design notes

Where bus volumes and speeds are high (>10 buses per hour >30km/h), visual separation is recommended. Figure 5.5 (left half of road) shows recommended treatment for abutting lanes using red and green coloured pavements. This example is an approved use of green pavement surface colouring.

Where volumes are in excess of 20 buses per hour and speeds are above 50km/h, physical separation is advisable for bicycle routes.

Where marked bicycle network routes use bus lanes PS-2 pavement symbols should be marked in the centre of these lanes below "Bus Lane" lettering.

Comments

Where bicycle routes are located alongside bus lanes it is important that the safety and continuity of riders be carefully considered at intermediate bus stops. Two treatments for maintaining continuity of bicycle lanes past bus stops are shown in Photo 5.6 and Figure 5.6. Photo 5.6 shows the bicycle lane remaining on-road and with an unaltered alignment. In this instance bus drivers are required to cross the bicycle lane to move into the kerbside bus stop. Bicycle and bus peak period lanes also have this disadvantage. Buses

Figure 5.5: Bicycle lanes and bus lanes.

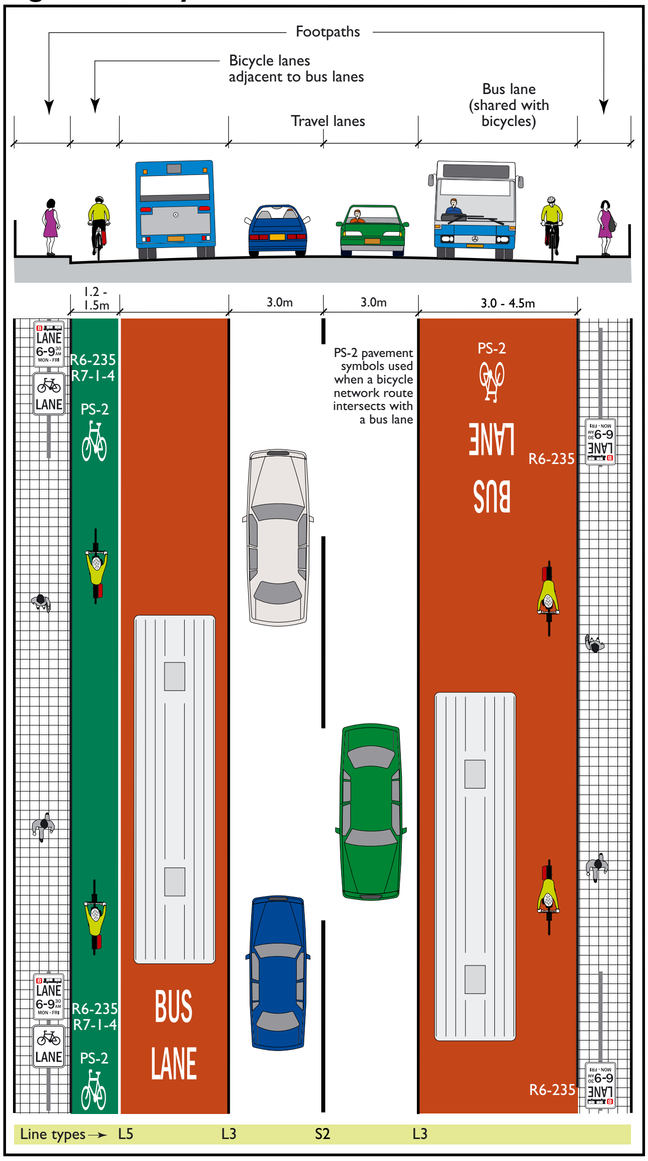
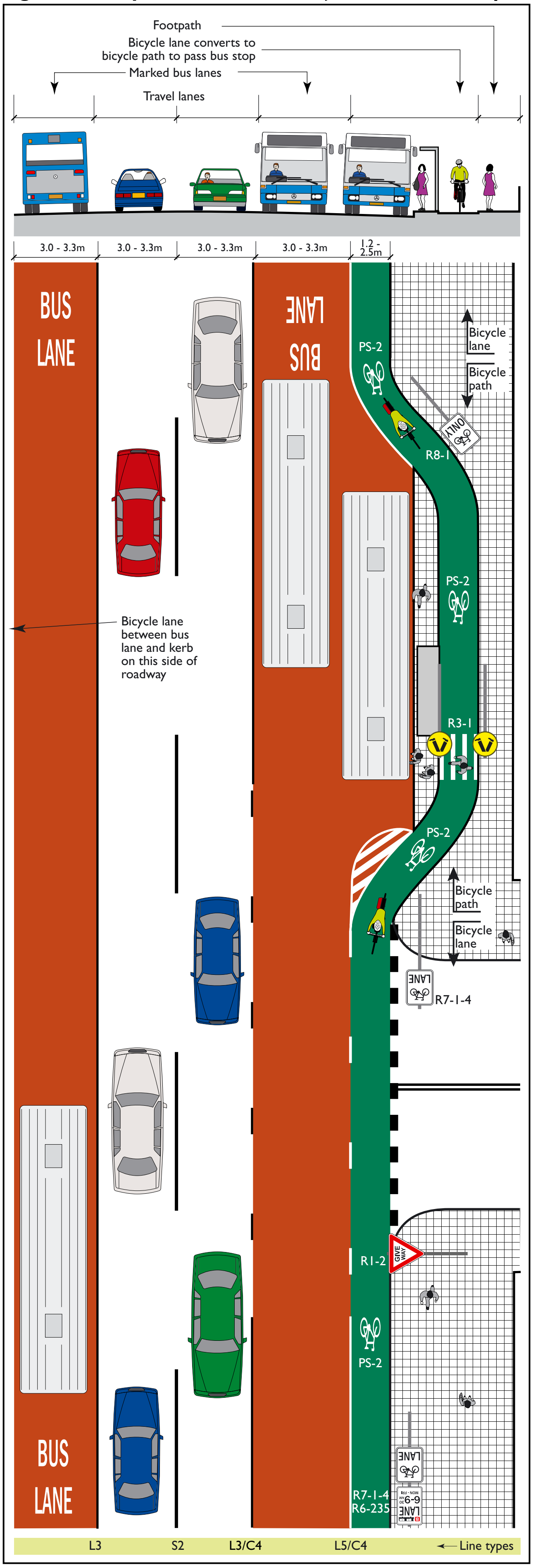


Photo 5.6: Bicycle lane located adjacent to a bus lane and a bus stop. Sunnyholt Rd, Blacktown.

Figure 5.6: Bicycle and bus lanes adjacent to a bus stop.



must pull into the kerb to pick up passengers. This means that bicycle riders must deviate into the bus lane to pass a stationary bus.

Figure 5.6 shows a bicycle lane deviating around the bus stop on the inside as a bicycle path. This treatment offers a high degree of continuity along with increased comfort and safety to riders as they do not have to negotiate with buses attempting to cross their path. This type of bus stop bypass treatment can also be applied to bus lanes shared by cyclists with the length of the bicycle path bypass marked in green surface colouring and pavement logos to indicate exclusive use by riders.

Photo 5.7 (above): Bicyclist operating in a bicycle lane adjacent to a bus lane. Sunnyholt Rd, Blacktown.
Photo 5.8 (below): Aerial view of bicycle lane adjacent to a bus lane shown in Photo 5.6. Sunnyholt Rd, Blacktown.

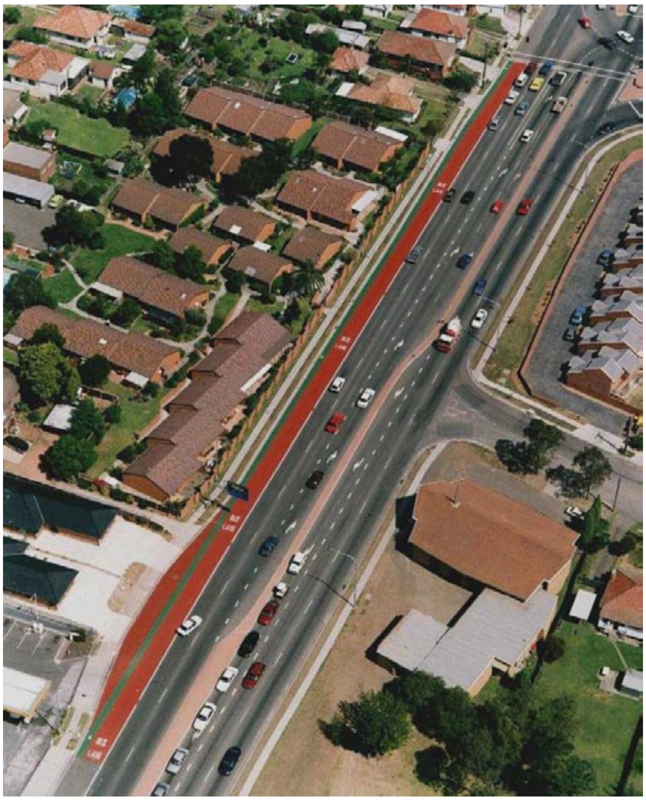
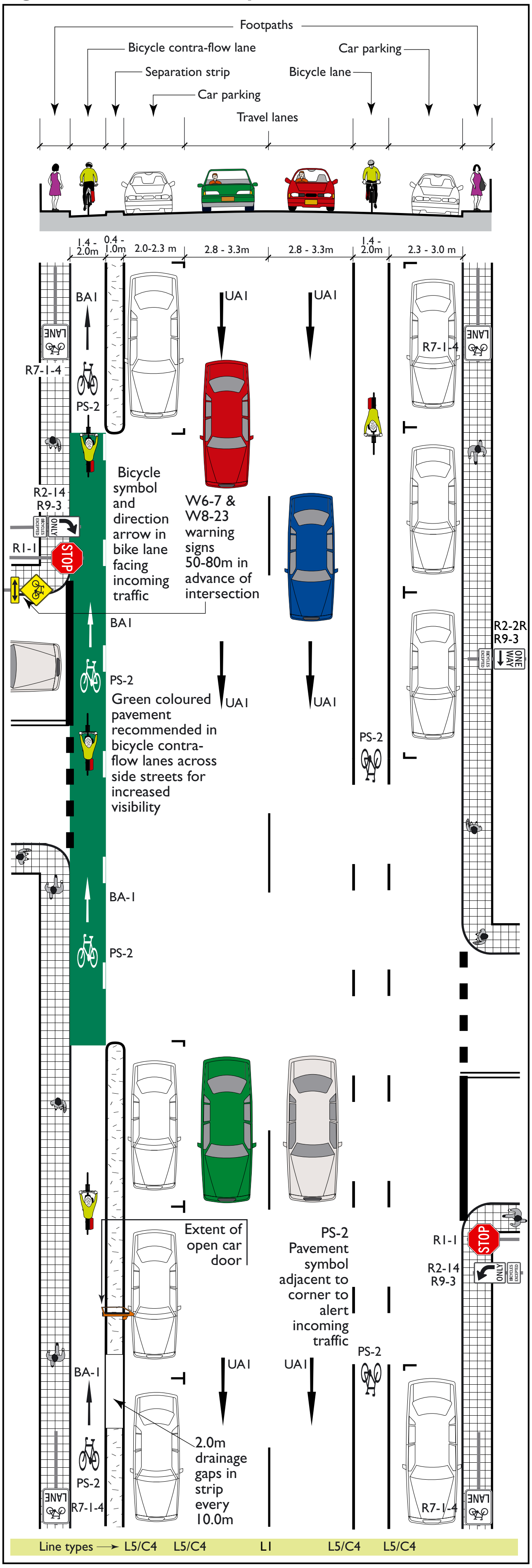


Figure 5.7: Contra-flow bicycle lanes.



5.1.4 Bicycle contra-flow lanes

Austroads – Part 14 (Section 4.4.3) provides detailed information about exclusive-use bicycle lanes.

Application

Bicycle contra-flow lanes provide visually separated operating space for the exclusive use of riders to permit travel in the opposite direction on designated one-way streets.

Design notes

Bicycle contra-flow lanes are part of the road usually the kerb lane and sometimes to the centre of marked parking. The contra-flow lane is marked by means of continuous white L5 lines separating bicycle traffic from either moving traffic or parked vehicles (see Figure 5.7). Green coloured pavement, PS-2 bicycle symbols and PA-1 pavement travel direction arrows should be used in conjunction with all bicycle contra-flow lanes to maximise their visibility across side streets and driveways. At intersections bicycle riders using a contra-flow lane should be brought out into clear view of motorists and not be hidden behind obstacles.

PS-2 pavement symbols and PA-1 pavement arrows should be placed in the contra-flow lane at minimum 75m intervals and adjacent to intersecting streets. The L5 lane lines should be replaced with C4 bicycle lane continuity lines at minor side streets and exits. Start and finish of C4 lines should correspond with the signed or statutory prohibited parking zone adjacent to intersections.

Figure 5.8 shows a bicycle contra-flow lane in a mixed-

Photo 5.9 (above): Protected bicycle contraflow lane located to the kerbside of parallel car parking. Bourke St, Surry Hills.
Photo 5.10 (below): Bicycle contraflow lane in narrow low traffic volume street. Middlemiss St, North Sydney.

traffic type street with riders sharing the opposite travel lane. This type of treatment is recommended for speeds of 40km/h and less.

Night time visibility of the bicycle contra-flow lane (especially in wet weather conditions) can be enhanced by placing yellow raised pavement markers just inside the adjacent vehicle lane facing oncoming traffic to indicate the centre of the road.

Comments

Riders must be able to keep a safe distance from opening parked car doors without deviating from the lane. To give riders some protection from opening car doors a 0.4 – 1.0m separating strip should be provided between the edge of the bicycle lane and parking space. Kerb side bicycle contra-flow lanes can often be used illegally by motor vehicles either for double parking or for travel so lanes should not be wider than 2.0m.

Where space permits bicycle contra-flow lanes should be wide enough for one rider to pass another without deviating significantly from the lane.

Figure 5.7 shows a bicycle contra-flow lane linemarking treatment past minor side streets. Entry to the contra-flow lane by cyclists from side streets must be permitted by the supplementary plate R9-3 "Bicycles Excepted" beneath the R2-6 sign restricting turn movements into the street.

Figure 5.8: Contra-flow bicycle lanes in narrow streets.

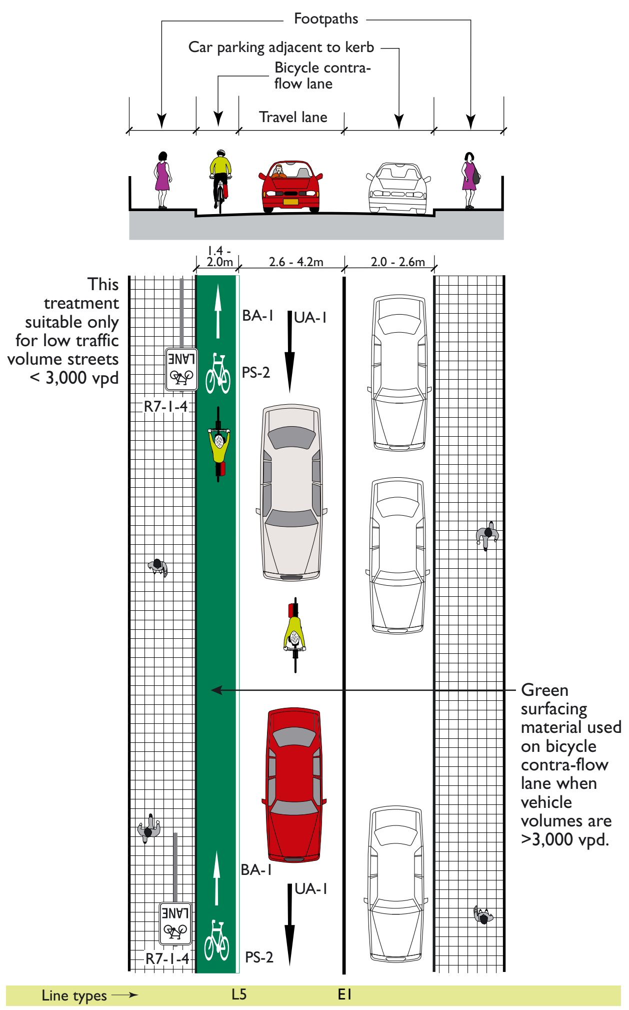
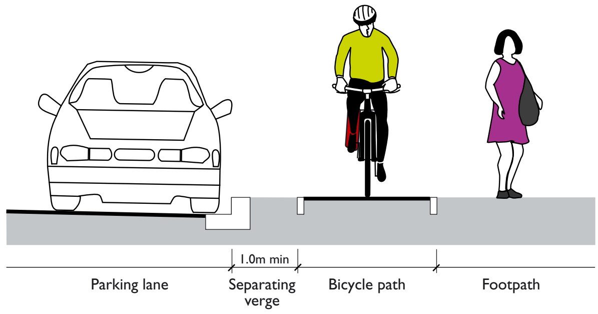
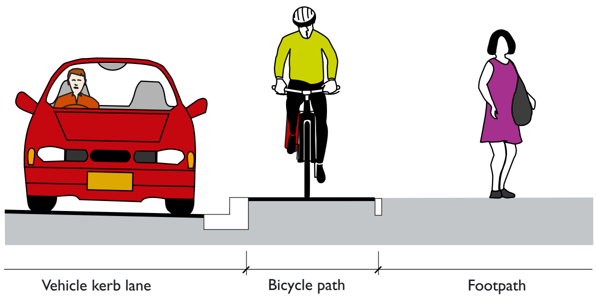


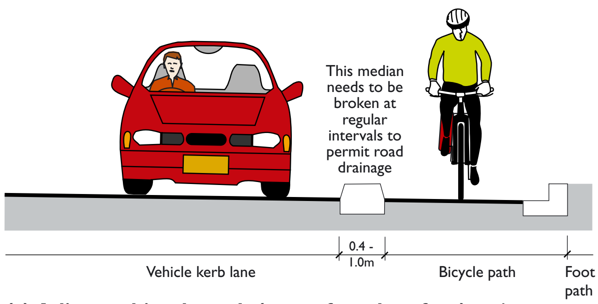
Figure 5.9: Separation methods for off-road bicycle paths.



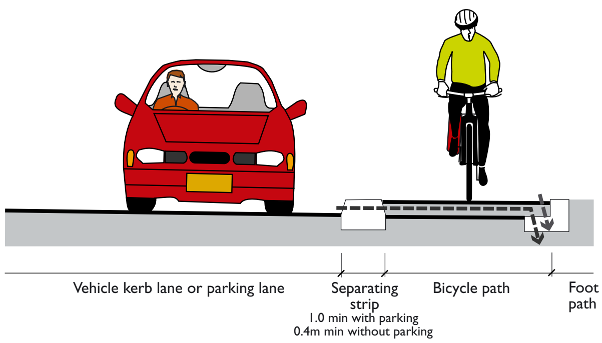
(a) Fully separated bicycle path with separating verge of adequate width to allow for adjacent car parking. Bicycle path can be one-way or two-way.



(b) Adjacent bicycle path with no separating verge. Not recommended where adjacent car parking is present or for a two-way bicycle path.



(c) Adjacent bicycle path (part of road surface) with separating kerb. Width of separating kerb: 0.4m no parking; 1.0m with parking or where pedestrian activity is high. Bicycle path can be one-way or two-way.



(d) Adjacent bicycle path (narrowed road surface) with separating verge of adequate width to allow for vehicle travel lane or adjacent car parking. Bicycle path can be one-way or two-way. New channels laid under bicycle path to deliver road run-off to existing drainage pits.

5.2 Off-road bicycle paths within the road reserve

Bicycle paths within the road reserve provide physically separated operating space for the exclusive use of riders off-road. They can provide a higher level of comfort and safety than on-road lanes. They can be constructed as one-way facilities on each side of the road corridor or as a single two-way pathway on one side of the reserve.

5.2.1 One- and two-way off-road bicycle paths

Austroads – Part 14 (Section 4.4.5, Sections 6.5, 6.6.2 and 6.6.3) provide related information about bicycle paths.

Application

Off-road bicycle paths provide physically separated bicycle operating space adjacent to a road on either side. They are used as either one-way or two-way paths on two-way streets to define bicycle routes where the prevailing road speed and traffic volume requires physical separation. They require more land than either mixed-traffic streets or bicycle lanes. Priority and crossing design at side streets

Figure 5.10: Bicycle path (one-way pair) off-road within the road reserve.

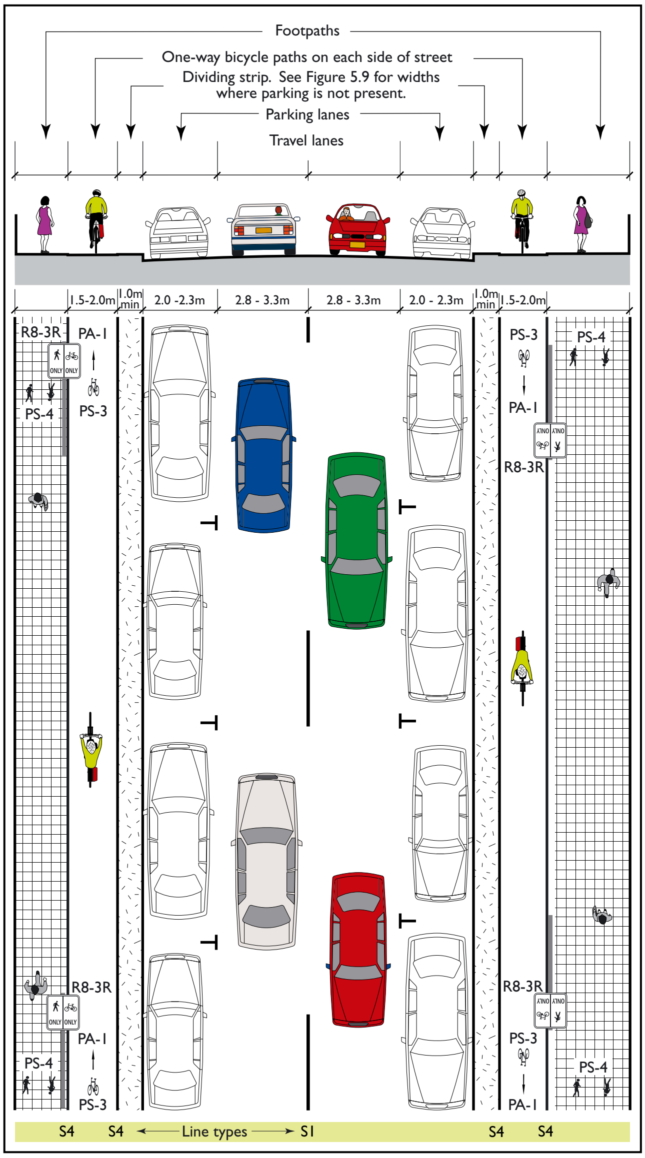
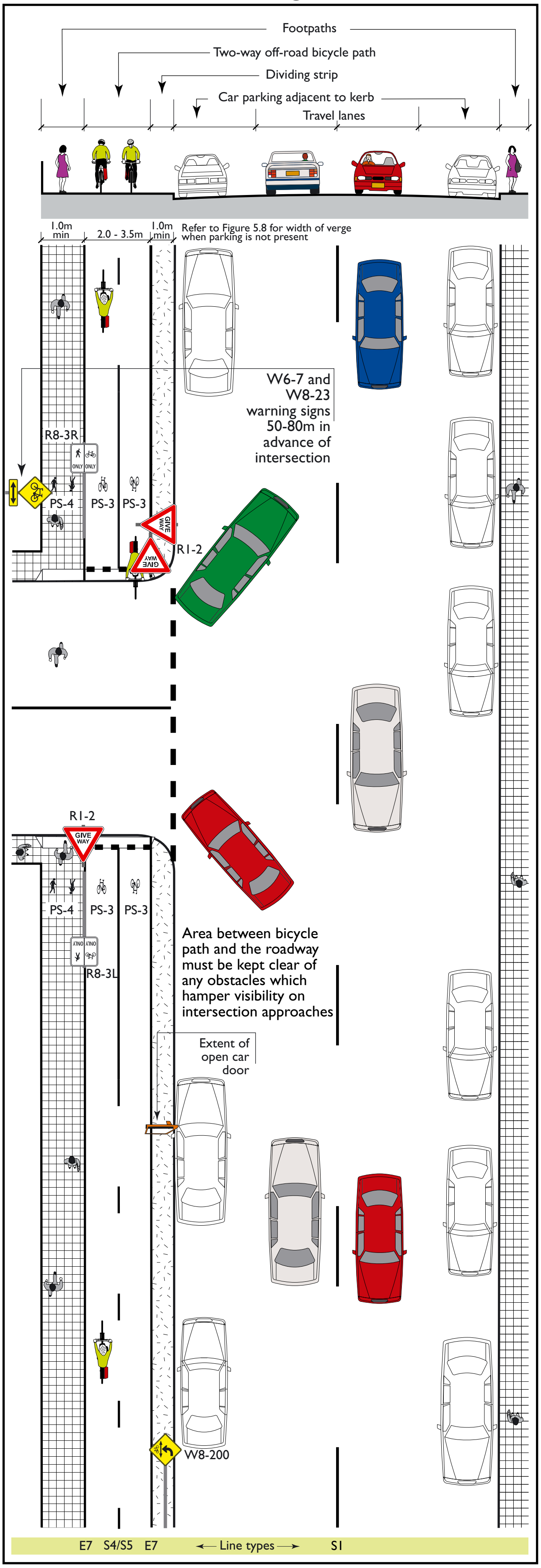


Figure 5.11: Bicycle path (two-way) off-road in the road reserve and crossing a side street.



is an issue which needs to be carefully addressed especially where a two-way path is used. Figure 5.10 shows one-way pair bicycle paths. Figure 5.11 depicts a two-way bicycle path on one side of the road only. One-way path pairs are preferable to single two-way paths as bicycle riders travel in the same direction as other vehicular traffic.

Design notes

Bicycle paths are part of the road related area and are usually separated by a dividing strip (see Figure 5.9 Separation Methods for Off-Road Bicycle Paths) and are regulated by the sign R8-1. PS-3 pavement symbols and PA-1 pavement arrows are used in an advisory capacity at 75m intervals or adjacent to intersecting streets to indicate travel direction. Solid edgelines can be used in areas of high bicycle and pedestrian traffic to precisely define the riding area or as an aid to navigation in low light conditions. Raised platforms can be used in special circumstances to increase bicycle route coherence at these crossings.

Two paths within transport corridors. Photo 5.11 (above): A shared path section of the 17km urban rail trail project linking Parramatta and Liverpool. Military Rd, Guildford. Photo 5.12 (below): A bicycle path. Sydney Harbour Bridge Cycleway.

Comments

A major issue in the application of any bicycle facility off-road is continuity. Bicycle paths paralleling major or collector roads should be afforded the same priority as the parallel road at minor street intersections. The *Australian Road Rules* (Rule 71) provides for Give Way signage as a means of regulating approaching vehicles on side streets. A crossing using contrasting pavement material and smooth wide kerb ramping (*Austroads – Part 14* Figure 6-44) can be provided at the crossing point.

5.2.2 Shared paths

Austroads – Part 14 (Section 4.4.5, Sections 6.5, 6.6.2 and 6.6.3) provide related information about bicycle paths.

Application

Shared paths provide physically separated operating space for pedestrians and cyclists off-road within the road corridor. They are used on two-way streets to define bicycle routes where the prevailing road speed and traffic volume requires physical separation. They require more land than either mixed-use or bicycle lanes and priority and crossing design at side streets is an issue which needs to be carefully addressed.

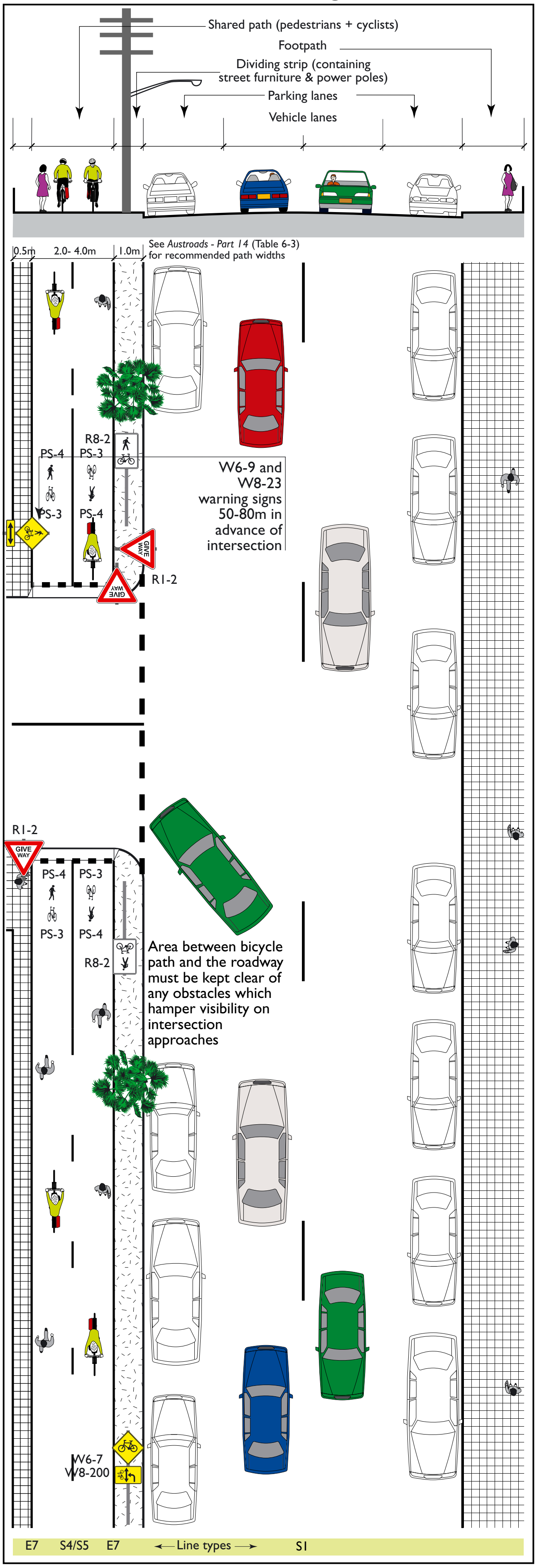
Design notes

Shared paths are part of the road related area and are usually separated by a dividing strip (see Figure 5.9 Separation Methods for Off-Road Bicycle Paths) and are regulated by the sign R8-2. PS-3, PS-4 pavement symbols and PA-1 pavement arrows are used in an advisory capacity at 75m (200m max) intervals or adjacent to intersecting paths/streets to indicate travel direction. An S3 separation line is used to separate opposing flows of riders with a solid line used on tight corners or where visibility is reduced. Solid edgelines can be used in areas of high bicycle and pedestrian traffic to precisely define the riding area or as an aid to navigation in low light conditions.

Comments

Shared paths can provide good access for both cyclists and pedestrians provided that the number of users is moderate and path widths are wide. See *Austroads – Part 14* (Table 6-3) for recommended widths. Where a shared path has the function of a regional route, consideration should be given to providing the route priority over lower volume side streets. The *Australian Road Rules* (Rule 71) provides for Give Way signage as a means of regulating approaching vehicles on side streets. Smooth wide kerb ramping (*Austroads – Part 14* Figure 6-44) and contrasting pavement surfacing can also be provided to enhance the crossing. A shared path crossing of a local side street is shown in Figure 5.12.

Figure 5.12: Shared path (two-way) off-road within the road reserve and crossing a side street.



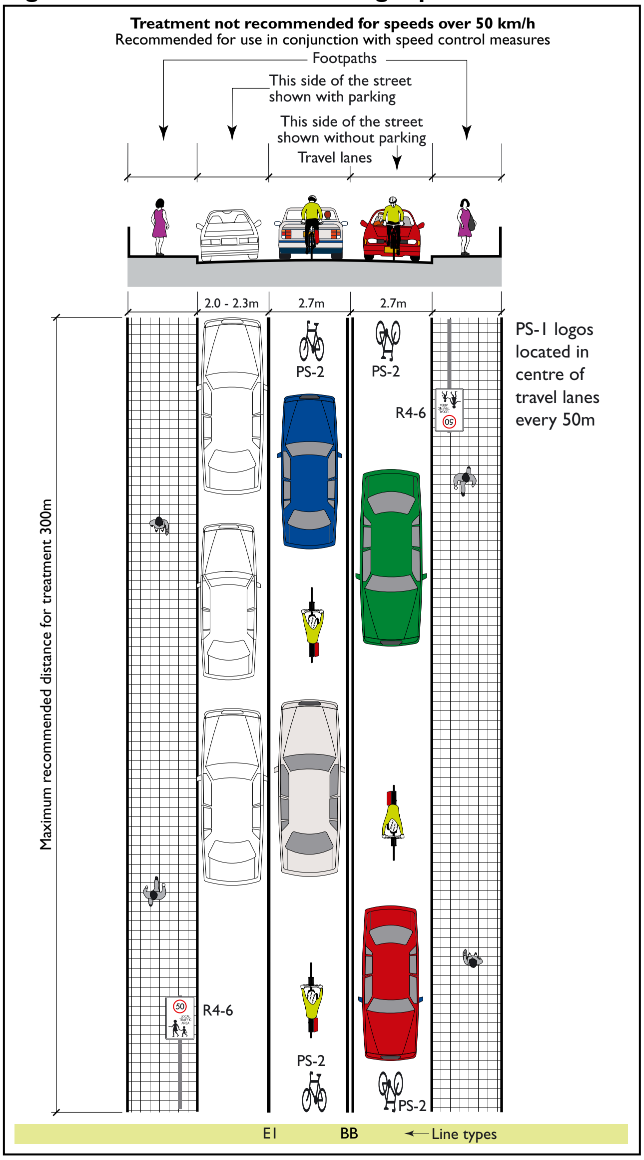
5.3 Mixed traffic streets

Mixed traffic streets are the most common type of facility currently available to bicycle riders. There are three types of mixed traffic profile and not all of these are suitable for bicycle network routes.

Wide cross section roads provide for comfortable sharing by motor vehicles and bicycles with lanes wide enough to permit comfortable passing. *Austroads – Part 14* provides comprehensive details of this type of facility in the sections: 4.4.2 Bicycle/Car Parking Lanes; 4.4.6 Advisory Treatments: and, 4.4.7 Wide Kerbside Lanes. Wide cross section roads are most commonly used to provide bicycle access on a broad range of streets and roads across urban areas. *Austroads – Part 14* recommends that lane widths between 3.7m and 4.2m are suitable for cyclists to share with vehicles.

Narrow cross section roads usually occur in the older residential areas and are generally low-speed and low traffic volume roads. Where bicycle network routes use this type of street it is desirable for the lane widths to be designed so that it is not possible for cars to pass bikes. Traffic is forced to queue and provided that the speed regime is 50 km/h or

Figure 5.13: Mixed traffic road - tight profile.



below all types of user can reasonably share the road space for short distances. Bicycle traffic in these streets also acts as a speed inhibitor.

Critical cross section roads lie between a narrow and wide cross section road. On this type of road there is not enough space to safely share road space but just enough space to squeeze past. This type of road profile can produce dangerous overtaking manoeuvres and higher than normal speeds. Critical road cross sections should be avoided. Similarly on roads with shared lanes, critical lane widths are those which do not provide enough space for motorists to easily pass cyclists within the lane. Lanes with a critical width of 3.3 – 3.7m should not be used.

5.3.1 Mixed traffic – tight profile

Austroads – Part 14 does not cover this type of street environment.

Application

Tight profile streets are a type of mixed traffic facility suitable for marked bicycle network routes. They are used in very narrow older residential areas where speeds are low and traffic is localised. As traffic is forced to queue along these streets, bicycles and other vehicles share the roadspace and travel at the same low speeds. They are only recommended for distances up to 300m and at operating speeds at or below 40 km/h.

Design notes

Mixed traffic – tight profile lanes are part of the road (usually occupying the only available road space) and are defined by means of normal road lane markings. A solid white E1 edge line, 120mm wide (which defines the road shoulder) can be used to separate moving traffic from parked cars. PS-2 pavement symbols are placed in the centre of the travel lanes at 75m intervals and before and after intersecting streets to indicate the presence of a bicycle network route.

Comments

Riders use these lanes as normal vehicles and will generally track the centre of the lane so clearance to parked car doors is not as critical an issue as with bicycle shoulder lanes. Figure 5.13 shows a mixed traffic – tight profile street used in a low speed residential street. Providing lane widths wider than 2.6m should be avoided as excess width increases the possibility of risky overtaking behaviour. Any excess street width should be allocated to the parking lane rather than the travel lanes. A 2.6m lane on a two-way street will allow for emergency vehicle access.

Photo 5.13: Mixed traffic - tight profile street used by a bicycle route. Halls Lane, Woollahra.

5.3.2 Bicycle routes along mixed traffic streets with speed humps

Austroads – Part 14 (Section 4.7c) provides related information about speed humps and on-road bicycle facilities.

Application

Bicycle routes are often located along quiet residential streets where speeds and traffic volumes are low. Where there is a localised tendency for particular streets to be used by motorists as connector routes or short cuts, councils have often installed speed humps to moderate traffic speeds. In local streets which are not fitted with bicycle route facilities *Austroads Guide to Traffic Engineering Practice, Part 14 – Bicycles* advises that the plateau (flat top) and rounded (Watts) profile speed humps are most compatible with bicycle use.

On mixed traffic streets and along streets with marked bicycle lanes or shoulder lanes speed humps are not recommended. If humps are required to be fitted specifically to slow motor vehicles, these humps should not protrude into the bicycle operating space.

Comments

Photo 5.14 shows a street which carries a bicycle route where speed humps do not protrude into the bicycle operating space. Figure 4-36 in *Austroads – Part 14* shows a treatment where bicycle bypasses have been marked as a bypass a plateau type speed hump.

Photo 5.14: Speed humps in this street have provided a smooth riding surface for riders travelling this bicycle route. Lilyfield Rd, Rozelle.

Figure 5.14: Off-road two-way bicycle path to on-road bicycle lanes transition (with central refuge).

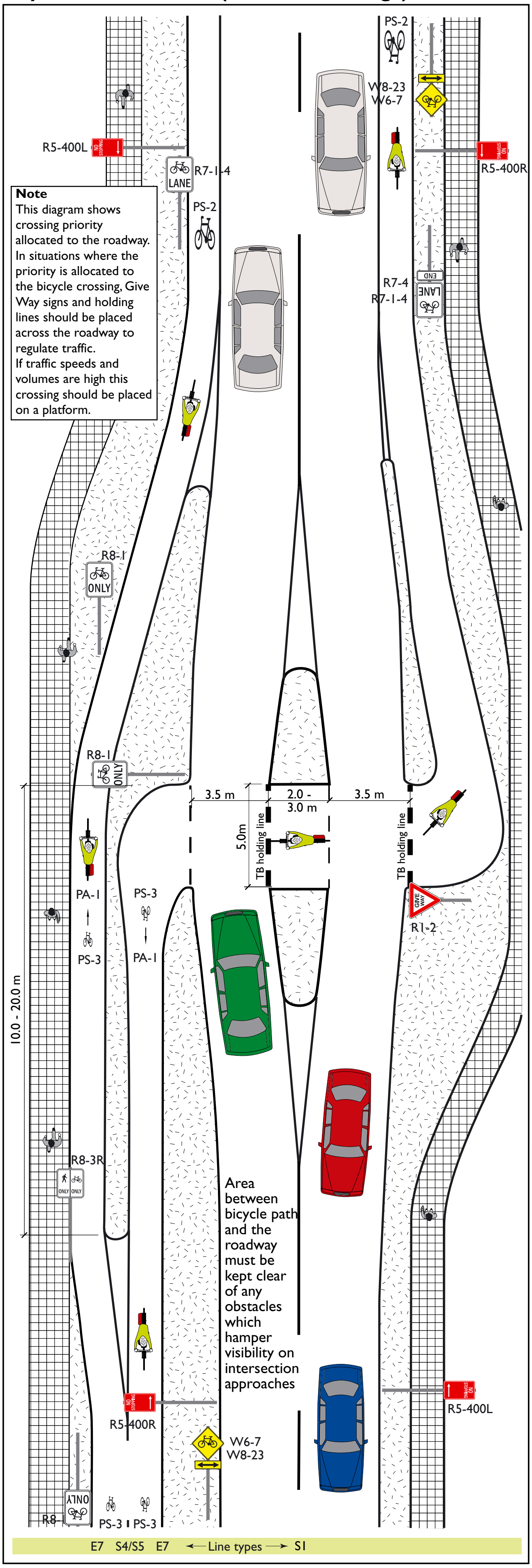
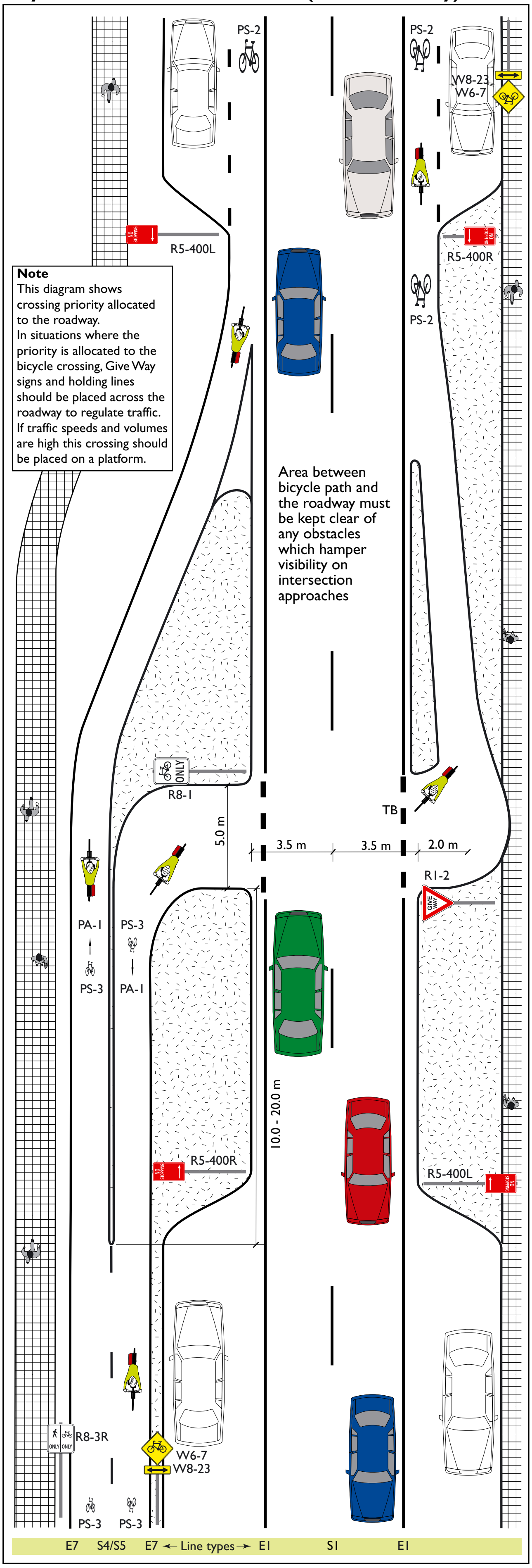


Figure 5.15: Off-road two-way bicycle path to on-road bicycle shoulder lanes transition (12.8m roadway).



5.4 Off-road bicycle path to on-road lane transitions

Austroads – Part 14 (Section 4.5.3 Ramps) provides information about off-road to on-road transitions. The diagrams (Figures 4-23 and 4-24 on page 36) provide details for one-way path to one-way lane transitions. The information below provides additional information for two-way path to one-way on-road lane transitions.

Application

Where off-road bicycle paths have to move on-road to become bicycle lanes it is usually necessary to provide an engineering treatment to permit a safe and smooth passage for riders. Where a two-way path converts to on-road lanes a crossing will also be required. This type of treatment can be used to join all types of exclusive off-road bicycle paths with exclusive two-way paired on-road lanes.

Design notes

Figure 5.14 shows a transition linking a two-way off-road bicycle path with on-road bicycle lanes. This diagram also shows a central refuge to permit a speed limiting deflection for the vehicles and a two-stage crossing option for the riders. Figure 5.15 shows a transition from a two-way bicycle path to on-road shoulder lanes without a refuge where space is tight. It is important to provide a protected entry and exit from the roadway and sufficient storage and turning space at the actual crossing. Where the priority at the roadway crossing is to be assigned to the cycleway, Give Way signs and holding lines should be used.

Comments

It is important to warn approaching motor vehicles and reduce vehicle speeds where there are high volumes of bicycle traffic. It is necessary to physically separate riders on one-way paths to channel them to the crossing point otherwise short cutting will take place.

5.5 Bicycle routes through car parks

Austroads – Part 14 does not provide guidance on marked bicycle space through car parking areas. The information below provides guidance for two-way marked access through car parking areas.

Application

Bicycle network routes through car parks are not preferred. However, where a route is required for reasons of continuity or access (to rail stations, sporting grounds etc) it is desirable to provide an engineering treatment to permit a safe, smooth and easy to comprehend path for riders.

Design notes

Figure 5.16 shows a recommended linemarking scheme along a two-way accessway within a car park. It is important to provide a safety strip between this marked lane and the car parking bays. When parking turnover is high it is also necessary to use green surface colouring to further define the bicycle operating space. Figure 5.17 shows a recommended treatment for an off-road path adjacent to a car park.

Figure 5.16: Bicycle route marking through car parks.

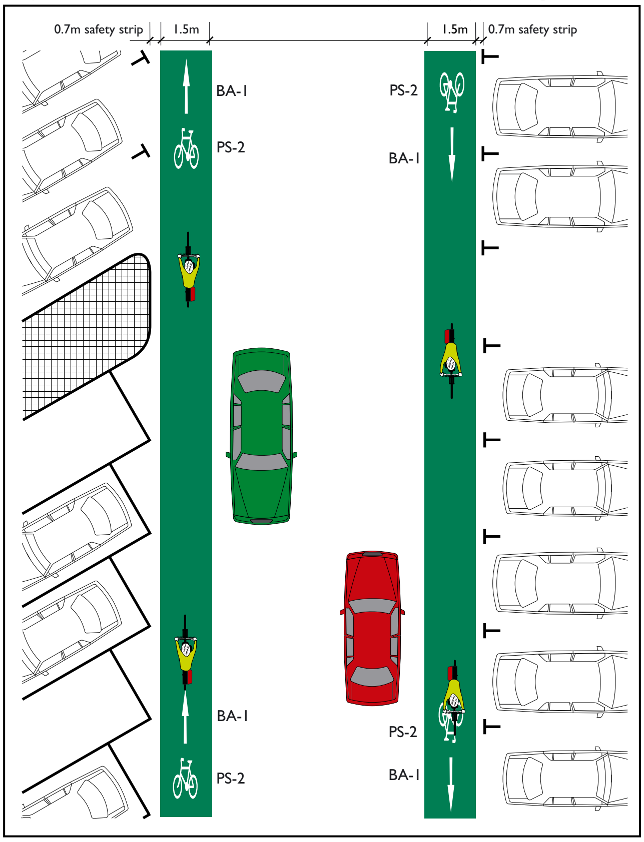
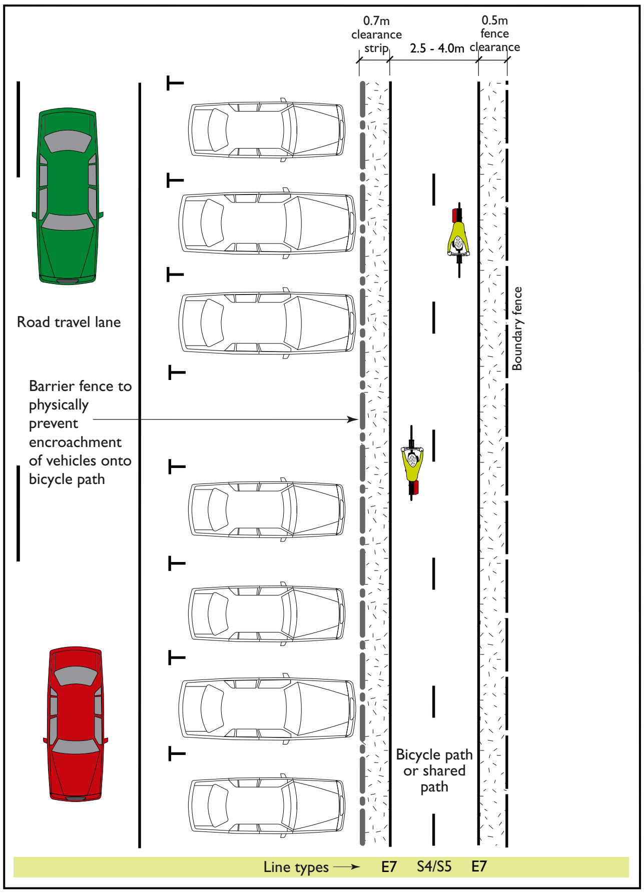


Figure 5.17: Bicycle route marking adjacent to car parks.



6. Bicycle facilities off-road and not within road reserves

Table 6.1: Scope of Section 6.

Type of facility	Coverage in *Austroads - Part 14*	Coverage in these Guidelines
Bicycle paths	6.6.3 Exclusive bicycle paths	6.1 Path design operating speed 6.2 Path linemarking and regulatory signage 6.3 Path speed controls 6.4 Prevention of illegal parking 6.5 Prevention of illegal vehicle access
Shared paths	6.6.1 Shared use paths	6.1 Path design operating speed 6.2 Path linemarking and regulatory signage 6.3 Path speed controls 6.4 Prevention of illegal parking 6.5 Prevention of illegal vehicle access 6.6 Shared path advisory signage
Rail trails		6.6 Rail trails

This section provides detailed recommendations and treatment examples on the main methods of providing bicycle routes off-roads: bicycle paths; shared paths; and separated paths. Off-road bicycle facilities are generally covered in *Austroads Guide to Traffic Engineering Practice, Part 14 – Bicycles*. These guidelines provide recommendations and advice on related issues not covered in *Austroads Part 14*.

6.1 Path design operating speed

The design speed of a path is influenced by the various geometric elements which contribute to the safe operation of the path. These design elements are listed in Table 6.2 and example values are given for a 30km/h design speed.

Application

Paths should be planned and constructed with a particular design operating speed relevant to the network function ie: Regional routes - high design operating speeds (25-40km/h); local routes – medium design operating speeds (20-30km/h); and local access paths and recreational paths – low design operating speeds (<20km/h).

Design notes

Table 6.2 shows the various design elements which need to be considered in planning and constructing paths to a particular design operating speed. This table lists the relevant sections in *Austroads Guide to Traffic Engineering Practice, Part 14 – Bicycles*, which provide more detailed information for each design element.

Photo 6.1 (above): A separated path no longer part of the road reserve - a result of the RTA's City West road project. This formerly busy road bridge is now used only by riders and walkers. Photo 6.2 (below): A shared pathway through David Carty Reserve, Fairfield.

Table 6.2: Design speed of off-road bicycle paths.

Design element	Coverage in *Austroads - Part 14*	Example values for 30 km/h design speed
Operating speed	6.3.1 Bicycle operating speed	30km/h
Horizontal curvature	6.3.2 Horizontal curvature Table 6-1	25m minimum path radius
Bicycle path width	6.3.4 Width of paths Figure 6-28, 6-25, Table 6-4, 6.5, 6-6	1.5m one-way 2.5m two-way
Shared path width	6.3.4 Width of paths Figure 6-19, Table 6-3	2.5 - 4.0m
Clearances	6.3.5 Clearances Figure 6-8, 6-13,6-22	0.5 - 1.0m to walls and fences
Gradient	6.3.6 Gradient Figure 6-2	5% maximum
Sight and stopping distance	6.3.7 Sight distance Figures 6-6, 6-5 and 6-7 for vertical	35-40m 8m sight clearance on min 25m radius curves
Super elevation and crossfall	6.3.8 Super elevation, crossfall and drainage Table 6-2, Figure 6-8	2% for minimum radius of 25m

6.2 Path linemarking and regulatory signage

Austroads – Part 14, Section 6 (Figures 6-17, 6-21and 6-27) provides detailed information about the marking of the three principal types of off-road paths. Figure 6.1 provides a summary of this information.

Application

Off-road bicycle paths and shared paths are road related areas and should be marked with a centreline to separate two-way flows and to permit safe operation of the facility. Signage should be erected to regulate the type of permissible path usage.

Design notes

Bicycle paths are regulated by the sign R8-1. PS-3 pavement symbols and PA-1 pavement arrows are used in an advisory capacity at intervals or adjacent to intersecting streets to indicate travel direction. Shared paths are regulated by the sign R8-2. PS-3 and PS-4 pavement symbols and PA-1 pavement arrows are used in an advisory capacity at 75m intervals or adjacent to intersecting streets to indicate travel direction. Solid edgelines can be used in areas of high bicycle and pedestrian traffic to precisely define the riding area or as an aid to navigation in low light conditions.

Figure 6.1: Bicycle path, separated path and shared path linemarking.

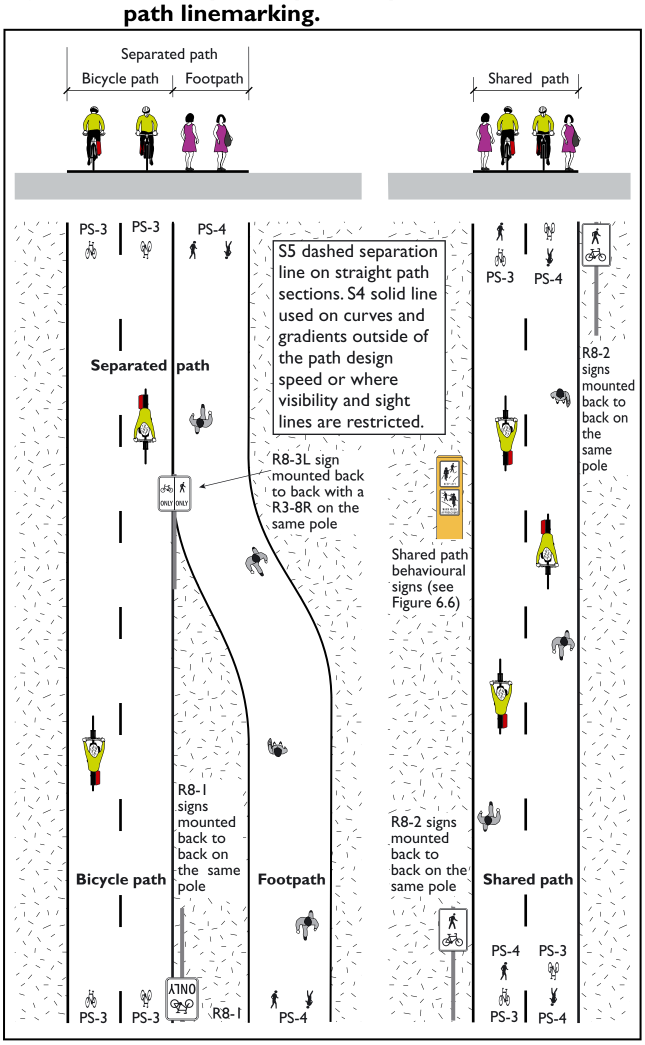


Table 6.3: Path speed limiting devices.

Device	Recom-mended	Comments
Speed humps	No	Can destabilise riders and increase hazards
Path narrowing	Yes	Minimum one-way width 1.4m. Warning signage and adequate linemarking required
Path deflection	Yes	Maximum deflection angle 10 degrees for high-speed path and 20 degrees for low-speed path
Path terminal deflection rails	No	Can destabilise riders and increase hazards if used as speed limiting device. Used only to prevent unauthorised vehicle entry
Rumble strips	No	Used only as a warning device to alert riders to changed conditions ahead
Warning signage	Yes	Used to warn of approaching hazard and to advise of need to reduce speed. Used in conjunction with other methods
Holding rails	No	Not recommended at all by these guidelines
Bollards	No	Not recommended as a speed control device. Only used to prevent unauthorised vehicle entry
Alternative paving	Yes	Use different materials and colours

6.3 Path speed controls

Bicycles sometimes operate at slow speeds though in most situations operate between 20 and 30km/h and are capable of speeds in excess of 50km/h. It is seldom necessary to impose on bicycle riders the level and type of speed controls that are often needed with motor vehicles. However, physical measures are sometimes needed to moderate speeds at the entry to paths and areas shared with pedestrians. *Austroads – Part 14* does not provide guidance on speed limiting devices. The section below provides basic recommendations for use on bicycle paths and shared paths.

Application

Speed limiting devices for bicycle paths and shared paths follow the same principles as those used to limit motor vehicle speeds. The device must provide a clear unambiguous direction to the road user, the device must not add a hazard and the device must be supported by adequate regulatory and advisory signage and line marking. Devices are applied to off-road paths in order to limit the speeds of bicycle riders to a level compatible with a changed path environment.

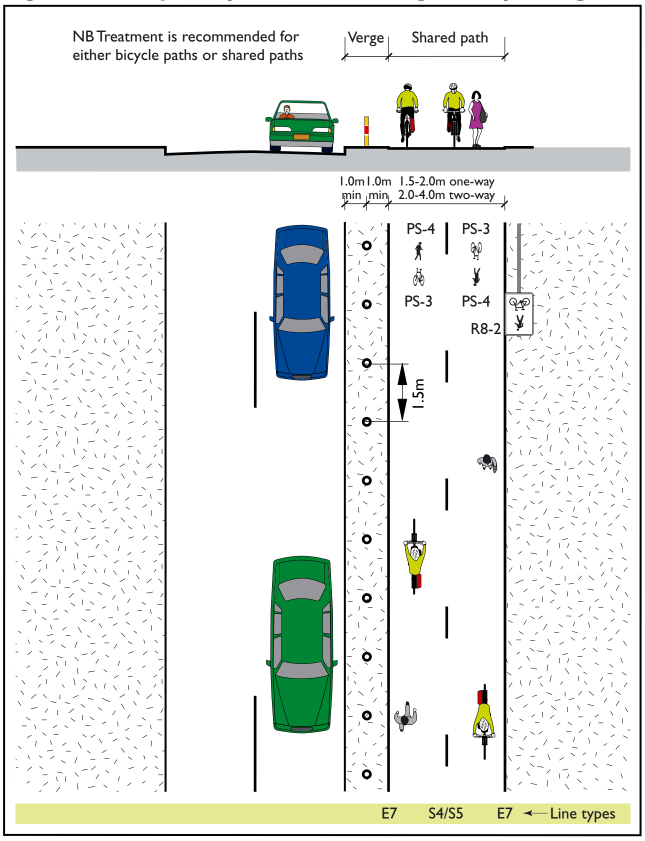
Design notes

Table 6.3 provides a listing of the acceptable and unacceptable speed limiting treatments for bicycle paths and shared paths.

6.4 Prevention of illegal parking

In heavily populated cities and towns there is often a very high demand for on-street parking. The prevention of illegal parking over bike lanes and paths adjacent to roadways is of great concern to designers if the coherence and safety of the bicycle network is to be maintained. Often physical

Figure 6.2: Physical prevention of illegal overparking.



methods are required in order to prevent continual overparking problems.

Figure 6.2 shows an example of the use of bollards to prevent illegal overparking in situations where the incidence of this behaviour is persistent. Bollards should not be used when pedestrian activity in the area is moderate to high. See *Austroads Guide to Traffic Engineering Practice, Part 13 – Pedestrians*.

Application

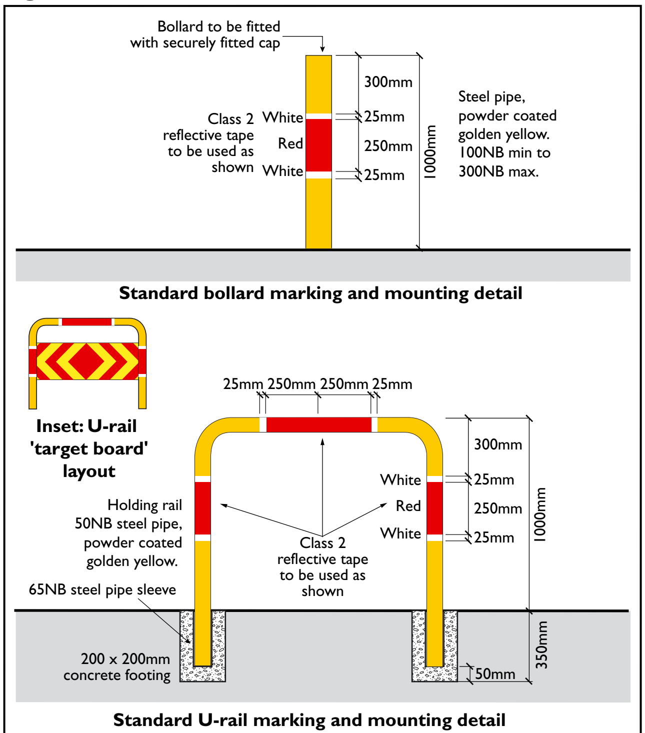
The width of the adjacent carriageway will often have an effect on the behaviour of parking motorists. If it is perceived that there is not enough width to park on the roadway then motorists will often park either partly or fully on the verge and any adjacent bicycle path unless physical measures are taken to prevent them.

Design notes

Bollards are potentially hazardous to cyclists and walkers. They must be properly marked, located in conjunction with appropriate linemarking and provided with adequate

Photo 6.3 (below): Example of physical restriction of overparking with kerb extensions. Bourke St, Redfern.

Figure 6.3: Bollard and U-rail details.



Notes

1. Length of U-rail can be varied to suit path width. A minimum of 600mm and a maximum of 1500mm should be adopted. Detail shown above has used 1200mm.
2. Bollards and U-rails can be fixed to path by using either a bolt system or pipe sleeve and concrete as shown. If a pipe sleeve is used, a metal wedge is to be used to secure the U-rail in the sleeve.
3. Where a U-rail is mounted at right angles to a path a 'target board' shall be fitted. If the U-rail is mounted longditudinally along the path a target board is not used. See inset for 'target board' detail.

clearances for riders and pedestrians. Bollards should be finished in a light bright colour with reflective tape to make them highly visible to road and path users in low light conditions (see Figure 6.3).

6.5 Preventing illegal vehicle access

The prevention of illegal vehicle access is critical to prevent damage to path structures particularly when they have been designed only for bicycle and pedestrian use. Often physical methods are required in order to prevent vehicles from entering paths or driving over lightweight bridge structures.

Austroads Guide to Traffic Engineering Practice, Part 14 – Bicycles (Section 6.7.3.1) provides a number of recommendations for path access control treatments. Figures 6.4 and 6.5 show two examples of terminal treatments for paths designed to prevent illegal vehicle entry but to also allow park maintenance vehicles access via removable locked bollards or barriers.

Application

Path terminal treatments are used when it is necessary to physically prohibit entry of motor vehicles to a path. *Austroads – Part 14* recommends that these barriers should not be designed to unduly restrict or present a hazard to riders. With good design of path entry treatments it is generally not necessary to use bollards or other restrictive and hazardous methods at path entry and exit points (see

Figure 6.4: Wide path terminal treatment using U-rail.

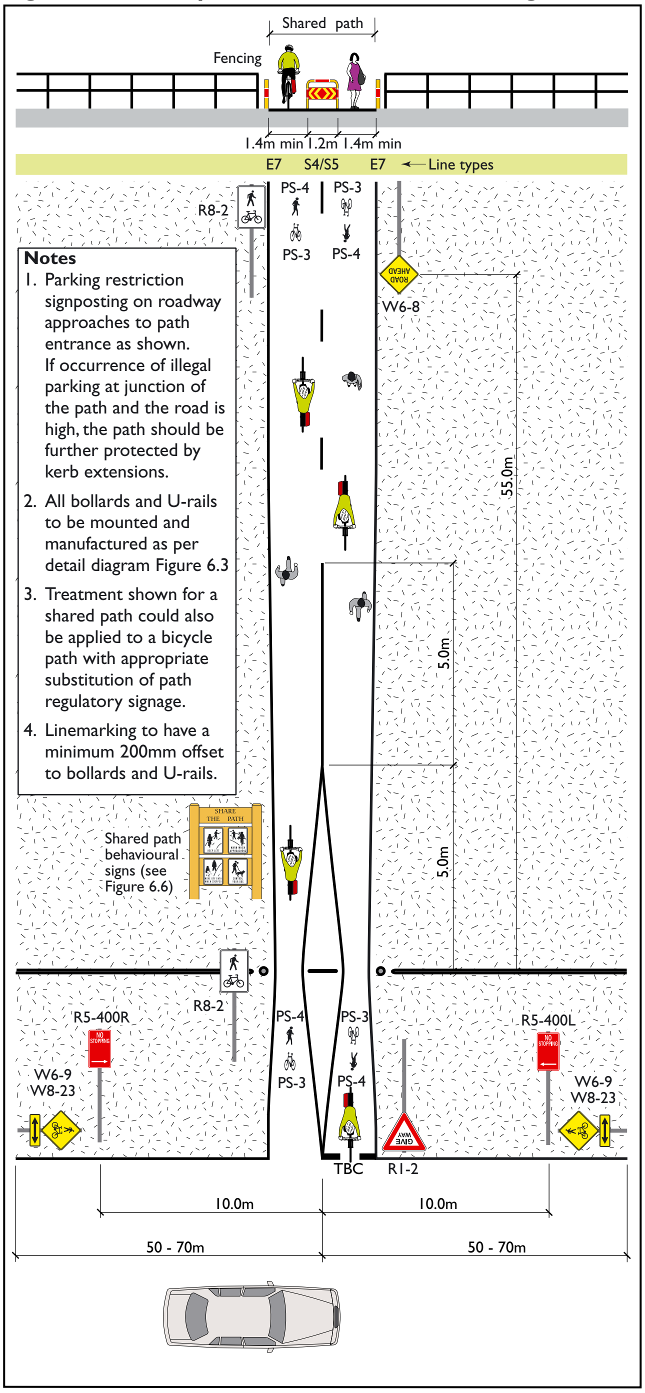


Figure 6.5: Narrow path terminal treatment using bollards.

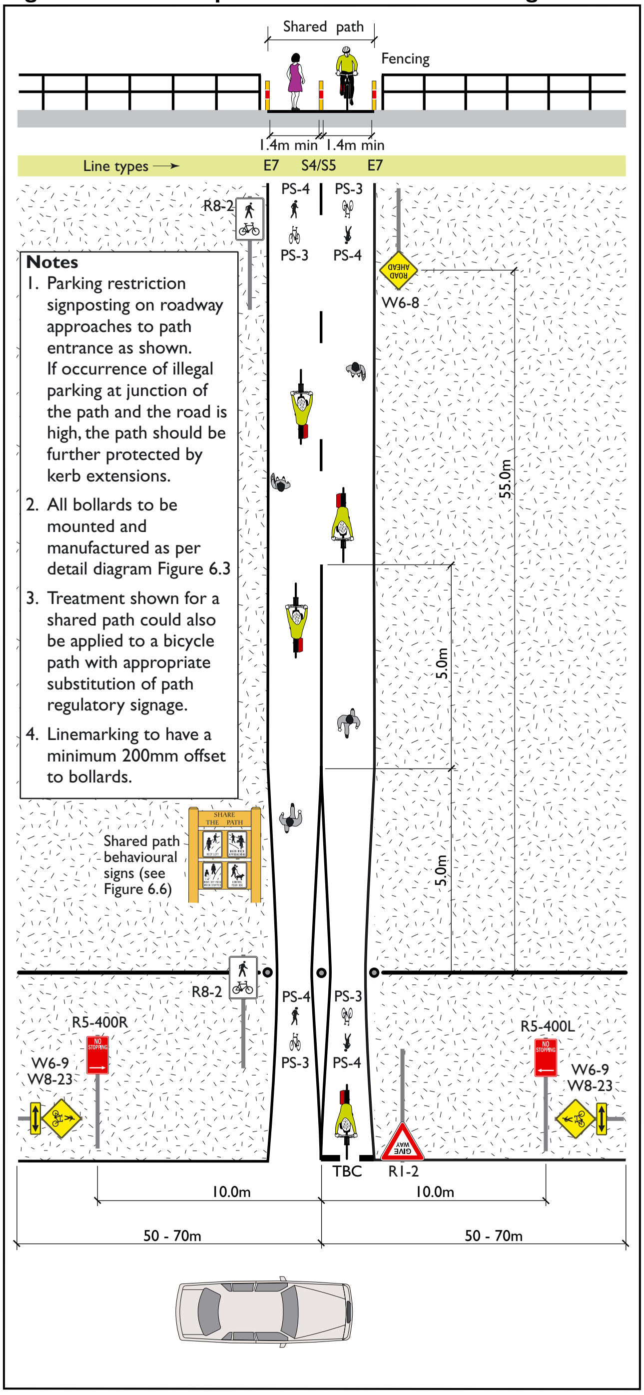


Figure 6-37 in *Austroads – Part 14*). Terminal treatments such as the two recommended in Figures 6.4 and 6.5 are only necessary when the path includes structures not designed to carry vehicle loads. In instances where paths are designed to take maintenance vehicles, bollards can be unlocked and temporarily removed to allow vehicles through the barrier.

Design notes

Bollards are potentially hazardous to cyclists and walkers and if used they must be properly marked with reflective tape (see Figure 6.3), supported by suitable linemarking (see Figures 6.4 and 6.5) and provided with adequate clearances for riders and pedestrians. They should never be used within a path travel lane. When used in the centre of paths they should always be marked with unbroken centrelines which provide clearance on the bollards.

Photo 6.4: Example of preferred bollard treatment (with linemarking) on shared path designed to prevent motor vehicle access. Frank St, Guildford.

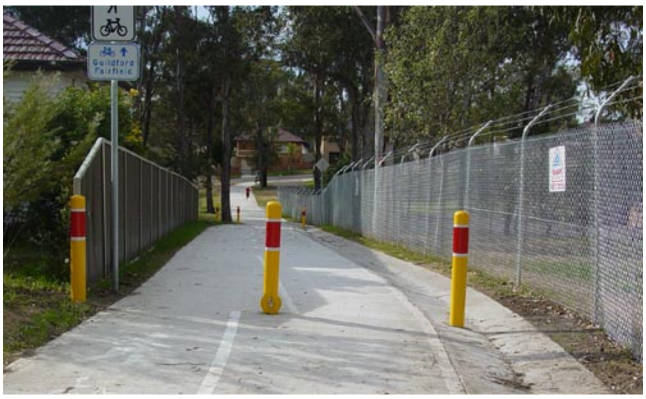


Figure 6.6: Shared path behavioural signage.

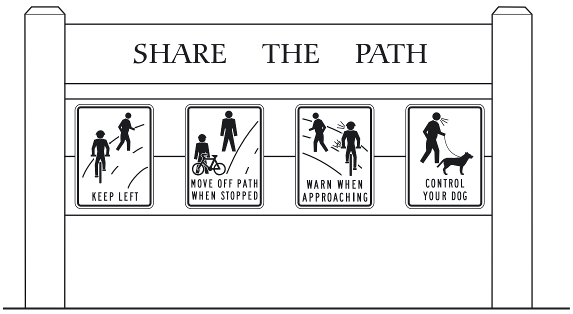
G9-259-1
(a) *Keep Left* sign encourages all path users to travel on the left

G9-259-2
(b) *Warn When Approaching* sign encourages path users to call out or use their bells

G9-259-3
(c) *Stop Off Path* sign encourages path users to keep the path clear

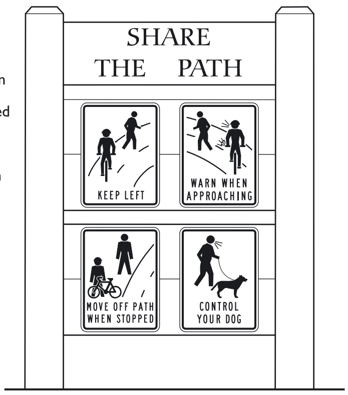
G9-259-4
(d) *Control Your Dog* sign reminds dog owners of their responsibilities

Above sign sizes: 250mm W x 330mm H



(e) Preferred group sign for path entry or major path access points. Recommended for Level 2 behavioural messages. Where space is limited use example (g) layout below.

(f) Level 2 sign column installed at inter-mediate locations (500m intervals)



(g) Alternate layout of group sign for path entry or major path access points. Recommended for Level 2 behavioural messages.

6.6 Shared path advisory signage

VicRoads, *Cycle Note Number 10* (Shared Path Behavioural Signs), provides information about the provision of behavioural signage for use on shared paths. Coverage in this manual is based on that publication.

Application

To encourage shared path users to behave in a predictable and co-operative manner, four key behavioural messages have been developed to advise and educate riders and walkers. These key messages are:

1. keep left when using the path;
2. warn other path users on approach and overtaking;
3. move off the path when stopped; and,
4. walkers control your dogs.

A set of four advisory signs have been developed for use on shared paths (see Figure 6.5) to enable these messages to be communicated to path users. These signs are to be used in conjunction with path linemarking and pavement symbols as outlined in Section 6.2 of these guidelines. To improve management of shared paths through the promotion of these four key messages, a three level implementation framework is recommended. This framework (Table 6.4) provides recommendations from a basic Level 1 management up to high Level 3, where specific problem issues are addressed by targeted signage erected at path 'hot spots'.

Design notes

Choosing the appropriate level of path signage requires an understanding of the types of path user and some information on the predominant types of conflicts and their locations.

Comments

It is recommended that an incremental 'bottom up' approach be used when installing the signs. Begin with Level 1 behavioural messages. These may be sufficient to significantly improve user behaviour and reduce conflicts to an acceptable level. Allow path users to get used to these Level 1 messages and, if necessary, make some observations or obtain feedback from path users. If further education of path users is required, consider introducing a Level 2 approach and then, if appropriate, site specific Level 3 messages.

Table 6.4: Shared path behavioural sign installation.

Level	Level of usage	Recommended installation
Level 1	Basic requirement for all shared paths. Low use and few reported conflicts.	Path centreline and pavement symbols (PS-3, PS-4 and PA-1). See Figure 6.1 for path linemarking recommendations.
Level 2	Moderate path use and number of reported conflicts.	As for Level 1 plus group signs (Figure 6.6 (e) or (g)) at key locations and sign columns (Figure 6.6 (f)) at min 500m spacings.
Level 3	High path use and number of reported conflicts.	As for Level 2 plus additional single or grouped behavioural signs according to the type and level of reported and observed conflicts.

6.7 Rail trails

Rail trails are bicycle path or shared path type facilities within or immediately adjacent to railway corridors. Current NSW Government policy supports the development of rail trails where space and opportunities occur. *Austroads Guide to Traffic Engineering Practice, Part 14 – Bicycles* does not cover this specific facility. The RTA has developed specific expertise in this area and it is recommended that advice be sought from the Bicycle Network Branch in formulating local rail trail projects. Due to the need to meet rail authority requirements close liaison with the rail agencies is essential.

Figure 6.7: Rail trail adjacent to active railway lines.

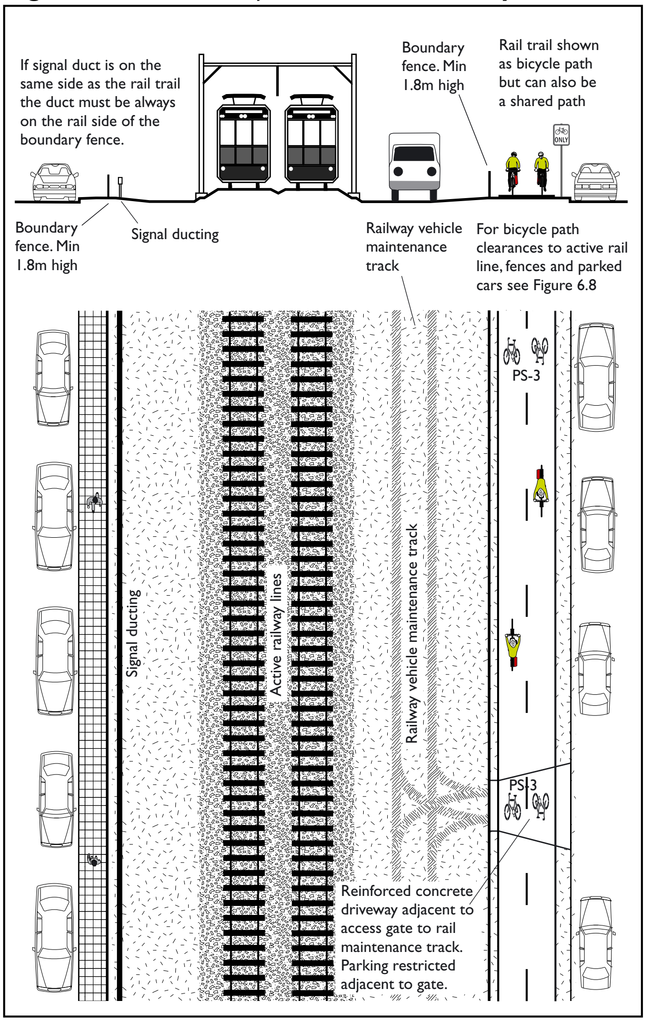
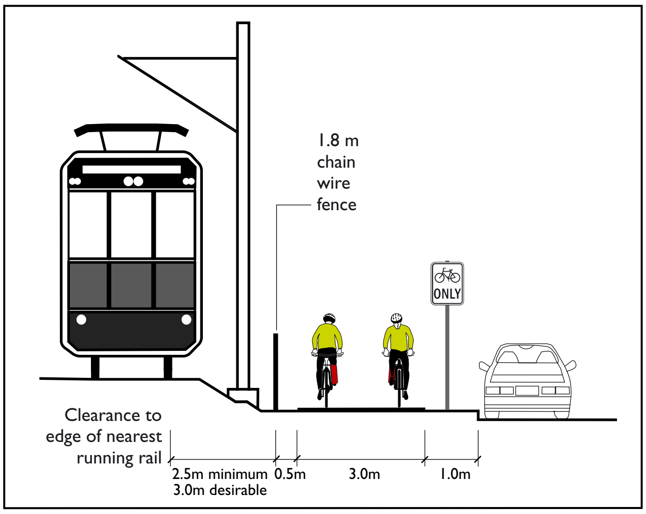


Figure 6.8: Minimum clearance dimensions for rail trails.



6.7.1 Rail trails using active rail corridors

In urban situations it is often possible to develop well connected and continuous bicycle routes by utilising sections of active railway corridors. Where the rail corridor abuts a local road it is often only necessary to move the boundary fence inwards to accommodate the space needed to build the rail trail. The development of rail trails partly or entirely on railway land depends on a number of factors including the proximity of railway infrastructure, such as signal ducting, the railway vehicle maintenance track, buildings and overhead wiring structures.

Application

Figure 6.7 shows a typical rail trail located between the rail corridor and a local road. Figure 6.8 shows minimum clearances required for the location of rail trails adjacent to active rail corridors. The closest a bicycle path or shared path can be safely located next to an active rail line is 2.5m to the outside running rail with a preferred distance of 3.0m or more.

Negotiation of a specific lease agreement with the rail authorities is necessary with each separate rail trail project.

Design notes

Where the corridor is broken by a drainage line, creek, subway, or road underbridge, a bridge structure or a culvert crossing may need to be provided. At road overbridges if there is enough space within the rail corridor, the rail trail can utilise spare spans in the bridge structure. Where space is restricted the rail trail would deviate from the corridor and cross the roadway at-grade via a specially designed crossing. A minimum width of 2.5m and a headroom of 2.4m should be provided at all underpasses.

Photo 6.5: Example of an urban rail trail alongside an active railway line. Parramatta to Liverpool Rail Trail, Yennora.

Crossings should generally provide priority for cyclists. Grade separation should be considered at arterial and State road crossings.

At railway stations any buildings, platforms, pedestrian overbridges and associated infrastructure will usually need to be bypassed by a route outside the rail corridor. Careful design is needed in order to route the rail trail past station car parks, pedestrian crossings, footpaths and bus stops. Where it is not possible to divert around the station off-road, on-road bicycle lanes or shared profile road space should be used.

Comments

Minimum height 1.8m chain wire fencing should be provided between the cycleway and railway infrastructure such as the rail formation, signal ducts, signal boxes, substations, railway sheds or buildings. Where signal ducts coincide with the ideal alignment of the rail trail, these may need to be relocated in order to remain within the fenced-off portion of the rail corridor. Given the nature of rail trails, for continuity purposes it is recommended that the path is off-road as much as is practicable, including sections paralleling low-volume local streets.

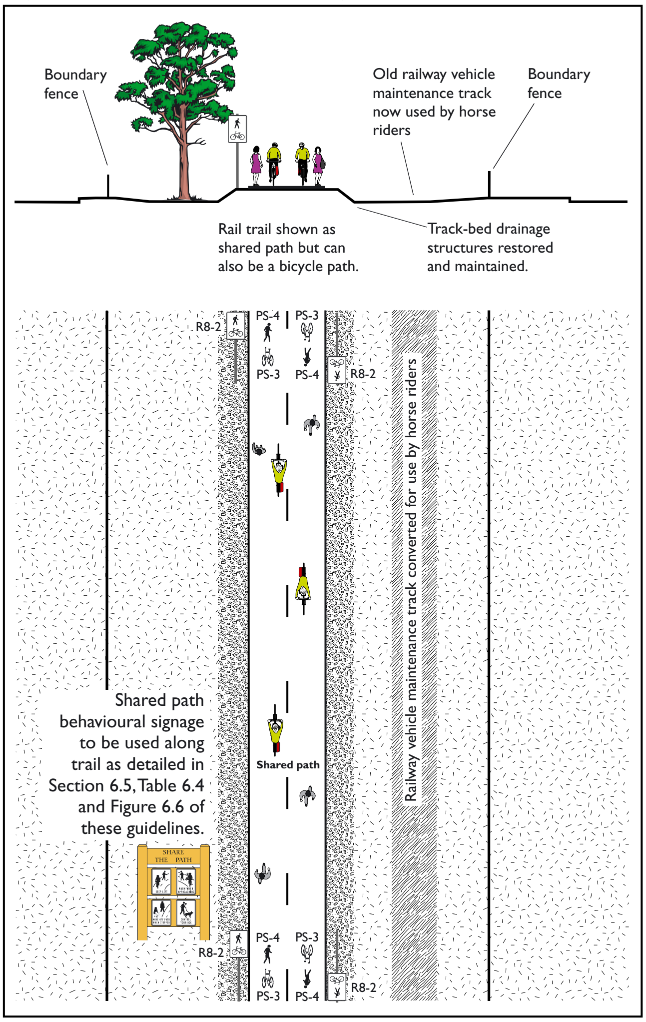
6.7.2 Rail trails using disused rail corridors

In rural locations opportunities exist for the conversion of disused railway lines into rural rail trails. In some situations rail lines have been abandoned with the steel rails left intact. In this situation design solutions will need to be found in order to minimise any hazards the disused rails may cause.

Application

Figure 6.9 shows a typical rural rail trail located along the bed of a former rail line. The cycleway/path is usually laid directly on top of the old rail formation. Negotiation of a lease agreement with the rail authority is necessary unless ownership of the railway corridor has been transferred to a local council or other authority. A process of consultation with adjoining private landowners, local government, and State Government agencies will need to be undertaken in order to plan and build rail trail projects. Problems such as the protection of cattle and stock, noise-disturbance, vandalism and littering are often the main concerns of adjoining private property owners. Community consultation, participation and negotiation are of great importance

Figure 6.9: Rail trail built along an abandoned railway.



in finding solutions which will result in the successful development of a rail trail.

Design notes

Key issues to be dealt with in designing a rail trail along a disused railway corridor are: track-bed drainage, passage through cuttings and along embankments, tunnels, road crossings, bridges, wet and low-lying areas, connection with local paths and accessways, development and maintenance of railway heritage, vegetation within the corridor, trail surface and construction, and information and interpretive signage.

7. Bicycle facilities at intersections

Table 7.1: Scope of Section 7.

Category	Method of separation	Coverage in *Austroads - Part 14*	Coverage in these Guidelines
Unsignalised intersections	Physical separation	5.3 Typical intersections details, Figure 5.7 5.5.2 Roundabouts	7.2.1 Off-road bicycle path bent-in 7.2.2 Off-road bicycle path bent-out 7.2.3 Off-road bicycle path straight 7.2.4 Off-road bicycle path at a roundabout
	Visual separation	5.3 Typical intersections details, Figure 5.3 5.5.1 High speed left turn slip lanes 5.5.2 Roundabouts	7.2.5 Bicycle lanes at unsignalised intersections 7.2.6 Bicycle lanes at roundabouts
	Mixed traffic	5.5.2 Roundabouts	7.2.7 Mixed traffic intersections 7.2.7 Mixed traffic intersections
Signalised intersections	Physical separation	5.4.2.5 Right turn storage bay for cyclists	7.3.1 Off-road bicycle paths at signals 7.3.2 Right turns from off-road paths
	Visual separation	5.4.2 Signalised intersection treatments 5.4.2.3 Bicycle head start storage area 5.4.2.4 Hook turns 5.4.2.7 Through access at junctions	7.3.3 Bicycle lanes at signals 7.3.4 Head start and expanded storage boxes 7.3.5 Hook turn storage boxes 7.3.6 Left turn through access at signals
	Mixed traffic	5.4.3 Phase times	
Off-road bicycle path road crossings		6.7.2 Crossings of roads 6.7.2.3 (b) Refuge crossings 6.7.2.1 Crossings of low volume streets	7.4 Bicycle path mid-block road crossings
		4.6.3 Treatments at interchanges	7.5 Motorway on-and off-ramp crossings

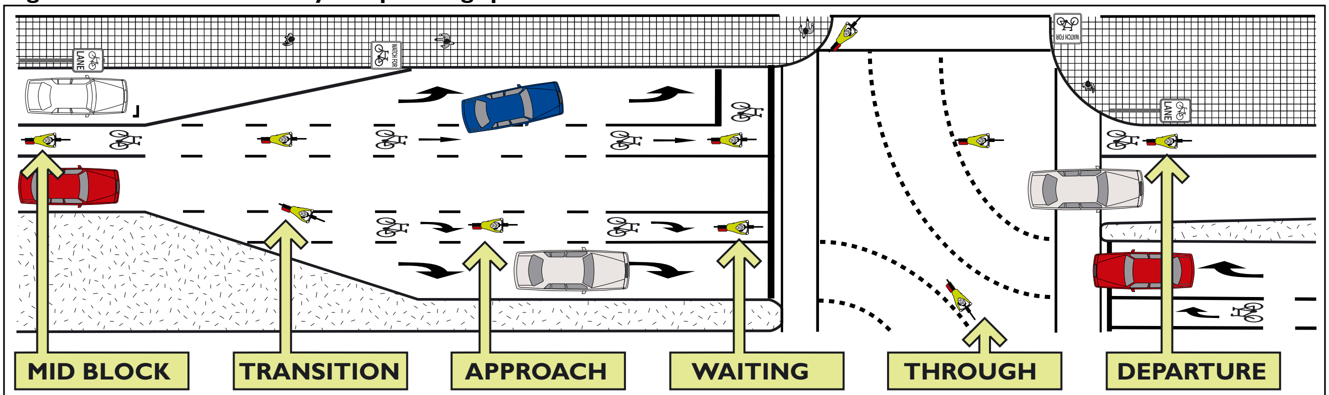
This section provides detailed recommendations and treatment examples on the main methods of providing bicycle facilities through intersections. Intersection provision for bicycles is covered in *Austroads Guide to Traffic Engineering Practice, Part 14 – Bicycles* (Section 5 Intersections and Section 6 Paths). These Guidelines provide recommendations and advice on related issues not covered in *Austroads Part 14*. Table 7.1 provides a summary of this information.

7.1 The six intersection elements

VicRoads *Cycle Note Number 8 – Providing for Cyclists at Signalised Intersections* introduces a framework for design to provide visually separated operating space for riders at intersections. The six intersection elements – mid-block, transition, approach, waiting, through and departure are summarised in Figure 7.1. Figures 7.15a and 7.15b provide more detail on the various design options for each element. Though Figure 7.1 depicts an intersection controlled by traffic signals, the six elements can apply to

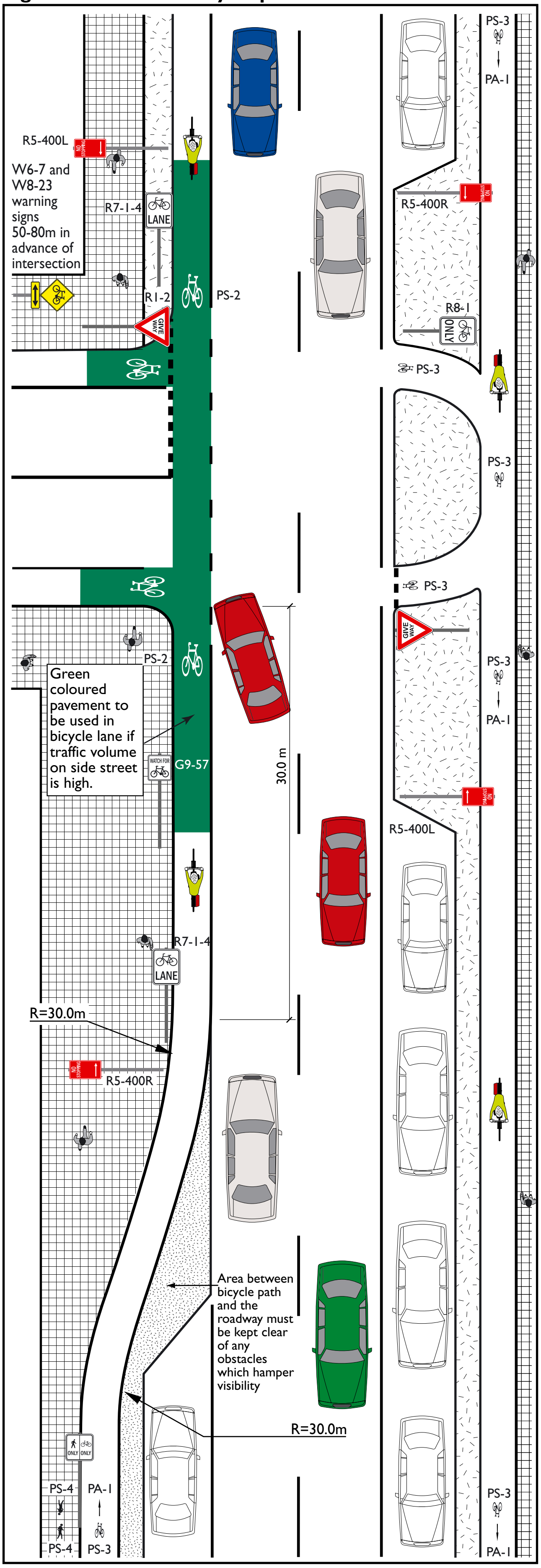
Photo 7.1: Example of on-road bicycle lane at a signalised intersection. Narellan Rd at Kellicare Rd, Campbelltown.

Figure 7.1: Provision for bicycle operating space at intersections: the Six Intersection Elements.



Adapted from: VicRoads, *Cycle Notes No 8,* (Providing for Cyclists at Signalised Intersections), February 2001

Figure 7.2: Off-road bicycle path bent-in at intersection.



any type of intersection and should also be considered in the design process when providing intersection treatments for unsignalised intersections and crossings of roadways by off-road bicycle paths.

7.2 Unsignalised intersections

Unsignalised intersections with bicycle route facilities can occur where the road carrying the route is of greater, equal or lesser importance (in the overall road hierarchy) than the side street or road being crossed. Diagrams in Section 5 of this manual provide recommended layouts and markings for intersections where the side street or road being crossed by the bicycle route is of lesser importance. These examples are:

- Bicycle lanes (Figure 5.1);
- Bicycle shoulder lanes (Figure 5.3);
- Contra-flow bicycle lanes (Figure 5.7);
- Two-way off-road bicycle paths within the road reserve (Figure 5.11);
- Shared paths off-road within the road reserve (Figure 5.12); and,
- Bicycle paths off-road to on-road lane transitions (Figures 5.14 and 5.15).

This section covers intersections where the road being crossed is of equal or greater importance in the overall road hierarchy, where two bicycle routes cross and where off-road bicycle paths cross roads mid-block.

Austroads Guide to Traffic Engineering Practice, Part 14 – Bicycles (Section 5-5 and Figure 5-3) provides information predominantly on signalised intersections. *Australian Standard AS1742.9 – Manual of Uniform Traffic Control Devices, Part 9 Bicycle Facilities* (Figure 2.8) provides guidance for bicycle lane provision at an unsignalised intersection where the bicycle route parallels the road with the priority.

7.2.1 Off-road bicycle path – bent-in

This treatment is designed as a method of providing for one-way off-road bicycle paths through intersections. It is not recommended for two-way paths or where the side road is a major road and has a higher priority than the through road.

Application

When an off-road path parallels a roadway and the road corridor narrows, the path may need to be directed onto the road to become an exclusive bicycle lane or shoulder lane. In this instance the path is said to be 'bent-in'. This treatment has the advantage of giving greater visibility to riders at the intersection and permits drivers to better anticipate cyclists travelling towards and through the intersection. It also easily permits the priority of the bicycle route to be maintained the same as the parallel roadway. If the intersecting road is a major road, straight or bent-out treatments are preferred solutions.

Design notes

Figure 7.2 shows an example of a bent-in path becoming a lane and continuing through an intersection. The bending-in should take place at least 30m before the intersection. This distance is necessary to allow for left-turning traffic to account for cyclists travelling in the bicycle lane up to and through the intersection. It is also possible for the bicycle lane to bend back out on the other side of the intersection and revert to an off-road path.

Comments

Where traffic volumes on all roads is significant it is recommended that green coloured pavement be used to increase overall road user awareness of the positioning of cyclists through the intersection. Figure 7.2 shows the one-way bicycle path on the opposite side of the roadway continuing off-road. Linking paths are shown at the intersection to permit full access from the off-road path to the side street where lanes are provided on this street.

7.2.2 Off-road bicycle path – bent-out

Where space within the road corridor permits, paths can be bent away from the parallel roadway at its intersection with the cross street. The principal reason for bending-out is to allow storage space for turning vehicles entering or leaving the side road. For this reason the minimum distance between the bicycle path and the parallel roadway should be 5m. It is essential that the area between the bicycle path and the roadway be kept clear of obstructions to visibility and that the path not be bent-out more than 15m, otherwise drivers on the main road will lose sight of cyclists and riders will perceive the bending- out as a major detour and look for short cuts. For some limited examples of bending-out see *Austroads, Part 14 – Bicycles* (Section 6.7.2.4 Paths Adjacent to Roads, Figure 6-35 and Section 5.3.5 Protected two-way lanes, Figure 5-7).

Application

Off-road paths (either one-way on both sides of the road corridor, or two-way on one side of the corridor) crossing side streets or cross roads can be bent out to provide improved integration with adjacent roadways where space permits. Priority can either be allocated to the bicycle path, if it parallels the major road, or to the intersecting road, if this road has the priority in the normal road hierarchy. Figure 7.3 shows an example of an off-road path bent-out crossing a minor side street. In this example the bicycle path retains the priority of the road it is paralleling and the crossing is regulated with Give Way signage and holding lines. In determining the amount of bending-out the volume of traffic and vehicle storage space in the side street needs to be taken into account.

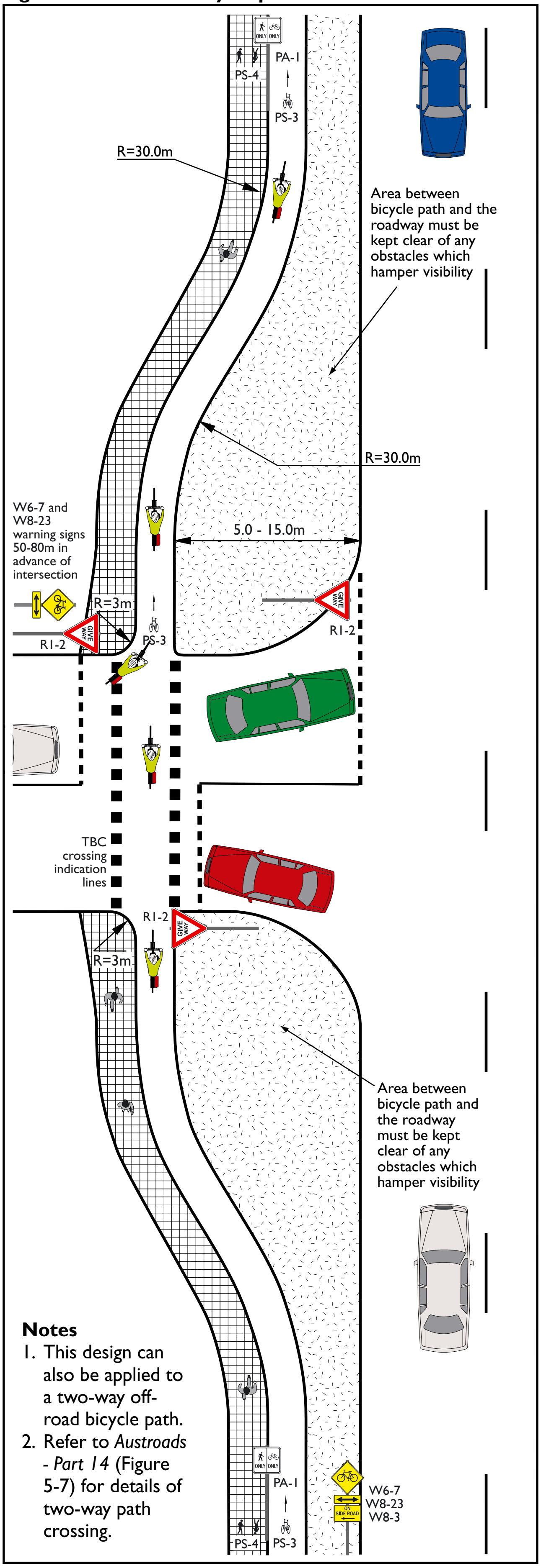
Design notes

Bending-out of the off-road path should be smooth with a recommended curve radius of 30m. Smaller path curve radii (such as the 5m recommended by *Austroads – Part 14*) is not recommended as these tight curves can introduce difficult manoeuvres for riders at a point where their attention should be fixed on the crossing and approaching vehicles.

Comments

In the past there has been a common misconception in intersection design practice that the purpose of bending out is to reduce the speeds of approaching cyclists. The use of tight destabilising curves, rails and bollards are not acceptable as speed reduction devices at these locations and normal traffic management methods such as warning signs and regulatory signs (Give Way and Stop) should be used to control approach speeds and crossing priority.

Figure 7.3: Off-road bicycle path bent-out at intersection.



Notes
1. This design can also be applied to a two-way off-road bicycle path.
2. Refer to *Austroads - Part 14* (Figure 5-7) for details of two-way path crossing.

Figure 7.4: One-way off-road bicycle path intersection crossing on platform (not bent).

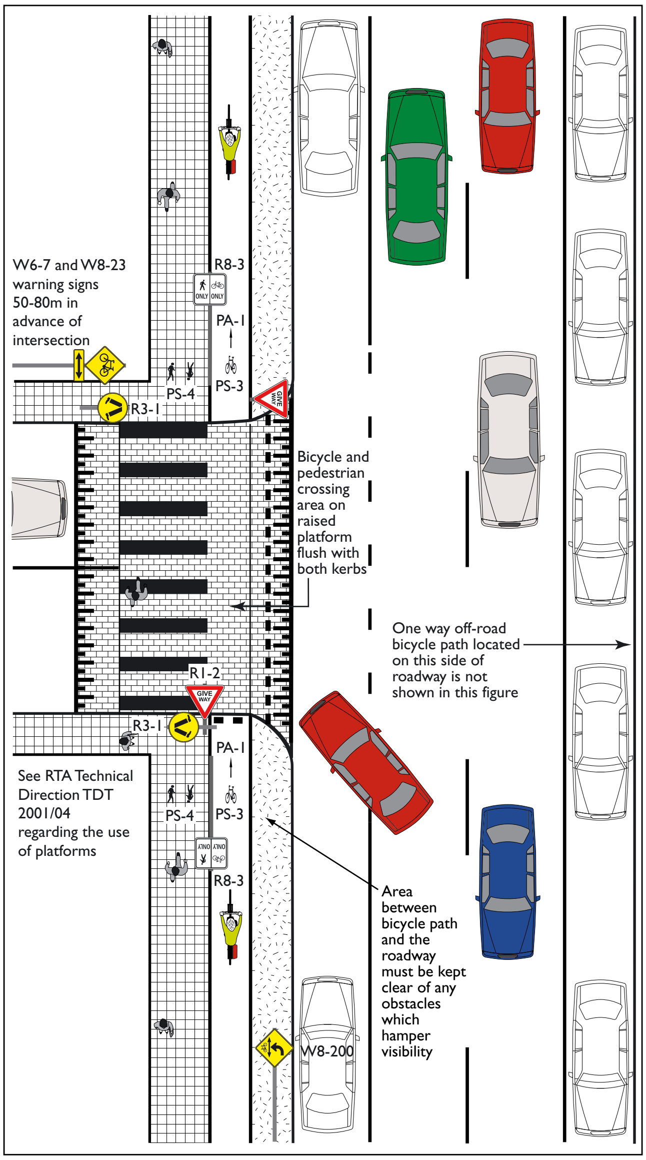
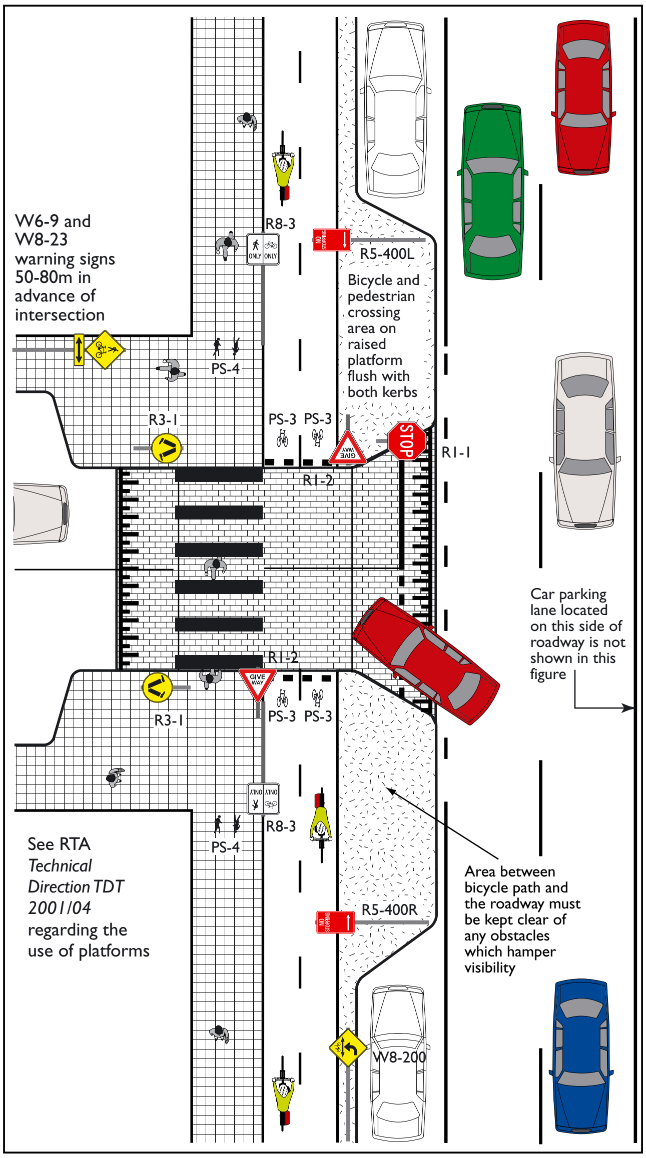


Figure 7.5: Two-way off-road bicycle path intersection crossing on platform (not bent).



7.2.3 Off-road bicycle path - straight

Figure 5.11 in these Guidelines shows a recommended layout for an off-road path crossing of a side street where the cycleway parallels a major road. The off-road path in this instance may be either two-way (on one side of the parallel road) or one-way (with paths on both sides of the parallel road). Figure 5.12 shows a similar crossing where the path is shared with pedestrians. For some limited examples of straight path crossing treatments (not bent-in or –out) see: *Austroads, Part 14* (Figure 6-24 Separated One-way Path). In this example the crossing is not marked.

Application

Off-road paths (either one-way on both sides of the road corridor or two-way on one side of the corridor) crossing side streets or cross roads where space is limited. To maintain better route continuity and rider comfort, this crossing may be placed on a platform as shown in Figure 7.4 for one-way paths and Figure 7.5 for two-way paths. See RTA *Technical Direction TDT2001/04* for usage of pedestrian crossings on platforms.

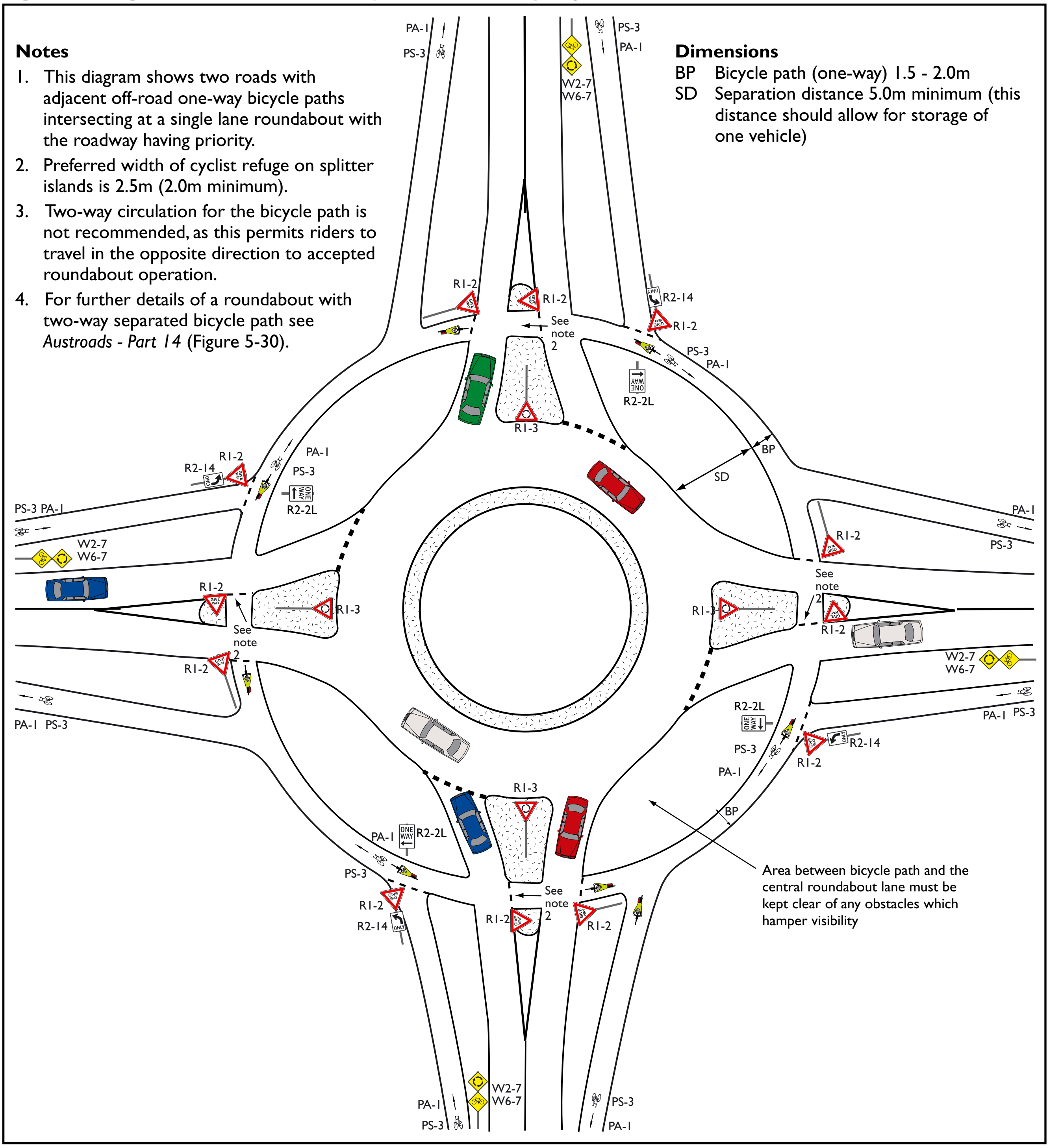
Design notes

The main benefit of a straight crossing is that the path has a higher visibility for road users where space for a bent-out crossing is not available. With two-way off-road paths there is a potential for conflict between bicycle traffic and turning vehicles and these should be resolved in the application of the treatment. It is important that the distance of the dividing strip be kept to a width of 1.0m to maintain visibility. In Figure 7.5 this distance has been enlarged at the mouth of the intersection by extending the kerbs. The area between the bicycle path and the roadway must be kept clear of any obstacles which may hamper visibility.

Comments

This type of treatment is suitable where traffic volumes on side streets are low (residential streets). Where side streets and cross roads have higher volumes a bent-out or bent-in crossing should be considered.

Figure 7.6: Single lane roundabout with adjacent off-road bicycle path.



7.2.4 Off-road bicycle path at a roundabout

Austroads Guide to Traffic Engineering Practice, Part 14 – Bicycles, (Figure 5-30) provides a detail diagram of a section of a multi-laned roundabout with a two-way cycleway crossing of one of the approach roads. Large roundabouts fitted with two-way off-road adjacent bicycle paths are not favoured as the two-way flow on the cycleway is in the opposite direction to normal roundabout operation.

Application

In situations where a bicycle route passes through an intersection controlled by a single-lane roundabout it is desirable to provide safe passage for riders while still maintaining priority for the bicycle route. Figure 7.6 shows a design for a single-lane roundabout which is fitted with an off-road bicycle path at its perimeter.

Design notes

Refer to the notes listed on the Figure 7.6.

Comments

This type of intersection treatment requires space within the road corridor. Where limited space is available it may be necessary to bend-in the bicycle paths on approach to the roundabout and use either of the intersection treatments recommended in Figures 7.8 and 7.9.

Figure 7.7: Bicycle route (in bicycle shoulder lanes) crossing a road via a central refuge.

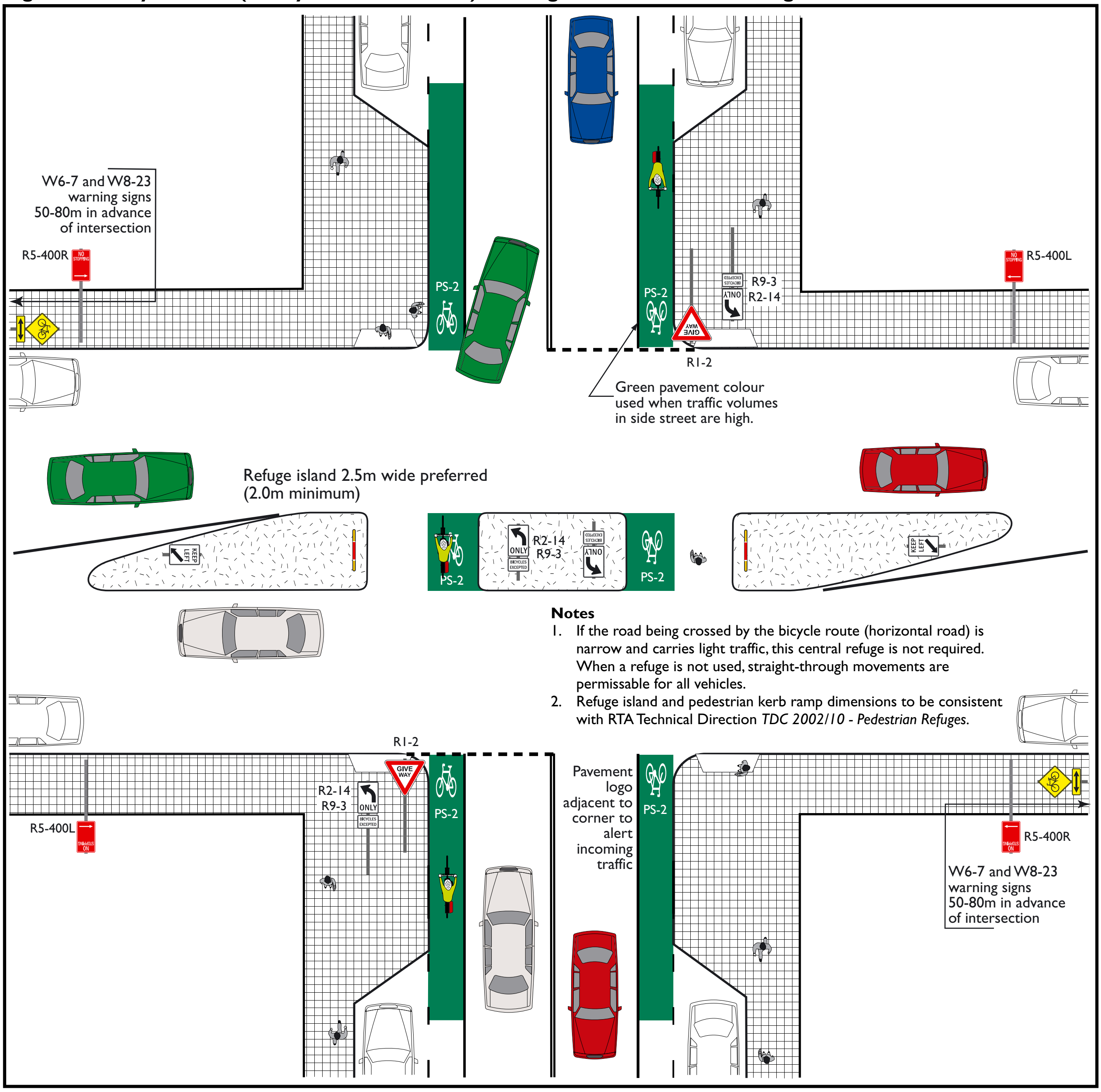


Photo 7.2: Example of through lanes linking bicycle shoulder lanes at an unsignalised intersection on a rural type road with a left-turn lane. Blacktown Rd, Richmond.

7.2.5 Bicycle lanes at unsignalised intersections

Application

Exclusive bicycle lanes or bicycle shoulder lanes should be marked up to and beyond unsignalised intersections. Figures 5.1, 5.3 and 5.7 in Section 5 of these Guidelines show recommended layouts and linemarking for bicycle lanes along roads which have priority over intersecting side streets. Where the priority is allocated to the cross street, the example in Figure 7.7 is recommended.

Design notes

Where bicycle lanes are marked along a street, for safety and continuity, they should be marked continuously across the mouth of any intersecting minor side street (Figures 5.1, 5.3 and 5.7). Where a bicycle route follows a minor street and crosses an arterial or other major road, it should be marked up to the intersection and, if the road to be crossed is heavily trafficked, extra provision in the form of signal control may be required. Where the street to be crossed is minor but still requires priority, a central refuge and road narrowing, should be provided to assist a safe and convenient passage for riders. Figure 7.7 shows a recommended layout for an intersection where the bicycle route follows the minor street and where the road it crosses has the priority. Green coloured pavement may be used as shown in the diagram to heighten visibility of the bicycle operating space.

The treatment shown restricts right-turns by motor vehicles into and out of the minor street, as well as prohibiting straight-through movements across the major road. These restrictions enable the refuge island to operate exclusively for bicycle riders and pedestrians crossing the major road. Conflicts between non-turning riders and left-turning vehicles are minimised by the use of kerb extensions at the mouths of the side streets as shown in Figure 7.7.

Figure 7.8: Bicycle route at small single lane roundabout.

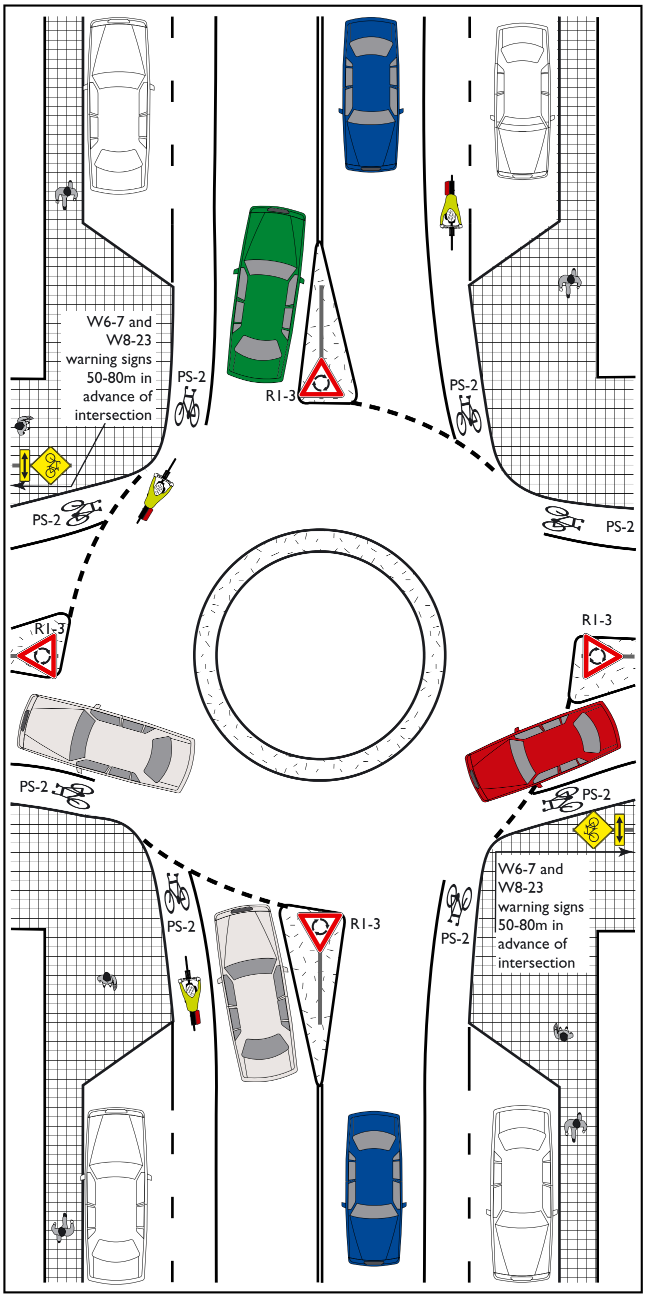


Photo 7.3: Example of bicycle lanes through an unsignalised intersection. Lilyfield Rd, Lilyfield.

7.2.6 Bicycle lanes at roundabouts

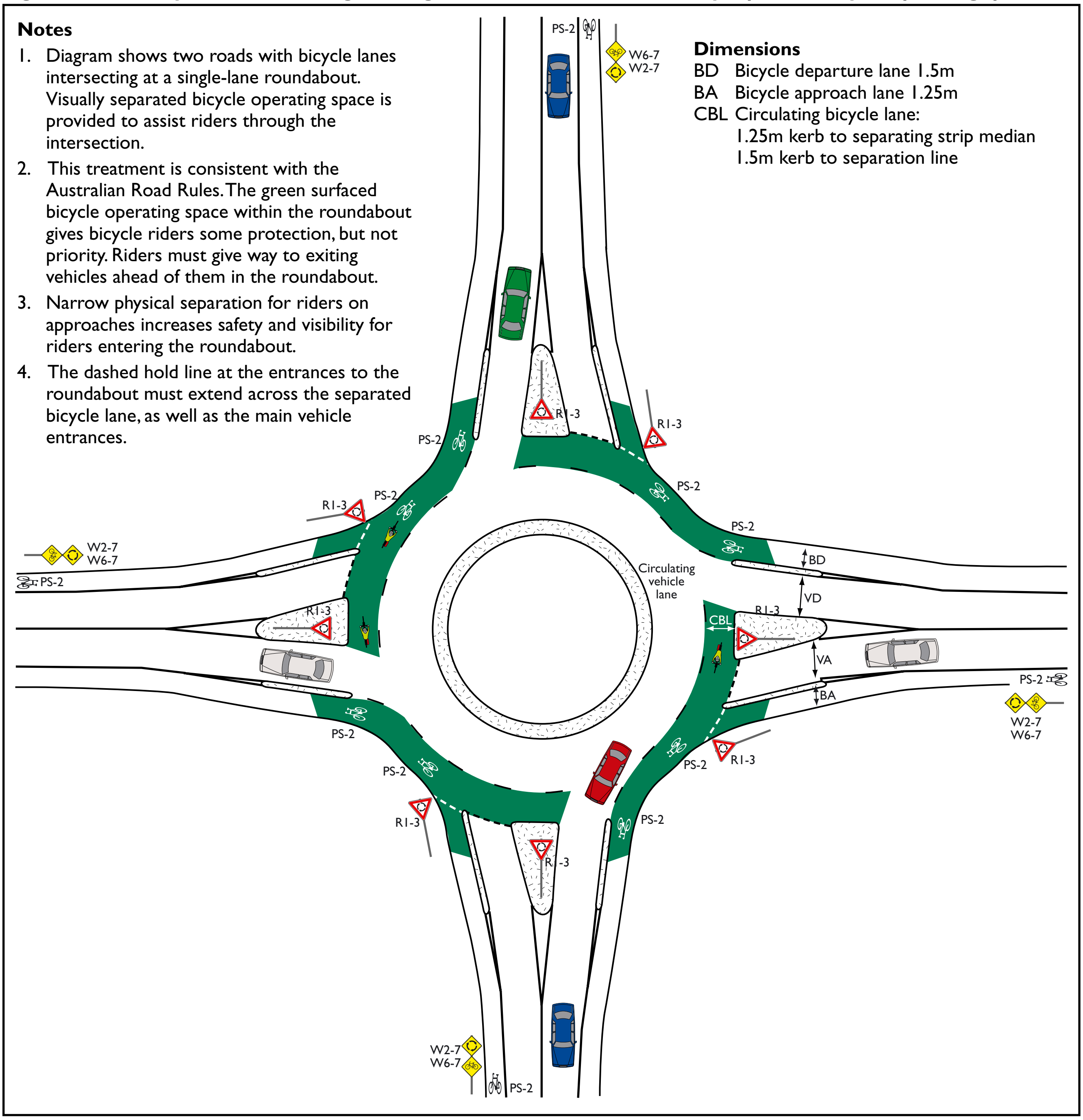
Austroads – Part 14 (Section 5.5.2 Roundabouts) provides basic information about the provision for cyclists at roundabouts. The Australian Road Rules (Rules 111 and 119) permit riders to travel in the outside lane of a multi-lane roundabout, but they must give way to exiting vehicles. Figures 7.8 and 7.9 provide two examples of recommended roundabout treatments.

Application

The operating requirements of bicycle riders should always be considered in the design of roundabouts. To provide bicycle network route continuity and safety passage for riders through roundabouts bicycle lanes should be marked up to the roundabout and recommence on the other side. Figure 7.8 shows a small retro-fitted roundabout with a

Photo 7.4: Example of a bicycle lanes marked up to a single lane roundabout. Edgecliffe Rd, Bondi Junction.

Figure 7.9: Two bicycle routes crossing at a single-lane roundabout with visually separated bicycle operating space.



bicycle route passing through it. The route treatment in this example uses bicycle shoulder lanes. There are numerous examples of this type of roundabout in operation. It is suitable where vehicle speeds are 50 km/h or less.

Design notes

Figure 7.8 shows bicycle shoulder lanes carried through a single laned roundabout. Bicycle traffic, once in the roundabout, has to use the roundabout as would any road vehicle. For this reason this type of treatment is not recommended where speeds or volumes are high (see Figure 3.2 for recommendations). Bicycle lanes should be marked up to the holding lines at single-lane or multi-lane roundabouts. If traffic volumes are high it is recommended that bicycle lanes be protected by a narrow median on approach as in Figure 7.9, and additional comfort and safety be provided by means of a marked circulatory space around the outside edge of the roundabout. This perimeter circulatory bicycle lane offers riders no additional priority within the roundabout, but allocates highly visible operating space to enable them to more easily negotiate the roundabout.

Comments

There are a number of examples across Australia of marked bicycle operating space within roundabouts. Cyclists prefer the added visibility this treatment affords, but education programs must still stress that normal road rules still operate within the roundabout and riders must be constantly aware of exiting vehicles.

Figure 7.10: Bicycle route through mixed traffic intersection.

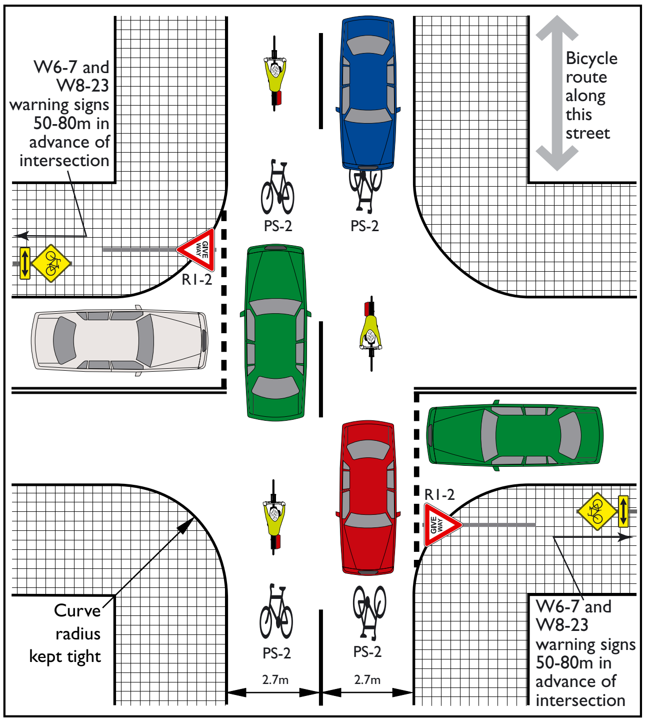
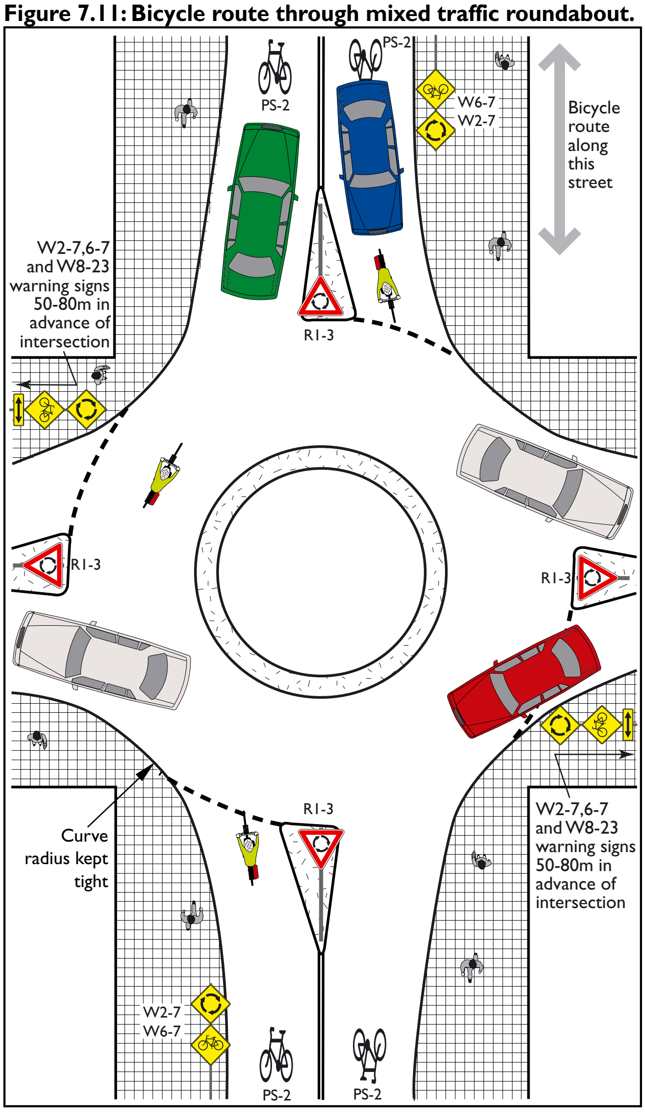


Figure 7.11: Bicycle route through mixed traffic roundabout.



7.2.7 Mixed traffic intersections

Austroads – Part 14 does not provide specific coverage of this type of intersection.

Application

Tight profile streets (see Sections 4.7 and 5.3 of these Guidelines) are a type of mixed traffic facility suitable for marked bicycle network routes. They are used in very narrow older residential areas, where speeds are low (40km/h or below) and traffic is localised.

Design notes

Mixed traffic lanes usually occupy the only available road space and are defined by means of normal road lane markings. PS-2 pavement symbols are used at 75m intervals and before and after intersecting streets to indicate the presence of a bicycle network route. Figure 7.10 shows a mixed traffic street carrying a bicycle route through a small cross type intersection.

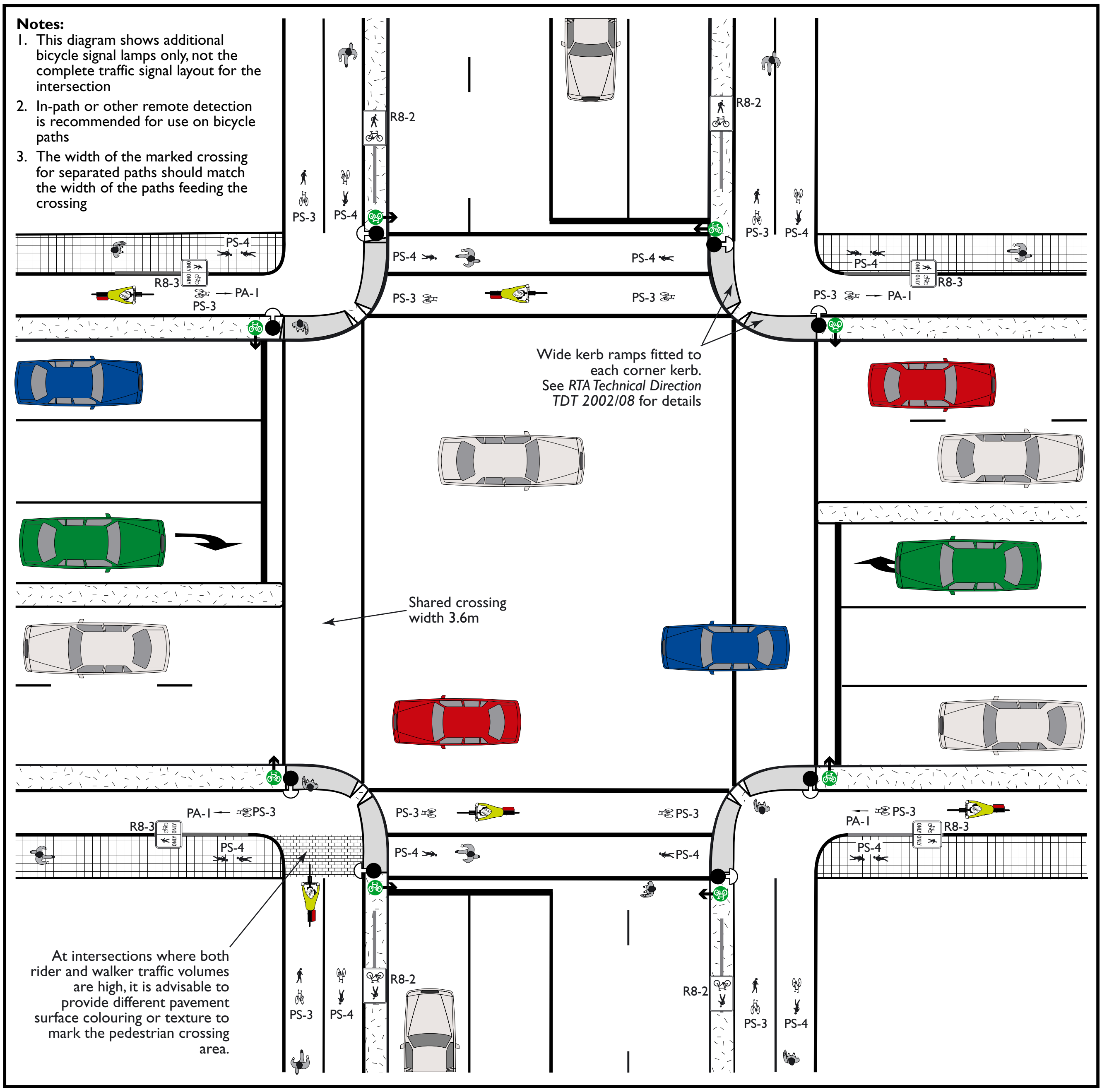
Figure 7.11 shows a recommended treatment for a mixed traffic roundabout. It is recommended that the circulating lane within the roundabout be kept tight (close to the minimum recommended radius) to maintain a visually tight environment and avoid the possibility of vehicles attempting to pass riders within the roundabout.

Comments

Riders use these intersections as normal vehicles and will generally track the centre of the lane so clearance to parked car doors is not as critical an issue as with bicycle shoulder lanes. Figure 7.10 shows a mixed traffic – tight profile street used in a low speed residential street. Providing lane widths wider than 2.6m is to be avoided, as excess width increases the possibility of risky overtaking behaviour. Any excess street width should be allocated to parking lanes rather than travel lanes.

Photo 7.5: Example of bicycle signal lamps used to control entry to contra-flow lane. Bourke St, Surry Hills.

Figure 7.12: Off-road bicycle facilities (one-way bicycle paths east-west and shared paths north-south) crossing at a traffic signal controlled intersection.



7.3 Intersections with traffic signals

Ease of crossing and good visibility are two major issues when designing routes through signalised intersections. Bicycle routes can travel through signalised intersections as either off-road paths or on-road lanes. The layout of signalised intersections with mixed traffic streets should be similar to the example given for unsignalised streets (see Section 7.2.7).

This section covers a number of lane marking strategies which permit riders to safely use signalised intersections with a similar level of service and minimum delay time to that of other vehicles.

Riders turning right at major four-way signalised intersections may be required to make two separate crossing movements whereas cars can make turns easily in a

Photo 7.6: Example of a signal activation button for a bicycle crossing. Bourke and Cleveland Sts, Surry Hills.

single movement or traffic signal phase. Such crossings have to be carefully planned to include efficient and convenient bicycle movements, otherwise riders will become frustrated and may attempt to 'run' red lights.

Careful consideration must be made on waiting times and the coordination of crossing signals. For example where an off-road bicycle path crosses a roadway via a wide central median, the rider should not have to wait for a separate phase on the island to complete the crossing. At intersections with higher volumes of riders and more complex movements, a possible solution may be to give a separate green bicycle phase for all directions at once. In limited situations this may also be synchronised with a 'scramble' phase for pedestrians.

Austroads Guide to Traffic Engineering Practice, Part 14 – Bicycles (Section 5.4.3) presents a discussion on traffic signal phasing times, particularly in relation to the relatively slower speed of bicycles compared to motor vehicles through an intersection. *Austroads – Part 14* also contains details on the type and location of detection loops for bicycles at signalised intersections (Section 5.4.1). Off-road paths can also be fitted with detector loops for traffic signals. Where signalised crossings of minor side streets are located along a major bicycle route, these loops may be located in advance of intersections to permit progressive green phasing of the lights synchronised to a comfortable riding speed.

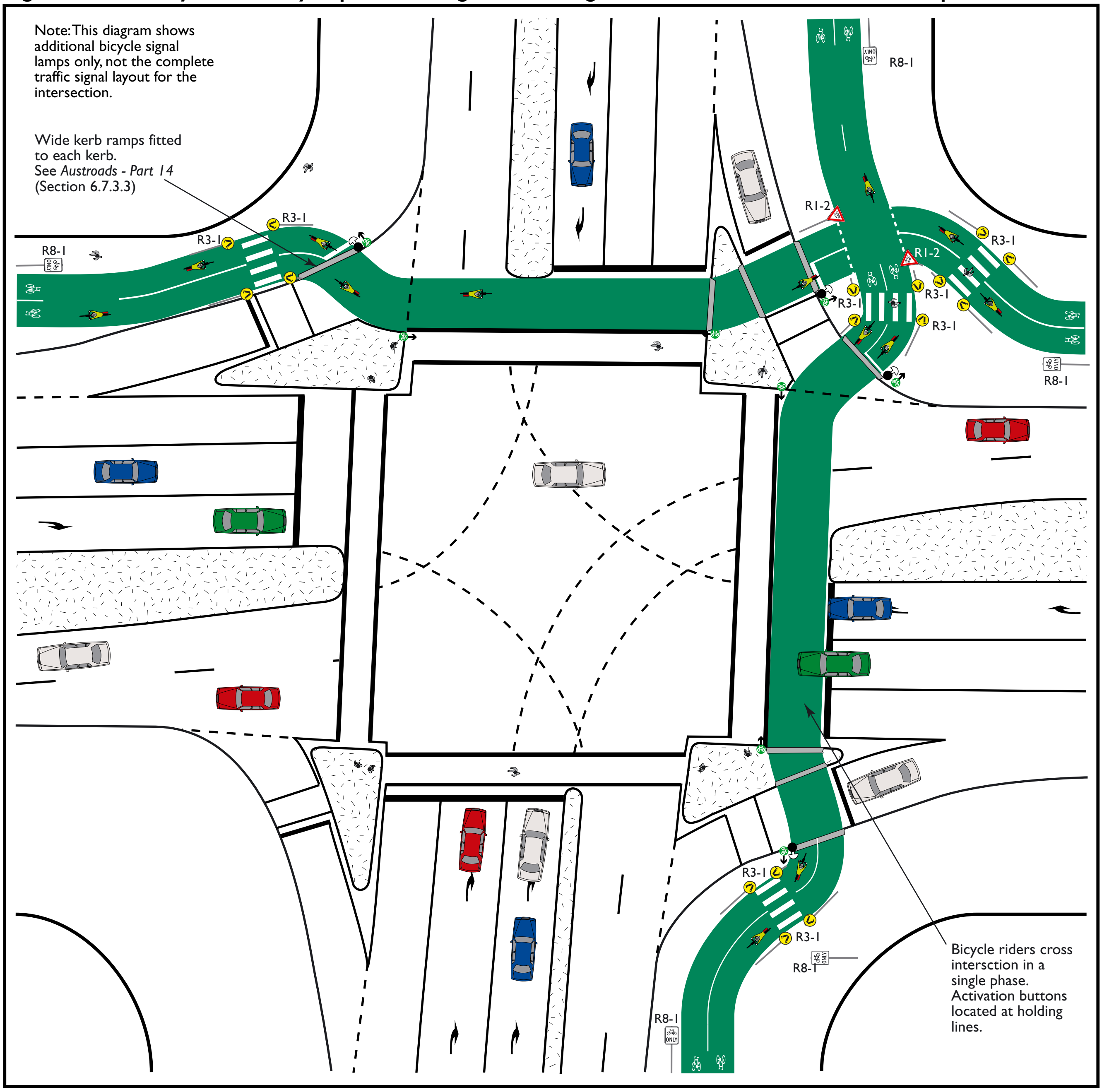
Consideration should be given to the removal of any existing 'Left Turn on Red' provisions at intersections.

The criteria required for the installation of new traffic lights at an intersection are not contained in these Guidelines, refer to the RTA's document *Traffic Signal Practice – Design*.

7.3.1 Off-road bicycle paths at signals

At signalised road junctions potential conflicts should be regulated by the layout, marking and signal phasing of the intersection. Off-road path crossings of intersections are

Figure 7.13: Two-way off-road bicycle paths crossing at a traffic signalised intersection with controlled slip lanes.



usually planned and executed alongside pedestrian crossing space. It is common practice to place the bicycle crossing between the motor vehicle lanes and the pedestrian crossing. Conflicts between cyclists and pedestrians should be also regulated by the intersection design. *Austroads Guide to Traffic Engineering Practice, Part 14 – Bicycles* does not provide detailed guidance for off-road paths at signalised intersections.

Application

Figure 7.12 shows a typical multi-lane road intersection with off-road bicycle paths, shared paths and footpaths adjoining and crossing adjacent and parallel to each intersecting road. Where bicycle traffic favours a particular movement, or where there are a number of common movements which require a two stage crossing (in one direction only), it may be desirable to introduce a green bicycle phase. It may also be possible to include pedestrians in this phase.

Figure 7.13 shows off-road bicycle paths crossing a signalised intersection with controlled slip lanes. The aim of this design is to provide the same level of service through the intersection for riders as for other on-road vehicles. Signal phasing should be designed to allow passage across both slip lanes and through the intersection in one stage.

Where off-road bicycle routes are required to pass through major intersections, signal control should be considered for slip lanes.

Design notes

Careful design and marking of pedestrian and bicycle space is necessary to avoid conflicts. Where both pedestrian and bicycle volumes are high it may be necessary to extend the marking of the crossing lines to join up with the bicycle paths and footpaths which feed the crossings.

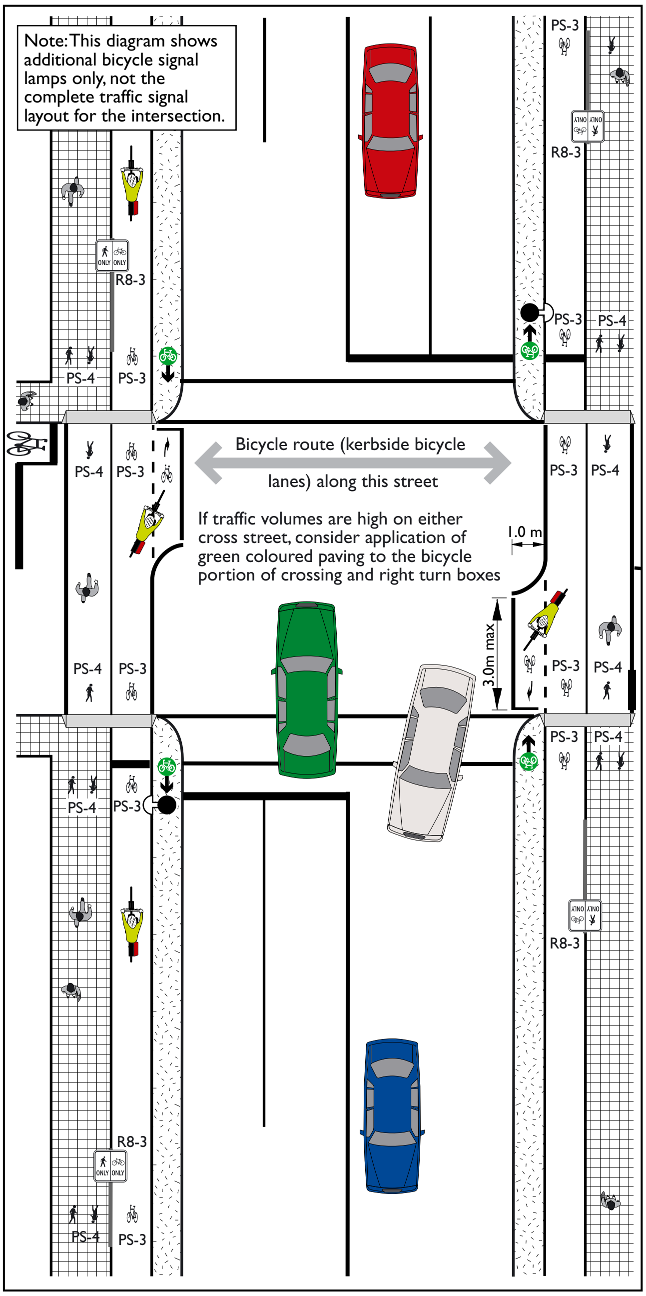
On bicycle path approaches to the intersection, detection loops should be placed in the path surface in advance of the intersection to increase the opportunity for riders to minimise delay time and proceed through on the green phase. See *Austroads – Part 14* (Section 5.4.1) for further information on path surface detection loops.

Activation buttons when used at signalised intersections should be located in a convenient location close to the crossing approach or holding line. The use of cyclist holding rails is not recommended as these are often destabilising for the rider and encourage poor bike handling practice especially on take-off manoeuvres. Holding rails, like post and rail fencing, if located close to a bicycle path with insufficient clearance can sometimes present a hazard to riders. Paths and the areas between path and road should be kept free of all obstructions to improve visibility, manoeuvrability and maximum storage space at the intersection.

Comments

The length of the marked approach waiting lane for off-road bicycle paths should be 4.0m (two bicycle lengths). The width of this lane at the holding line depends on the volume of bicycle traffic using the intersection. It is important to allow a generous amount of space at approaches to intersections (wider than the minimum recommended off-road one-way bicycle path width of 1.5m) due to the extra space often needed by riders on starting up.

Figure 7.14: Right turn for off-road bicycle path to on-road bicycle lanes at signalised intersection.



7.3.2 Right-turns from off-road bicycle paths

Design notes

The treatment shown in Figure 7.14 uses a marked bicycle turn holding area similar to that used at large signalised intersections for bicycle hook turns. Riders wait at this holding area for a green turn arrow. This holding area will accommodate up to four riders. If bicycle volumes are high, green pavement surfacing should be considered on both the holding area and the bicycle crossing.

Comments

As riders have to turn right from the far left lane, it is essential that the signal phase, when shared with right-turning cars, be an exclusive right-turn phase in one direction only. This is necessary to avoid conflicts between right-turning bicycles and straight-through motor vehicles.

Figure 7.15a: Design options for signalised intersections.

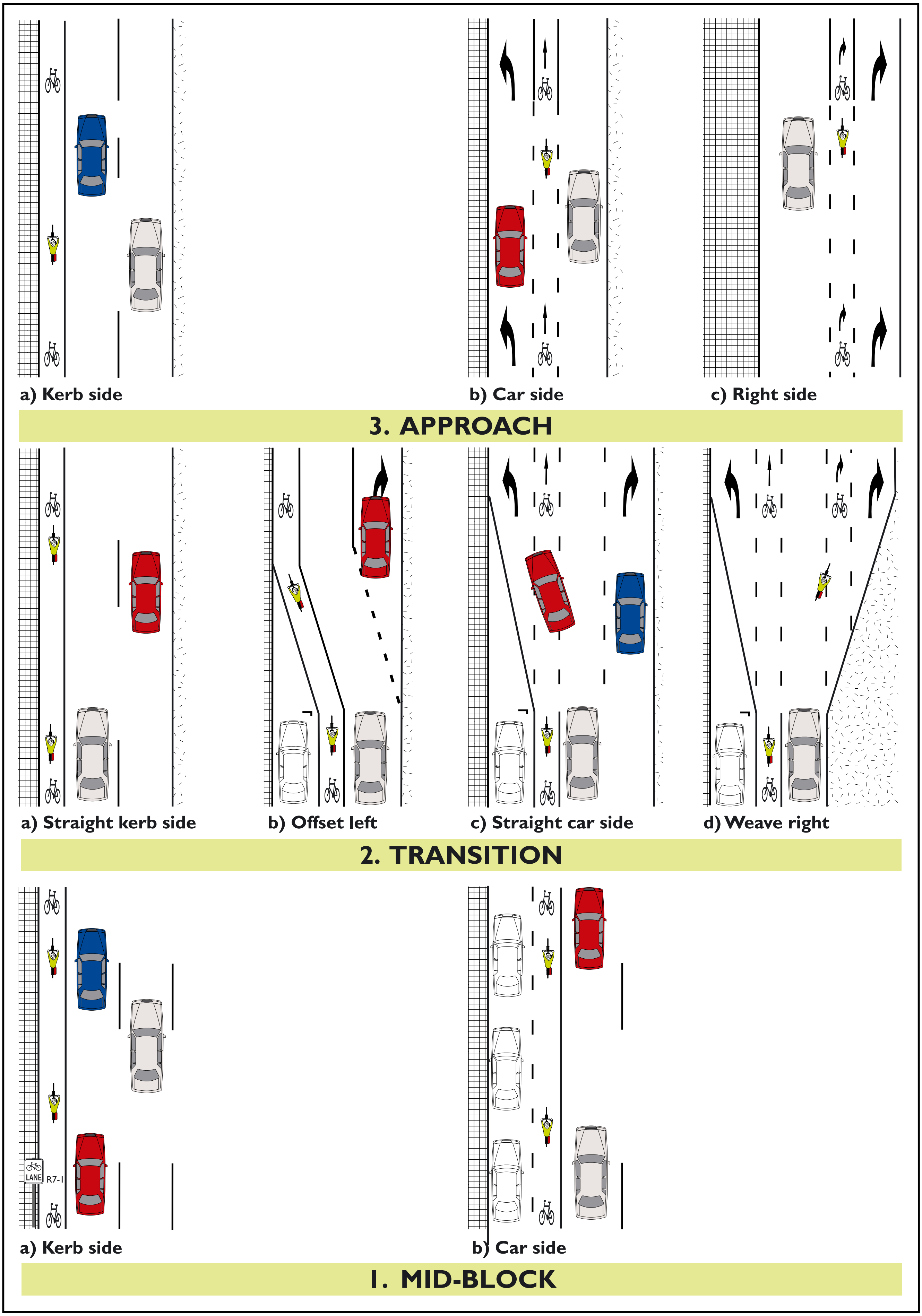


Figure 7.15b: Design options for signalised intersections.

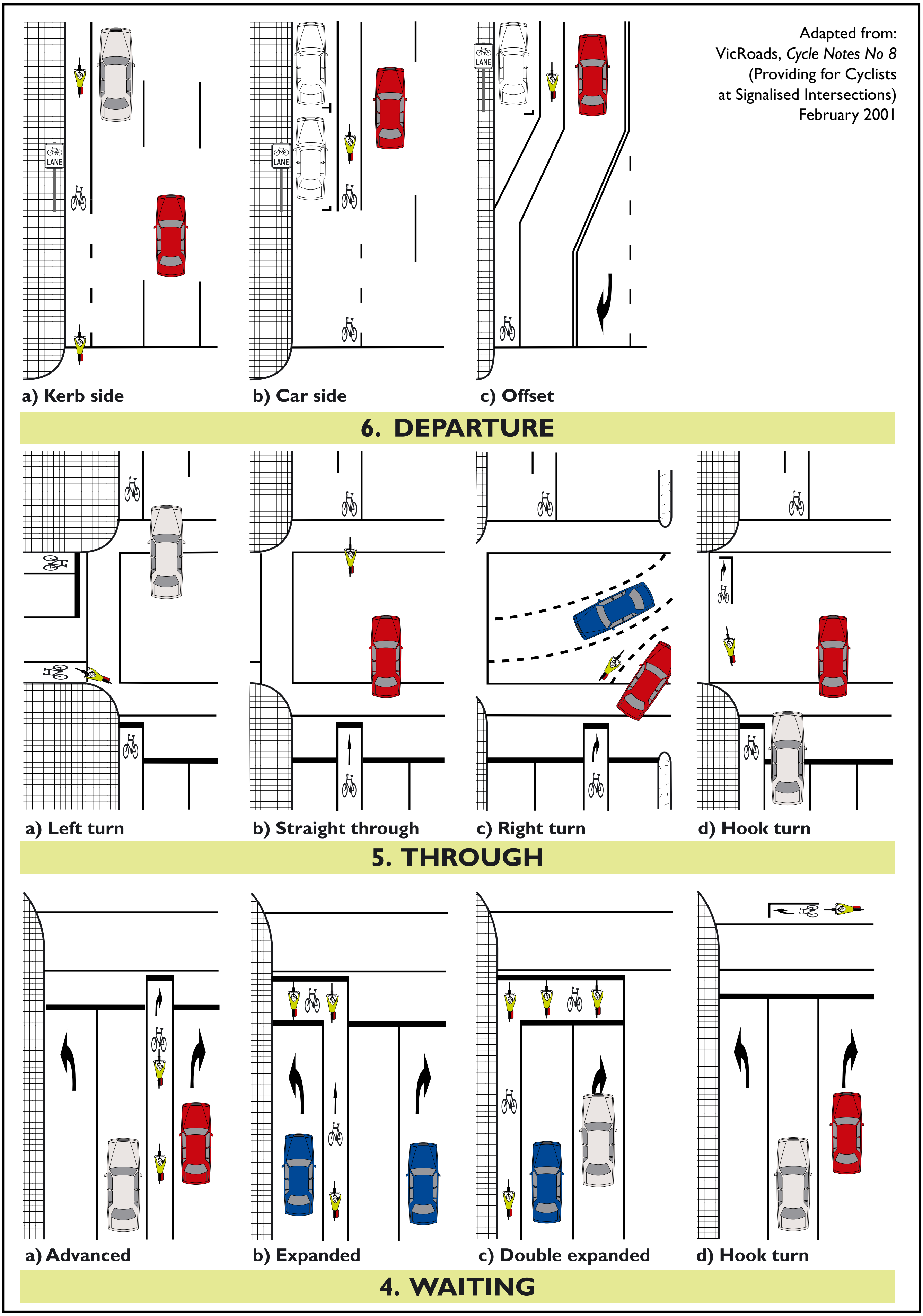


Figure 7.16: Bicycle shoulder lanes through a signalised intersection located car side on approach and departure

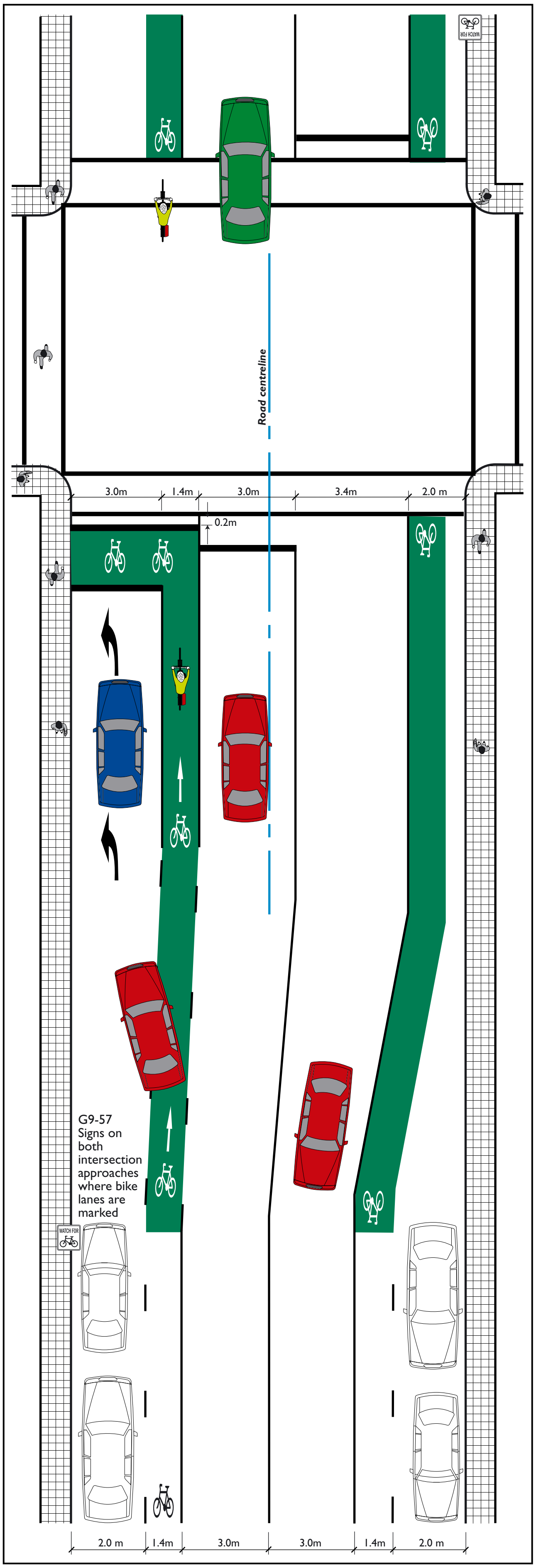


Figure 7.17: Bicycle shoulder lanes through a signalised intersection located kerbside on approach and departure.

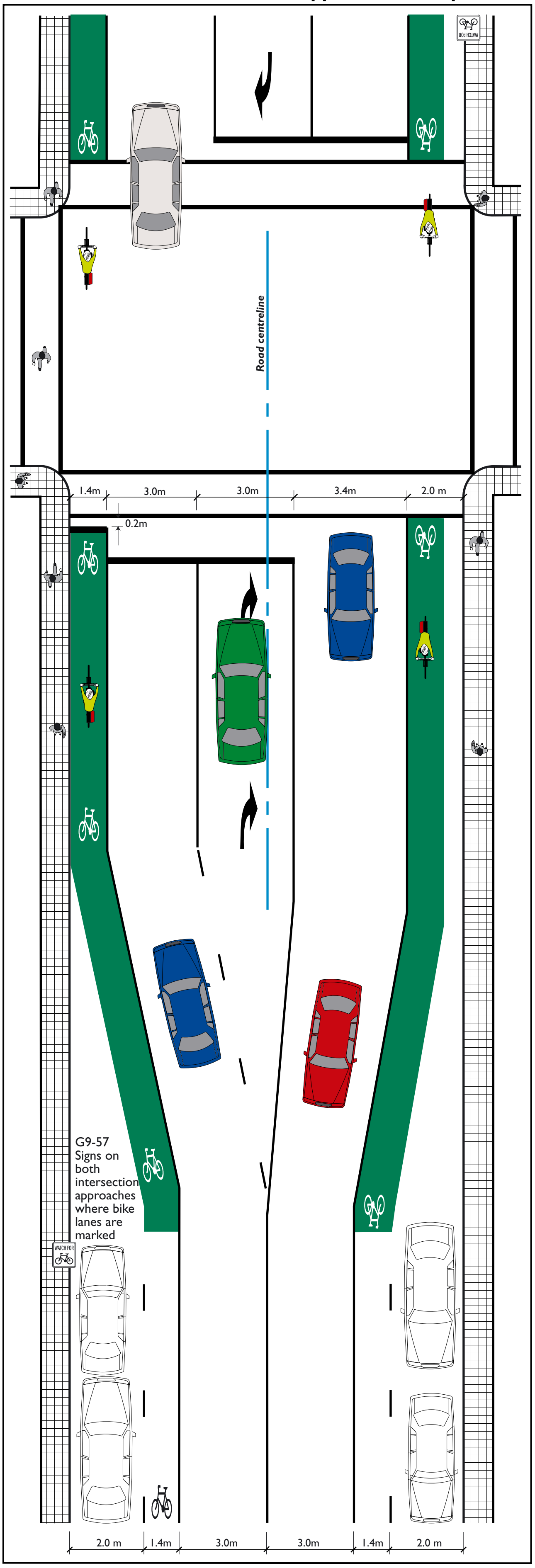


Photo 7.7: Example of bicycle lanes through a signalised intersection. Union St, Ultimo.

7.3.3 Bicycle lanes at signals

Figure 7.1 shows the six spatial elements for the provision of bicycle facilities at signalised intersections. Figures 7.15a and 7.15b give a more detailed depiction of the various design options for each element. This diagram includes adjustments which include NSW road conditions. *Austroads Guide to Traffic Engineering Practice, Part 14 – Bicycles* provides some guidance on various aspects of bicycle provision at signalised intersections. However, the systematic approach advocated in VicRoads, *Cycle Note 8* is a more comprehensive approach to intersection design.

Application

At intersections where bicycle lanes are present on one or more approaches, provision should be made for safe and convenient bicycle travel through the intersection.

Design notes

The primary aim of the road designer is to provide a clear indication as to the path a rider should take in order to safely and comfortably travel through an intersection. Bicycle facilities should be continuous through the intersection. If bicycle lanes are provided on approach these should be resumed on the departure side of the intersection. On approach the rider first enters the most difficult part of the intersection as they may have to make a transition across lanes (to a right-turn lane) or have their lane crossed by other vehicles. Once in their chosen lane they proceed to the intersection holding line to await the signal to proceed.

It is not good practice to install bicycle lanes at intersections where there will be two or more traffic lanes between the bicycle lane and the kerb.

Where bicycle turning movements are prominent (when a major route makes a right-turn) it is essential to mark additional lane guidance lines within the intersection to assist cyclists through the intersection (see also example in Figure 7.1). Advanced holding areas and expanded holding boxes are covered in detail in Section 7.3.4 below.

Figures 7.16 and 7.17 show two examples of bicycle shoulder lanes marked through signalised intersections of 12.8m roads. Figure 7.16 shows the bicycle lane located car-side to accommodate a left-turn only lane. In this example no separate left-turn lane is provided for the rider and they would need to make their turn from the vehicle lane and the expanded storage box.

Figure 7.17 shows the bicycle through-lane kerb-side permitting both left-turns and straight-through movements. This type of lane treatment should never be used in conjunction with left-turn only vehicle lanes (see Figure 7.16). This intersection layout is designed to accommodate opposing right-turn only vehicle lanes.

Finally it must be remembered when considering intersection treatments, the needs of all road users must be considered. Thus the overall performance of the intersection is an important consideration.

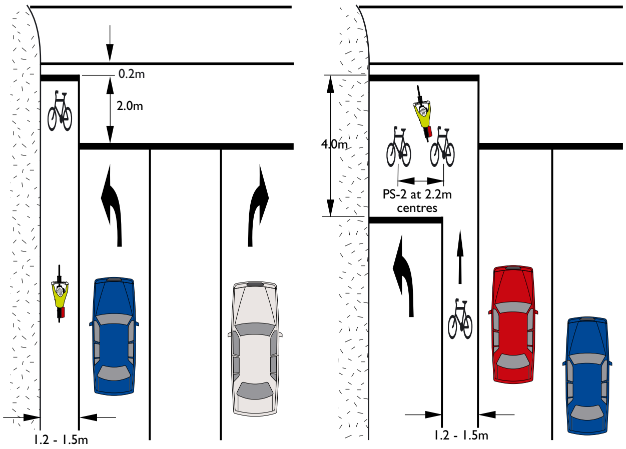
7.3.4 Head start and expanded storage boxes

Austroads Guide to Traffic Engineering Practice, Part 14 – Bicycles provides some coverage of storage boxes for cyclists (Section 5.4.2.3 Head Start Storage Areas). The purpose of these storage areas is to position riders in a highly visible location so that they can proceed through the intersection in full view of other vehicles. This is particularly important

Figure 7.18: Head start and expanded storage areas.

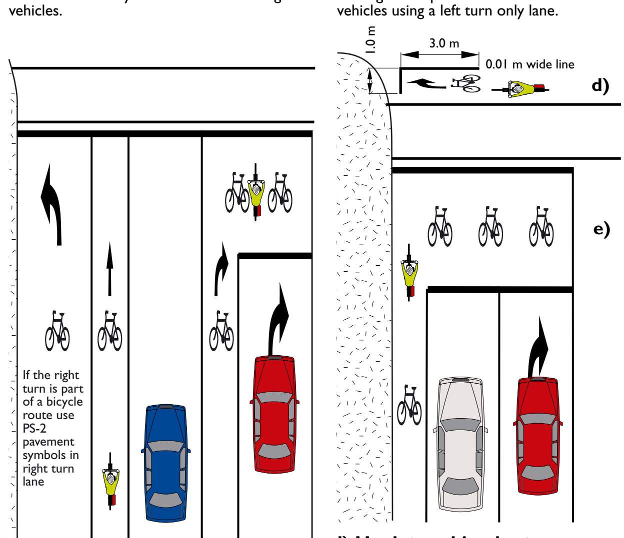
Notes

1. PS-2 symbols and BA 6 arrows used to mark head start and expanded storage areas.
2. Green coloured pavement is recommended in bicycle lanes through the waiting zone (corresponding with solid lane lines) and in all head start and expanded storage areas
3. See *Austroads - Part 14* (Figure 5-15) for further examples



a) Head start bicycle storage area
This example assists straight ahead riders where conflict may occur with left turning vehicles.

b) Expanded bicycle storage area
Left turn type. This example assists left turning riders position themselves ahead of vehicles using a left turn only lane.



c) Expanded bicycle storage area
Right turn type for use with a separate right turn phase. Right turn box may be reduced to a head start area if lane guidance markings are provided through intersection.

d) Hook turn bicycle storage area
This example assists riders on the cross street to make a right hook turn to join bicycle lanes on the street shown.

e) Double expanded storage area
This example assists turning riders position themselves ahead of all turning vehicles where there are no separate turn phases.

when riders have to make turns ahead of other traffic.

Design notes

Figure 7.18 shows four examples of storage boxes for cyclists at signalised intersections. Example a) shows a head start storage area. This bicycle storage area is only as wide as the bicycle lane and has its holding line 1.2 to 2.5m ahead of the usual vehicle holding line. The holding line should be 0.2m short of the pedestrian crossing line. Head start storage areas are used for straight ahead only bicycle movements. If the riders are allowed to make turns, then an expanded storage area should be used instead.

If for instance, in example b), cyclists were not permitted to make a left-turn, a head start storage area would be more appropriate for this situation, rather than the expanded storage area shown.

Figure 7.18 b) shows an expanded storage area which permits cyclists to turn left as well as to proceed straight ahead. In high traffic locations or where the number of bicycle turning movements is significant, or compliance by motor vehicle drivers is poor, green coloured pavement is recommended within the advanced storage area.

Figure 7.18 c) shows a right-turn expanded storage area for high volumes of bicycle turning traffic. Advanced storage boxes on right-turns are recommended, where the turn is made into a single-laned mixed traffic street without marked bicycle lanes.

Where bicycle lanes are provided in the cross street and bicycle turning volumes are not high, it is more acceptable to install a head start storage area in the right-turn bicycle lane. In this instance it is also necessary to include additional lane guidance lines to assist cyclists through the intersection (see also example in Figure 7.1 (Through) and Figure 7.14b 5c).

Figure 7.18 d) shows a hook turn storage box which positions riders waiting for the signal change.

Figure 7.18 d) also shows a double expanded storage area where right- and left-turn movements are necessary for riders.

7.3.5 Hook turn storage boxes and hook turn restrictions

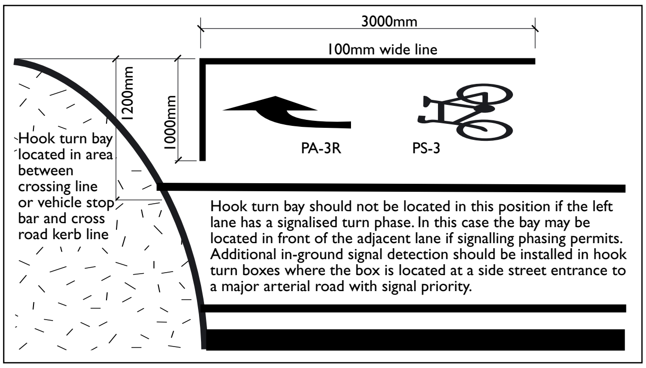
Austroads Guide to Traffic Engineering Practice, Part 14 – Bicycles provides coverage of hook turns for cyclists (Section 5.4.2.4 Hook Turns). The section below provides additional detail for marking holding areas within intersections to assist riders to position themselves in a highly visible location so that they can proceed through the intersection in full view of other vehicles.

Design notes

Hook turns are favoured by cyclists at large intersections where centre turning is difficult due to large volumes of traffic. The hook turn represents a decrease in convenience for riders, as the turn has to be made over two traffic signal phases instead of one, when turning from the centre lanes. As bicycle riders travel more comfortably in kerbside travel lanes, it is often a more popular option to make a hook turn at large cross road intersections despite the need for a two-stage crossing.

Figure 7.19 shows the layout of a marked hook turn storage

Figure 7.19: Bicycle hook turn bay detail.



box at a large cross intersection. This box should be no longer than 3.0m and 1.0m wide. It should be located in a 2.5m wide area immediately in front of the pedestrian crossing area and not protrude into the adjacent crossroad kerbside travel lane. Hook turn boxes should always be placed so that they do conflict with left turn signal phasing. Additional signal detection should be considered where hook turn boxes are placed at side street entrances to major arterial roads.

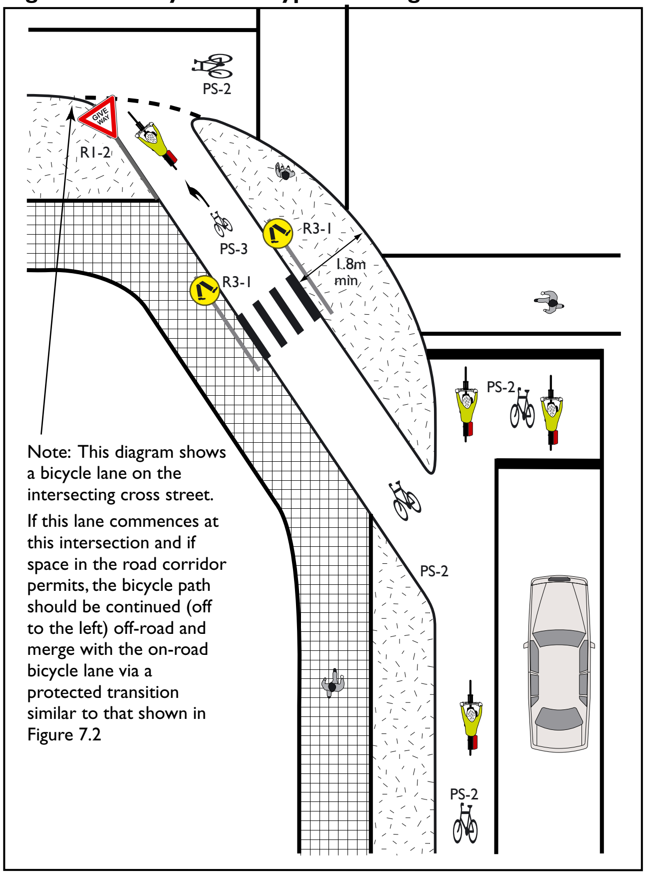
7.3.6 Left-turn through-access at signals

Austroads Guide to Traffic Engineering Practice, Part 14 – Bicycles provides details (Figure 5-21) on a bicycle bypass at an intersection.

Application

To improve bicycle rider throughput at intersections where a major bicycle route makes a left-turn, it is desirable to create a left-turn for riders bypassing the signals. Figure

Figure 7.20: Bicycle lane bypass at a signalised intersection.



7.20 shows a left-turn bypass for riders at a signalised intersection. The concept behind this treatment is similar to Figure 5-21 in *Austroads – Part 14*.

Design notes

The bypass path should be very clearly marked, so that pedestrians are aware that it will be used by riders. If pedestrian numbers are high, a marked crossing of the bicycle path may be necessary. The bicycle by-pass should always feed into a bicycle lane in the cross street. Where a bicycle route exists through the intersection via the cross street, the bypass should join the bicycle lane as shown in Figure 7.20.

Where the bicycle lane in the left hand cross street commences at the intersection, and where space permits, it is recommended that the path be continued away from the intersection off-road for some distance and rejoin the on-road bicycle lane via a protected transition similar to the treatment shown in Figure 7.2.

Comments

If bicycle lanes are not present in the cross street this treatment is not advised and riders should be directed to turn left at the signals.

7.4 Bicycle path mid-block road crossings

Austroads Part 14 – Bicycles and *Australian Standard AS1742.9* provide detailed coverage of road crossings by off-road bicycle paths and shared paths. Examples of treatments are provided for crossings where priority is allocated to the bicycle path or to the roadway.

Figure 7.21 shows a typical crossing by an off-road bicycle path of a road which has parallel one-way bicycle paths along each side.

Application

Where off-road bicycle paths cross roads which are fitted with parallel one-way bicycle paths along each edge, special attention needs to be given to the crossing design. In the example in Figure 7.21, priority is assigned to the roadway and its parallel bicycle paths. This requires riders approaching on the off-road path to first give way to riders and pedestrians, then give way to traffic on the road, and finally give way to riders and walkers using the footpath and bicycle path on the other side.

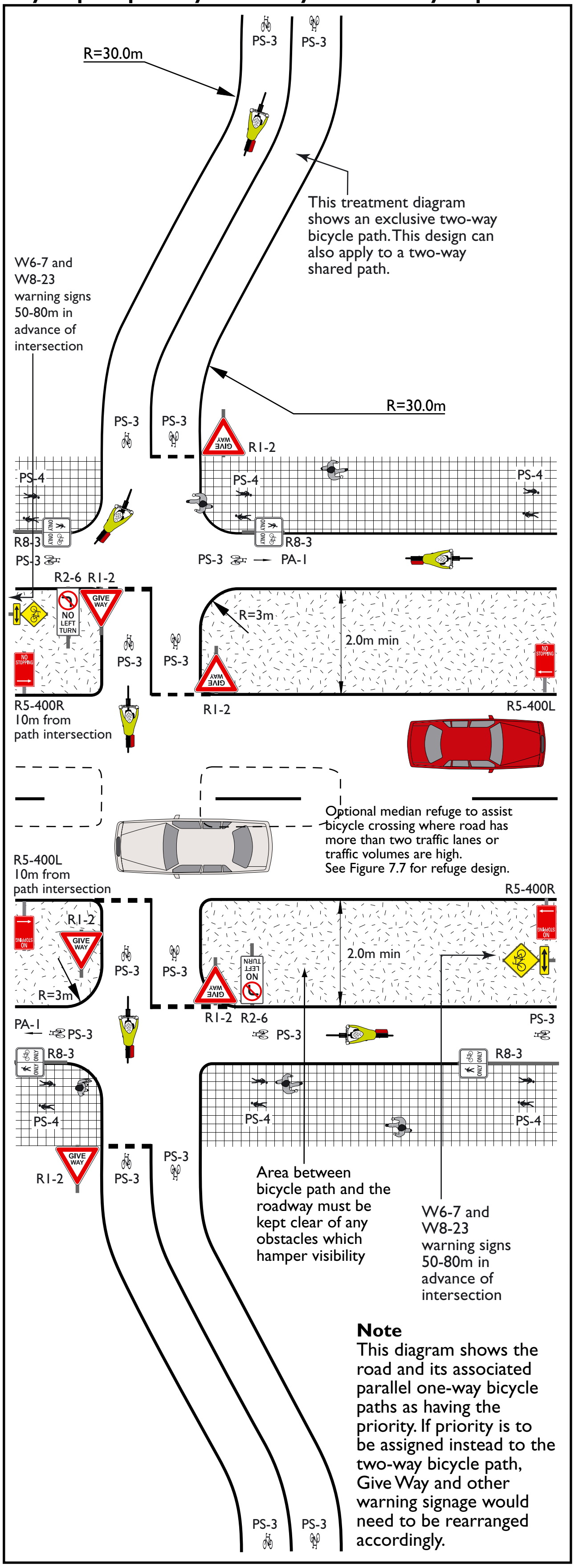
Design notes

Sharp curves and bollards, which can destabilise riders and present a hazard, are to be avoided near the crossing point. Obstacles such as trees and shrubs should be removed from the verges along the road approaches to ensure good visibility.

7.5 Motorway on- and off-ramp crossings

Austroads Part 14 – Bicycles and *Australian Standard AS1742.9* provide detailed coverage of cycling facilities associated with freeways and motorways. NSW best practice for the treatment of crossing points at on- and off-ramps differs from *Austroads Part 14* and *AS1742.9*.

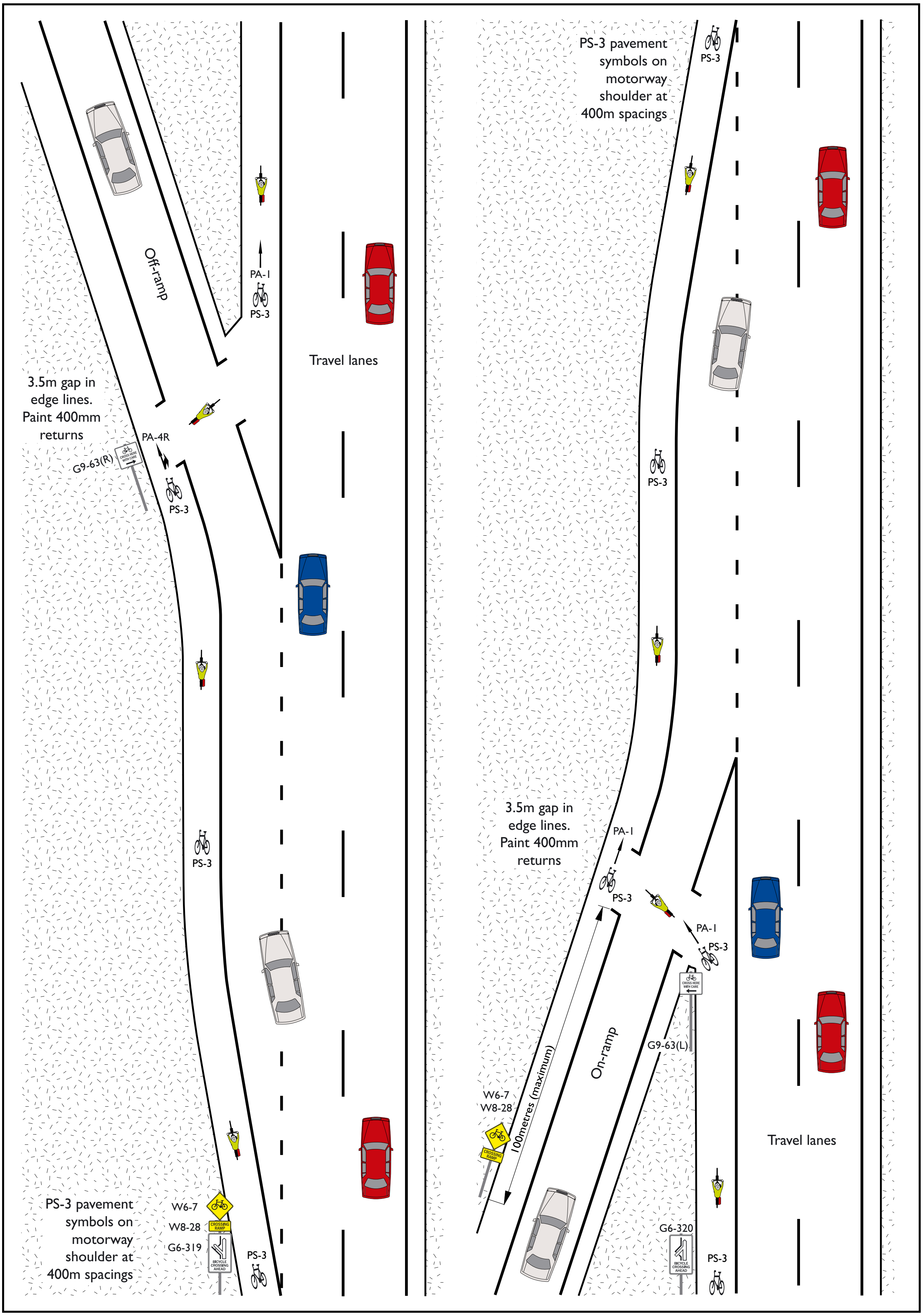
Figure 7.21: Mid-block crossing of a road and one-way bicycle path pairs by a two-way off-road bicycle path.



Design notes

The preferred treatment for NSW motorway/freeway on- and off-ramp crossings is shown in Figure 7.22.

Figure 7.22: Motorway on- and off-ramp crossings.



8. Surface treatments, linemarking and the finishing of bicycle routes

Table 8.1: Scope of Section 8.

Type of facility	Coverage in *Austroads - Part 14*	Coverage in these Guidelines
Surface treatments	8.5.2 Pavements for bicycle paths 8.2 Construction and maintenance of roads 9.7 Pavement surface colour	8.1.1 Off-road path surface treatments 8.1.2 On-road bicycle lane surface treatments 8.1.3 Use of coloured pavements
Linemarking and pavement symbols	9.6 Pavement markings	8.2 Linemarking bicycle facilities
Landscaping adjacent to bicycle facilities		8.3 Landscaping adjacent to bicycle facilities
Drainage of roads with bicycle facilities	6.3.8 Superelevation, crossfall and drainage	8.4 Drainage of bicycle paths and on-road bicycle lanes
Barrier fencing and railings	7.6.2 Fences and batters 6.7.3.2 Holding rails	8.5.1 Barrier fencing for off-road bicycle paths 8.5.2 Use of holding rails
Lighting	6.9 Public lighting of paths	

This section deals with issues relating to the quality of the physical riding environment. Bicycles as vehicles need a very good quality surface to operate safely and efficiently. They are much lighter, have narrower tyres and little or no suspension compared to motor vehicles. Small details such as cracks, concrete road joints and the smoothness and cleanness of the kerbside lane may not much affect the handling of a motor vehicle, but can cause great difficulties for the bike rider. If a bicycle path or bicycle lane has a poor quality, badly maintained or glass-strewn surface, riders will often prefer to ride in the adjacent road lanes, rather than negotiating the hazards of the bicycle facility.

8.1 Surface treatments for bicycles

The provision of a good riding surface for bicycle riders is a critical factor in ensuring safe and comfortable riding conditions. This requirement applies equally for on-road as well as off-road bicycle facilities.

8.1.1 Surfaces for off-road paths not in road reserves

Technical advice on suitable surface treatments for off-road paths is provided in *Austroads Guide to Traffic Engineering Practice, Part 14 – Bicycles*, (Section 8.2, Construction and Maintenance of Paths and Section 8.5.2, Pavements for Bicycle Paths). The information and recommendations provided below are additional to that advice.

Table 8.2 provides an overview of path materials and their relative costs, both in the short term and long term. However, local variations need to be taken into account when considering the Table. In urban situations asphalt or concrete are the preferred path surface materials because of their proven performance and resistance to slipping and skidding in wet conditions. If a path is to be surfaced in any other material it should be tested using a Standard Pendulum Test for slip and skid resistance.

Asphalt surfaces

Asphaltic concrete pavement material is the riding surface most preferred by regular bike riders as it provides a smooth, comfortable and jolt-free riding surface. As asphalt is a flexible pavement material, the riding surface can rapidly deteriorate if not properly prepared and laid. Spreading and subsequent cracking of the pavement surface due to the lack

Table 8.2: Life cycle costs for path surface materials.

Material	Construction cost[1]	Annual maintenance costs[2]	Life cycle costs[3]	Environmental impacts
Decomposed granite	$105,000	$27,000	$391,000	Reduced run-off and visual intrusion
Asphalt/ bitumen	$120,000	$3,000	$152,000	Visual intrusion due to path width
Concrete	$195,000	$1,500	$210,000	Visual intrusion due to path width and colour
Boardwalk[4]	$1,200,000	$2,000	$1,221,000	Visual intrusion varies depending on location
Fibreglass reinforced plastics[5]	$900,000	$2,000	$921,000	Reduced visual intrusion depending on colour and width. minimal run-off

Notes

1. Assuming a 20 year period, 3.0m wide path, 1km, no structures.
2. Assuming regular periods of significant rain or flooding requiring 30% replacement of surface annually.
3. Alternatives such as bluestone and limestone were also considered but there were concerns about leaching effects; shellgrit is widely used in the Netherlands as a surface material for pathways through forested areas but is not commonly used in Australia.
4. For use in special areas where constraints exist.
5. For an example of this material used as decking over disused rail tracks on the Meadowbank Rail Trail bridge see Photo 8.3 in these Guidelines.

Figure 8.1: Pavements for off-road bicycle paths.

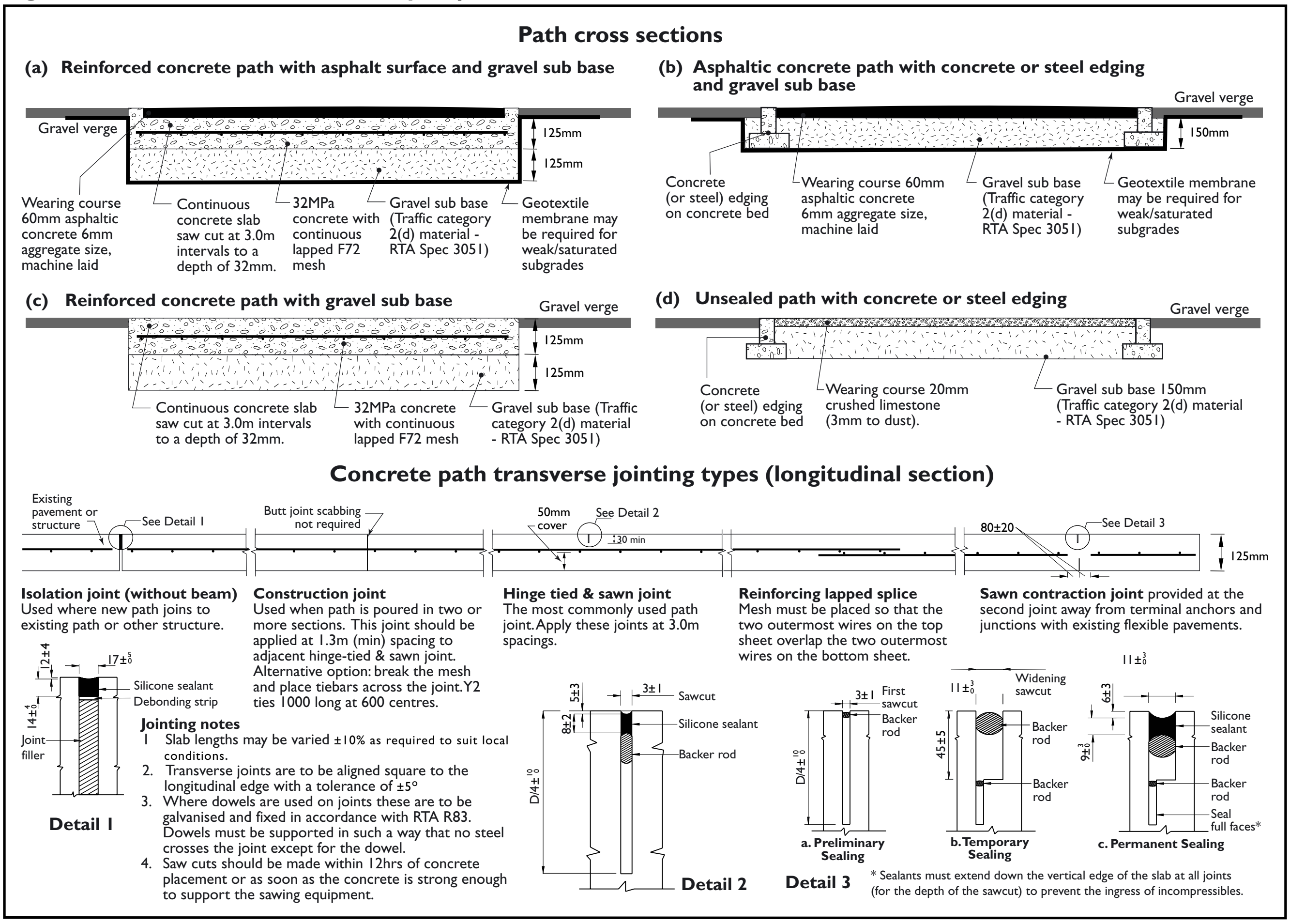


Photo 8.1 (Left top): Example of a reinforced concrete path with an asphalt wearing course. Running track adjacent is compressed granite with concrete edging. The Bay Run Cycleway, King Georges Park, Rozelle.
Photo 8.2 (Left bottom): Example of a reinforced concrete shared path. This path has been continuously poured with transverse saw cut contraction joints at 3m intervals. Broomfield St, Cabramatta.
Photo 8.3 (Below): An example of synthetic bridge decking (with non-slip, slotted surface) laid directly over existing rail tracks. Meadowbank Cycle/Pedestrian Bridge, Parramatta River, Rhodes.

of edging or kerbing, inadequate base material, or ground instability are the most common forms of deterioration. Figure 8.1 provides an updated version of Figure 8-8 in *Austroads – Part 14*.

Asphalt paths usually require more maintenance than reinforced concrete. Mainly for this reason, reinforced concrete is preferred by councils and other path construction authorities, even though the construction costs are higher. Asphalt is, however, easier to repair and restore to optimal condition if the path surface is to be dug up at any stage to replace or repair pipes, cables or other services located below.

Bitumen seal surfaces

When sprayed bitumen, followed by a layer of single-sized chippings, are applied to gravel pavements, it is important that all excess and loose material be brushed off, or removed with a suction sweeper. Loose stone chippings can present hazards to cyclists, by increasing the chance of skidding, or by having material thrown up into a rider's face or eyes.

Concrete pavements

From a construction and maintenance point of view, reinforced concrete is the off-road path material preferred by most councils and other asset construction and maintenance authorities. Advanced construction techniques, particularly in the development of jointing methods, has resulted in path surfaces which are comfortable to ride and virtually free of the regularised bumping and jolting produced by poor surface finishing and levelling, ill-made expansion jointing and random cracking caused by insufficient reinforcement.

Even though concrete paths have better resistance to damage from tree roots, close plantings by certain species can lift even thick paths especially if the damage occurs near a joint.

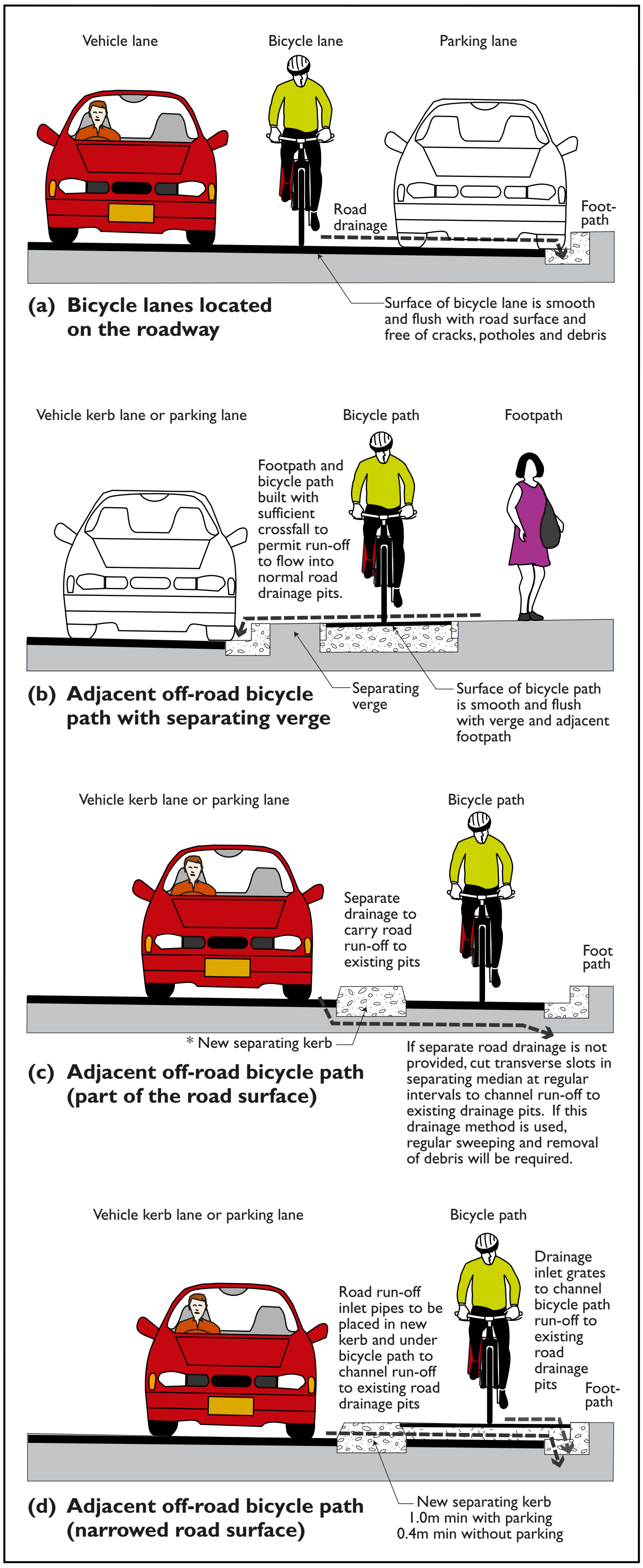
The common problem of cracking and edge deterioration caused when the path is used by park maintenance motor vehicles has largely been overcome by upgrading path construction standards to take light commercial vehicles. If sections of paths are to be used by heavy vehicles, path thickness, sub-grade material and the amount of reinforcing used should be increased to withstand vehicle loadings.

Unsealed surface treatments

In certain rural situations, such as multi-use recreational pathways and rural rail trails, an unsealed path surface may be appropriate. The choice of a surface material which is always firm, well bound and drains effectively, is critical in the provision of a comfortable and safe riding surface. Crushed limestone chips or decomposed granite have good binding and draining properties and can be used to produce successful unsealed path surfaces.

When paths are only used by bicycles, the constant wearing and rolling of their tyres creates a smooth wide groove or pad, which, if adequately drained, will produce a very good long wearing riding surface. When paths are used even occasionally by vehicles, heavily loaded walkers and horses, this pad is damaged and rutting and potholing occurs. It is therefore important to prohibit motor vehicles and to provide a separate space for horses if necessary. Where this type of use is to be permitted, a regular inspection and maintenance program should be carried out to repair path surface damage, especially after periods of prolonged wet weather.

Figure 8.2: Pavements for bicycle lanes or paths.



Timber and synthetic bridge decking

Section 8.5.3 of *Austroads – Part 14* provides advice on the hazards to cyclists of longitudinally planked timber bridges. For new bicycle bridge deck construction a number of timber and synthetic materials are now available, which provide good surface adhesion and a smooth continuous surface with minimal gaps.

Photo 8.4: Example of concrete road jointing and bicycle shoulder lanes. Edgecliff Rd, Bondi Junction.

Photo 8.3 shows a refurbished rail bridge, where special slotted planking made of a resin based plastic is laid directly on top of the steel rail tracks. The planking is coated with a low slip material and provides a very smooth riding surface.

Lightweight structures made from laminated timber beams with decking constructed from treated marine plywood offer an appropriate and low cost method of bridging for bicycle-only and shared pathways. A low-skid surface treatment is recommended on all smooth finished timber surfaces such as marine ply and plastics/composites.

8.1.2 Surfaces for bicycle paths and lanes in road reserves

Successful on-road provision for bicycle riders requires a greater attention to detail than is usually necessary for motor vehicle provision. Slotted drainage grates, longitudinal jointing cracks on concrete roads and steep drop-offs on the edges of the pavement surface can present severe hazards to the rider which may even affect their stability.

For technical advice on suitable surface treatments for on-road bicycle facilities see *Austroads Guide to Traffic Engineering Practice, Part 14 – Bicycles*, (Section 8.2, Construction and Maintenance of Roads and Section 8.5, Surfaces for Cycling).

Asphalt bicycle paths and lanes

Asphaltic concrete is the surface material preferred by cyclists for on-road bicycle lanes and off-road paths within the road corridor. Figure 8.2 shows typical cross sections for bicycle lanes and paths adjacent to roads.

Bicycle lanes on concrete roads

Special care should be taken when fitting bicycle lanes to concrete roads. Older concrete roads often have enlarged and damaged expansion jointing and require some surface preparation and remedial work before bicycle facilities can be fitted. Large gaps can be filled with a flexible material and the surface overlaid with a wide bituminous textile material to provide a level riding surface.

A key issue in the marking of bicycle lanes on this type of road is the positioning of the lane lines in relation to the road jointing. It is often preferable to paint the line on the road joint so the bicycle rider is not forced to ride along this joint when occupying either the bicycle lane or the outside edge of the adjacent road lane.

Concrete roads, which have been overlaid with asphaltic concrete or other bituminous road surfacing, often develop cracking along the underlying pavement joints. These gaps and cracks should be filled, so that the surface is brought back to a smooth, flush condition.

Sealed shoulder surfaces

When bicycle facilities are provided in road shoulders, the road surface should be consistently smooth and high quality across the full width of the sealed pavement. When existing road shoulders are resheeted, care should be taken to ensure that any build-up of pavement material does not create a drop-off at the edge.

Concrete block and brick paved paths

Though concrete block paving has been widely used by authorities in Europe, it is no longer favoured as a surface material for bicycle paths. Concrete or brick pavers laid on sand or earth provide a poor riding surface even when well laid. This type of surface settles unevenly and is easily damaged by motor vehicles illegally driving on, or overparking the path.

Where either separated or shared bicycle path facilities are to be installed along existing sections of brick or concrete block paved footpath, it is preferable to use a new asphaltic concrete or reinforced concrete surface for the new path, as this will provide a good delineation of the facility and provide a safer, more comfortable riding surface for the riders and walkers.

Block paving should only be considered for shared paths for moderate use where a visual message is needed to alert riders to pedestrian traffic. A high quality sub grade is needed to ensure an even riding/walking surface.

Location of services under paths or lanes

Bicycle facilities located either off-road adjacent to the kerb, or on-road in the kerbside lane are sometimes subject to disruption and damage by utility companies and authorities when accessing their pipes, cables or ducts. In the long term it is better that services not be located under bicycle paths or lanes. To ensure that this is achieved the following is recommended:

Photo 8.5: Example of green pavement colour used to mark a bicycle lane. Miller St, North Sydney.

- Path (asset) authorities should organise consultation between the various utility companies and authorities to develop a structural management program for services lying under paths. An aim of this program is to ensure that any programmed new or refurbishment work is done at the same time avoiding the need to repeatedly dig up the path (refer to the *Streets Opening conference Information Bulletin on Codes and Practices,* IPWEA 1997 for methodology);
- Removal, shifting of, or repairs to service pits and manhole covers (so that they are not aligned to the path most commonly tracked by riders) should be planned as part of any excavation of services located below bicycle facilities;
- The path-owning authority or council should oversee the accurate repaving of the path or lane after the work has been completed; and,
- Path-owning authorities or councils should take any opportunity during major constructional changes or realignments of the roadway to relocate services at minimal cost

8.1.3 Use of coloured pavements

Coloured surface treatments have been recommended in a number of treatments in these Guidelines to improve the visibility of the bicycle operating area in complicated road environments and to mark the preferred path through complicated intersections. The RTA has adopted green as the colour for use on such bicycle facilities.

In the absence of specific recommendations within these Guidelines, the approval of the RTA General Manager, Bicycles and Pedestrians should be sought on the use of green coloured pavement to mark bicycle facilities.

General considerations

Austroads Guide to Traffic Engineering Practice, Part 14 – Bicycles (Section 9.7, Pavement Surface Colour), provides general background information on this issue. Recommendations for the specific use of green surface pavements on bicycle facilities throughout NSW are outlined below.

- The principal use of green coloured pavement is to improve the visibility and legibility of bicycle facilities that are defined by normal regulatory means (signs and linemarking), or to mark a recommended path or holding space for bicycle riders in, or through, complicated intersections. Used on its own, it is advisory only and does not require compliance by either the rider or other road user (ie it does not define a regulatory bicycle lane or path – that is done by signs and linemarking);
- Green coloured pavement should be used carefully. Its impact and ability to highlight bicycle operating space is diminished if used indiscriminately; and,
- It is predominantly used for on-road marking, however, it can be used on off-road paths if desired by the asset-owning authority as a visual enhancement in environmentally sensitive areas. It should not be used on shared paths as the green colour can only be used to indicate exclusive use by bicycle riders.

Recommended applications

Green surface colouring is recommended to improve visibility and legibility of regulatory bicycle facilities, where the application of distinctive surface colouring is considered necessary to improve the operating safety of the facility. This applies particularly to facilities which permit cyclists to operate in ways different to other traffic such as:

- Contra flow lanes, peak period bicycle lanes adjacent to peak period bus lanes, bypass bicycle paths at bus stops, alongside kerbside loading zones and on bicycle lanes through car parks. Green surface colour can also be used to improve visibility of bicycle lanes and bicycle shoulder lanes where both motor vehicle and bicycle rider volumes are high, and risk of conflicts is considered great;
- To indicate a path for bicycles in mixed-traffic streets and at constructed road narrowings (ie mid block slow-points and street thresholds) where route coherence is very important.
- To mark a recommended path through an intersection but only when the bicycle facility has priority over traffic movements from other directions; and,
- Inside head start, expanded, right-turn and hook-turn storage boxes at busy intersections where bicycle turning movements are significant.

Where green surfacing should not be used

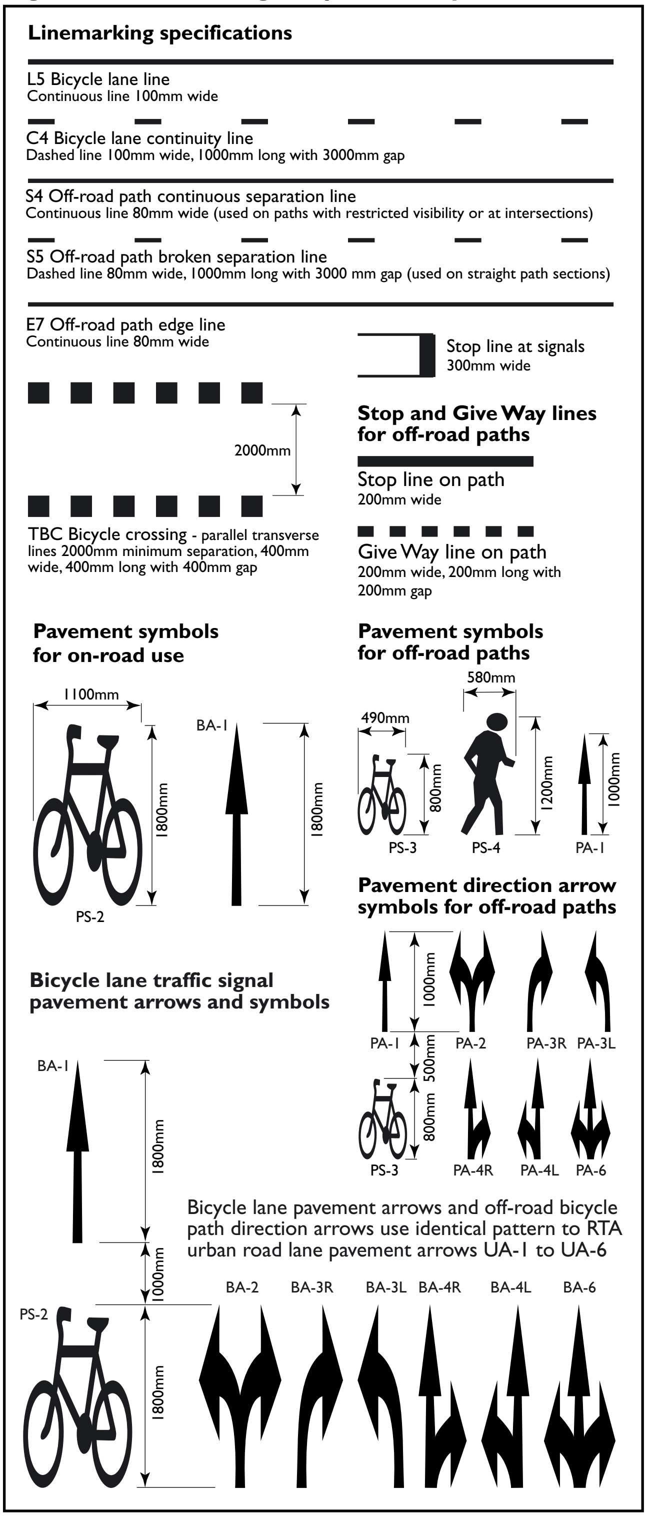
Green surface colouring should not be used when its use, in conjunction with linemarking and/or pavement symbols, is liable to misrepresent the facility or its legal use, ie: where the mixture of colour, lines and pavement symbols creates a hybrid facility, which *looks* like it has priority when it legally does not.

8.2 Linemarking bicycle facilities

The linemarking layouts for bicycle facilities have been illustrated in preceding sections of these Guidelines. This section deals more generally with linemarking for bicycle facilities and includes recommendations for both on-road and off-road marking materials and line dimensioning.

Photo 8.7: Linemarking of an off-road shared path. Anzac Bridge Cycleway, Pyrmont.

Figure 8.3: Linemarking and pavement symbols.



Austroads Guide to Traffic Engineering Practice, Part 14 – Bicycles (Section 9.6, Pavement Markings), provides linemarking guidance for both on-road and off-road facilities. The information provided below is additional to this guidance.

The main linemarking types are shown in Figure 8.3. Elements shown in this diagram are also included in Figure 3.5 as a general key to linemarking and regulatory signage used in these Guidelines.

Application

All on-road bicycle route facilities should be fully linemarked for good route coherence and connectivity. The minimum linemarking for dual-direction off-road paths is a dashed S5 centre line on straight sections becoming a S4 solid line on curves, steep gradients or where visibility is restricted.

Where off-road bicycle paths or shared paths cross roadways the TBC markings should be used. TBC lines should only be used where the crossing has priority over the road. This priority should be supported by regulatory devices such as Give Way signs and holding lines on the roadway.

Comments

Exclusive on-road bicycle lanes are defined by a combination of regulatory signage (which regulates the facility) and linemarking (to determine the extent of the facility). Other facilities are defined by linemarking alone. For example, bicycle shoulder lanes require no regulatory signage and are defined by linemarking alone: a solid white L5 edge line, which determines the extent of the road shoulder; and a dashed C4 line, which marks the extent of shoulder motor vehicle parking.

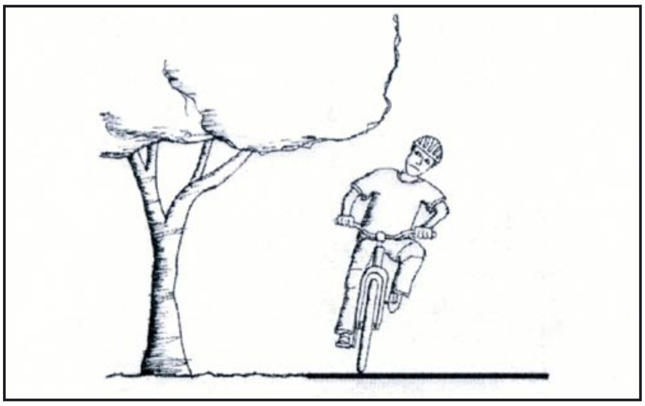
Edgelines are recommended for use on all off-road paths which are part of regional and local bicycle network routes. Stop and give-way holding lines should be used on off-road bicycle paths and on-road lanes in conjunction with regulatory signage at all bicycle network intersections.

8.3 Landscape design

Well designed and executed landscape adds to the comfort of riders and increases the enjoyment of bicycle paths through the creation of shade, reduction in temperatures, hindrance of winds and the creation of a more pleasing natural environment surrounding the facility. Landscape which is unplanned or poorly executed can often have a negative impact on path use through: reduced sightlines and side clearances; and, reduced general supervision of the path which creates a community perception of an area with poor personal security.

Landscape design for off-road bicycle paths should take into full account *Austroads Guide to Traffic Engineering Practice, Part 14 – Bicycles* (Section 6.3.5, Clearances and Section 6.3.7, Sight distance). All vegetation should be planted to within the tolerances set out in those sections, as applied to fully grown plants. At times when this is not done it can lead to increased maintenance costs or a compromised facility eg diminished safety and a deteriorated riding surface.

Figure 8.4: Landscaping should be planned to take into account the size of trees and shrubs when fully grown.



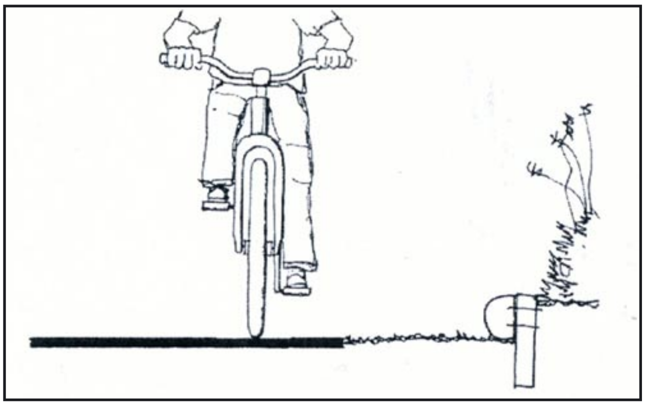


Figure 8.5: Clearances should be maintained on path edges to provide a safe and level run-off area.

Sightlines, visibility and clearances

Good sightlines and visibility are extremely important for the safety of both cyclists and pedestrians using a shared path. As cyclists are capable of travelling at speeds in excess of 50km per hour, clear sight distances are necessary to prevent collisions. Crests, curves, and intersections are all problematic areas where collisions may occur. Planting in these areas should always consider sight lines.

Cycle path edges should be level with the path and constructed of bound material that will not move onto the path. Materials such as grass or compacted gravel are appropriate and loose materials avoided. A clear zone adjacent to the edge of the path allows riders room to use the full width of the path pavement. In the event of a sudden erratic movement by a walker or animal a wide well maintained and level shoulder allows the rider to safely move off the path to take evasive action without losing their balance or stability. Different surface levels should be avoided as a sudden drop off the edge of the path has the potential to cause the rider to lose control.

When planting adjacent to bicycle paths it is always important to consider the height and width of trees and shrubs at their full maturity, to ensure that they will not grow across path and create hazards.

Frangible planting

The use of frangible plant species and structures adjacent to bicycle paths is an important safety consideration. Edges of bicycle paths should ideally be kept clear of hard, woody, or prickly vegetation or hard objects such as rocks. Using soft plant species can help prevent injury if a rider loses control and leaves the path.

Figure 8.6: Frangible plantings beside paths can often provide an important safety benefit.

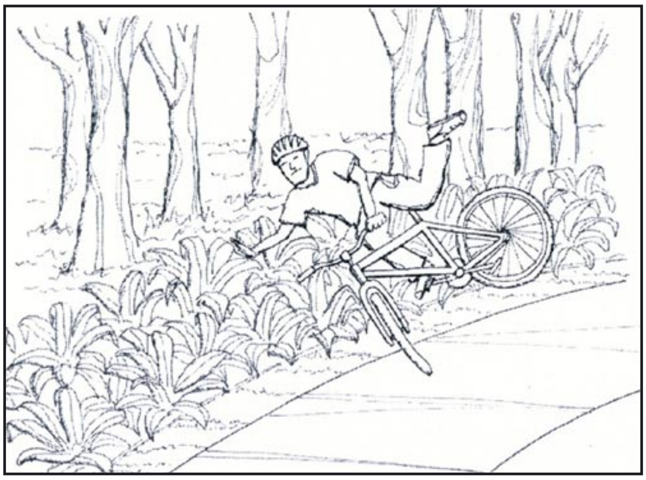


Photo 8.8 Example tree root damage to an off-road path. Near Malabar Rd, Malabar.

Tree root damage

Tree roots can badly damage the riding surface of off-road bicycle paths. Vegetation which is allowed to grow tall and wide close to bike lanes and paths reduces sight lines and creates side clearance hazards. Tree/shrub plantings for bicycle paths should be planned, taking into full account the fully grown height of the tree and shrub species utilised. If the growth characteristics of any plant species is unknown it should not be used.

Research has been undertaken by the RTA into the types of tree species most likely to cause path damage if planted within close proximity of bicycle paths (refer to the *RTA Roadscape Guidelines* 1998). Weeds or species which are known to be invasive should also not be used near paths.

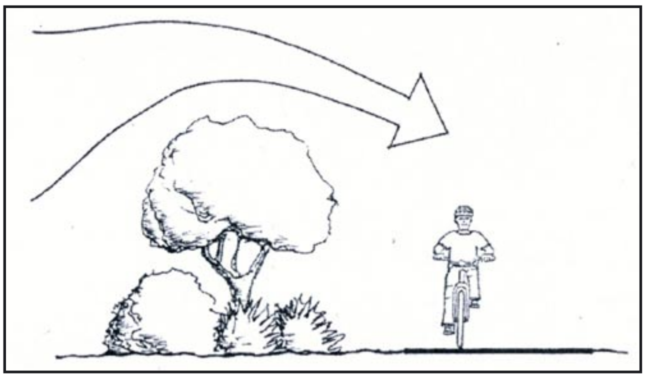
If bicycle paths are to be located in areas where damage from existing trees is anticipated, damage can be minimised or avoided by:

(a) using plastic root deflectors to help control the direction of the roots,

(b) using a thin strip of concrete to act as a root deflector, or,

(c) using more ridged pavements such as concrete which has a higher resistance to tree root damage than asphalt.

Figure 8.7: Well planned and executed landscaping can provide practical benefits to path users such as providing wind breaks and shade.



Public safety

When designing the landscape for off-road paths, public safety issues should always be considered. To create an open easily supervised environment which discourages anti-social behaviour, plantings should be carefully placed so as not to constrain or hide the path from public view. Landscape which aims to open up the path to views of the surrounding locality and to create good sightlines for riders and walkers is more likely to diminish community concerns that the path may be unsafe or may harbour illegal behaviour.

Functional landscape design

The landscape adjacent to off-road bicycle paths can provide important functional benefits to path users such as: wind breaks, screening of adjacent land uses, the creation of physical barriers, noise and climate control, erosion control, and visual delineation of the direction of the path.

Wind Breaks Cyclists are easily affected by wind. Cycling into a strong head wind requires greater energy and creates more discomfort to the cyclist. The design of planting to either block or direct wind in relation to the bicycle path can dramatically alter the comfort and ease of cycling.

Visual Screening Planting can be used as a visual barrier to screen the bicycle path from adjacent land uses. Trees and vegetation can offer a more aesthetically pleasing setting for the bicycle path.

Psychological Barriers Planting can form a psychological barrier in areas where certain types of land uses need to be delineated. Vegetation has the ability to be designed as a physical barrier. This can deter cyclists from straying off the path without needing to construct a fence.

Noise Control Vegetation has the ability to reduce noise and also psychologically separate the source of the noise from the viewer. Soft planting absorbs sound, hard objects such as wall deflect sound.

Climate Control Vegetation can provide shade and protection from the wind. This has the ability to create a more comfortable cycling facility.

Ecological Use of Planting Bicycle path easements can be used to regenerate natural bushland and hence enhance the ecological quality of the local area. This provides a safe area for fauna. Vegetation can also help to stabilise the soil and prevent erosion.

Aesthetic Use of Planting Planting is important to present a pleasing setting for cyclists, and pedestrians. A well designed facility will encourage more members of the community to use the bicycle path. Opportunities should be taken to create gateways, corridors, natural settings, or formal landscapes along the bicycle path.

Landscape maintenance issues

Ideally, the planting surrounding bicycle paths will need very little or no maintenance. Planting of a more natural character tends to require less maintenance than planting of an artificial character. Common maintenance problems consist of, pruning overhanging vegetation, removal of leaves and bark build-up on paths, and the repair of pavement damage from tree roots. Maintenance of the path surrounds should be carried out regularly and included in parklands maintenance tasks.

8.4 Drainage for bicycle paths and on-road bicycle lanes

Drainage issues for off-road bicycle facilities are covered in *Austroads Guide to Traffic Engineering Practice, Part 14 – Bicycles* (Section 6.3.8, Superelevation, Crossfall and Drainage). Where bicycle paths are to be located off-road and adjacent to roadways, drainage should be designed to direct run-off efficiently into existing drainage pits and channels.

Figure 8.2 shows recommended drainage schemes for a number of on- and off-road bicycle facilities. Where roads are narrowed down to create additional off-road bicycle paths, adjacent existing road drainage pits and pipes can continue to be utilised by installing specially designed rectangular section pipes under the surface of the path to carry run-off from the new edge of the road into the existing drainage pit (see Figure 5.9d in these Guidelines).

8.5 Fencing and railings

Barrier fencing is usually provided where a path needs to be physically segregated from an identified hazard such as a high speed road or on a bridge. The recommendations in the following section are additional to the advice provided in *Austroads Guide to Traffic Engineering Practice, Part 14 – Bicycles* (Section 7.6.2 Fences and Batters).

8.5.1 Barrier fencing and off-road paths

In accordance with broad road system principles, barriers and fencing may be erected parallel to off-road bicycle paths and shared paths where there is a safety risk. The critical issues are the design of the barrier or fence and its location both to the path and to the adjacent roadway or hazard. A poorly designed or wrongly located fence can sometimes present a greater hazard to riders than the dangerous conditions found outside the fence.

Application

Barrier fencing and railings may be erected to segregate riders from hazards such as precipitous edges, high speed roadways, drains, culverts and railway infrastructure. *Austroads – Part 14* recommends that low treated pine log, chain mesh and post and wire fences not be used within 1.0 metre of a bicycle path or shared path. Figure 8.4 shows the recommended location of barrier fencing adjacent to roads and other potential hazards.

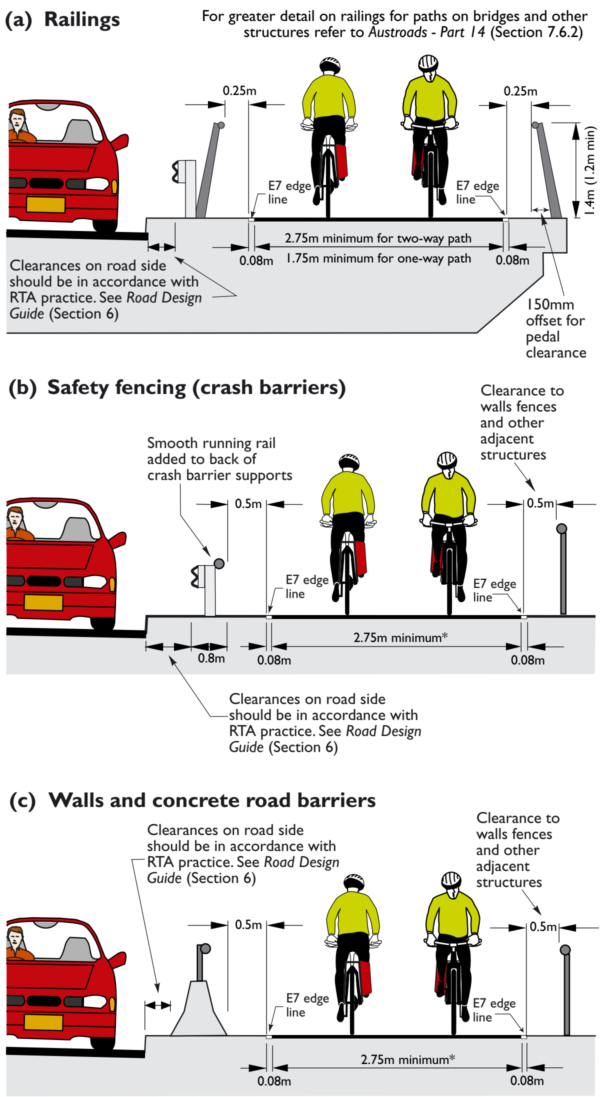
Design notes

Barrier fencing should be always designed to present a smooth running edge to riders. Fences made up predominantly of longitudinal members are preferred and increase the ability of the rider to recover stability in the event of a run-off incident.

Comments

When off-road bicycle paths are located adjacent to road barriers, the rear barrier support posts facing the path should be faced with a smooth running rail located to avoid snagging of pedals or other parts of the bicycle or rider. All path barrier fencing should be flared out at either ends and any protruding longitudinal members finished so that it is physically impossible for a rider to hit the raw end of the member.

Figure 8.8: Barrier fencing clearances for off-road paths.



Notes
*Widths given above are for two-way paths constrained by fences and other barriers on both sides. Minimum width for a one-way path with fencing on both sides would be 1.75m.
If path width is constrained and at minimum width path narrowing signage should be erected in advance of narrow section and reflective tape fitted to side fence vertical supports.

Photo 8.8: An important detail in finishing bicycle routes is this railing and facing treatment backing an existing road barrier. Pevensey St bridge, Canley Vale.

8.5.2 Use of holding rails

Austroads Guide to Traffic Engineering Practice, Part 14 – Bicycles (Section 6.7.3.2) provides guidance on the use of holding rails at intersections. Though these have been provided as a convenience for riders waiting at intersections, their application and use often present a number of disadvantages both to users as well as to facility designers and providers. The major difficulty in providing holding rails is in their safe placement.

When placed on, or near to a path, holding rails are invariably sited within the normal clearance zone required for safe operation of the path and can create additional obstruction to riders in situations where critical manoeuvring is often needed. Even experienced riders can have difficulties grabbing onto rails especially when decelerating to a full stop. A misjudged transfer of hand, from handlebars and brake levers to holding rail, at a crucial moment, can result in a poorly judged stop or a destabilised contact with the rail.

Holding rails also position riders poorly at intersections: off to one side instead of in the centre of their lane. Though in theory holding rails are said to enable a smoother start from a full stop position, it is often not the case as many riders erroneously use their hold on the rail to push off rather than concentrating all their bodily power through their legs. The momentary transfer of hand from rail to handlebars can be destabilising for less experienced riders and can provide a momentary distraction at a time when the rider should have all their attention focussed on the intersection crossing.

Application

Holding rails are not recommended for use in NSW, unless specifically sought by bicycle riders or their organisations. Due to safety implications discussed above, they are specifically not recommended at the following locations:

- traffic signalised intersections, particularly when the rider has to press a button to activate the crossing lights;
- on traffic islands;
- within 300mm of the edge of a bicycle path or shared path or within 600mm of a road kerb; and,
- at or on the approach to a path narrowing or vehicle entry barrier.

When located at intersections between bicycle paths and roads, holding rails should be positioned to always place the leading rider at the give way or stop holding line on the path. Visibility from this location should be clear throughout the intersection and all its approaches.

Holding rails should always be painted white and fitted with white and red reflective tape as per Figure 6-42 in *Austroads – Part 14*.

9. Signage and network information

Table 9.1: Scope of Section 9.

Type of facility	Coverage in *Austroads - Part 14*	Coverage in these Guidelines
Signage	9.2 Regulatory signs 9.3 Warning signs 9.5 Other useful signs 9.4 Guide signs	9.1.1 Regulatory signage 9.1.2 Warning and advisory signage 6.6 Shared path advisory signage 9.1.3 Directional and route marking signage
Network information		9.2 Network information and mapping

This section covers the signing of bicycle network facilities, which provides the critical overlay of the physical pavement regulating the system and making it safe and easy to use.

9.1 Signage for bicycle networks

The three main functions of signage systems for bicycle network facilities are:

- to regulate and determine the type of facility within the context of the overall road system;
- to warn users of identifiable potential hazards within the riding environment; and,
- to assist users to find their way around the network.

Regulatory signs are contained in the NSW Road Transport Legislation which includes the *Australian Road Rules*. The principal reference for the use of bicycle related regulatory and warning signs is *Australian Standard AS1742.9 – Manual of Uniform Traffic Control Devices. Part 9, Bicycle Facilities. Part 2, Traffic Control Devices for General Use* is also relevant to signage for bicycle networks.

Section 9.1.3 of these Guidelines, which covers directional and route marking signage, provides recommendations for a system of uniform directional signage for regional and local bicycle route facilities within NSW.

Signs at, or in, the vicinity of intersections should always be coordinated with other street furniture to ensure that: intersection sight distances at critical locations are not affected; the signs themselves are not obscured by other street furniture; as much as possible made of multiple supports so that unsightly clutter is kept to a minimum; signs and supports are located sufficiently clear of kerbs to avoid being struck by turning vehicles, especially cornering bicycle riders and large vehicles; and, not located so as to obstruct pedestrians and wheelchairs etc.

9.1.1 Regulatory signage

It is often the combination of regulatory signage and linemarking (see Figure 8.3) which defines the type of bicycle facility provided. Figure 9.1 shows the four principal signs and optional supplementary plates used to define some of the seven types of bicycle facilities covered in Section 4 and those elsewhere in these Guidelines.

Regulatory signage is always used to define the start of a facility. It is always best practice to carry bicycle lanes and paths right up to and through intersections to provide a complete network connection. The use of the END supplementary plate is only necessary if the facility is terminated mid-block, or at some other part of the road other than an intersection.

Some types of facilities defined in these Guidelines do not use bicycle specific regulatory signage (see: Figure 5.3, Bicycle Shoulder Lanes; Figure 5.7, Contra-Flow Bicycle Lanes: and, Figure 5.13, Mixed Traffic – Tight Profile). These facilities require linemarking and pavement symbols supported by general regulatory and warning signs at critical locations.

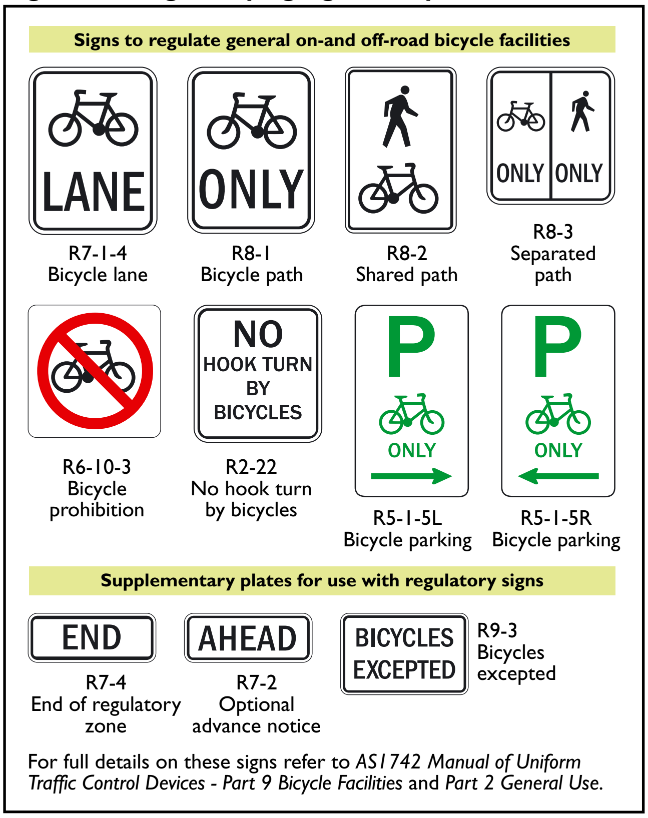
Application

All diagrams in this manual depict the typical regulatory signage required to define bicycle network facilities.

Design notes

Regulatory signs should be located so as to not conflict with other road directional signage, or create ambiguity at critical turning points or crossings. The precise location for regulatory signage should be adjusted to suit the design of the intersection/road to include the bicycle facility. The positioning of signs and the need for additional signs or

Figure 9.1: Regulatory signage for bicycle facilities.



delineating devices may be affected by the variations in layouts, particularly where there are curves and crests on any approach.

9.1.2 Warning, guidance and advisory signage

Yellow diamond shaped warning signs are used to alert riders to changed or potentially hazardous path or road conditions. This type of sign is similarly used to alert other road users of intersecting or merging bicycle movements.

Figure 9.2: Warning and guidance signage.

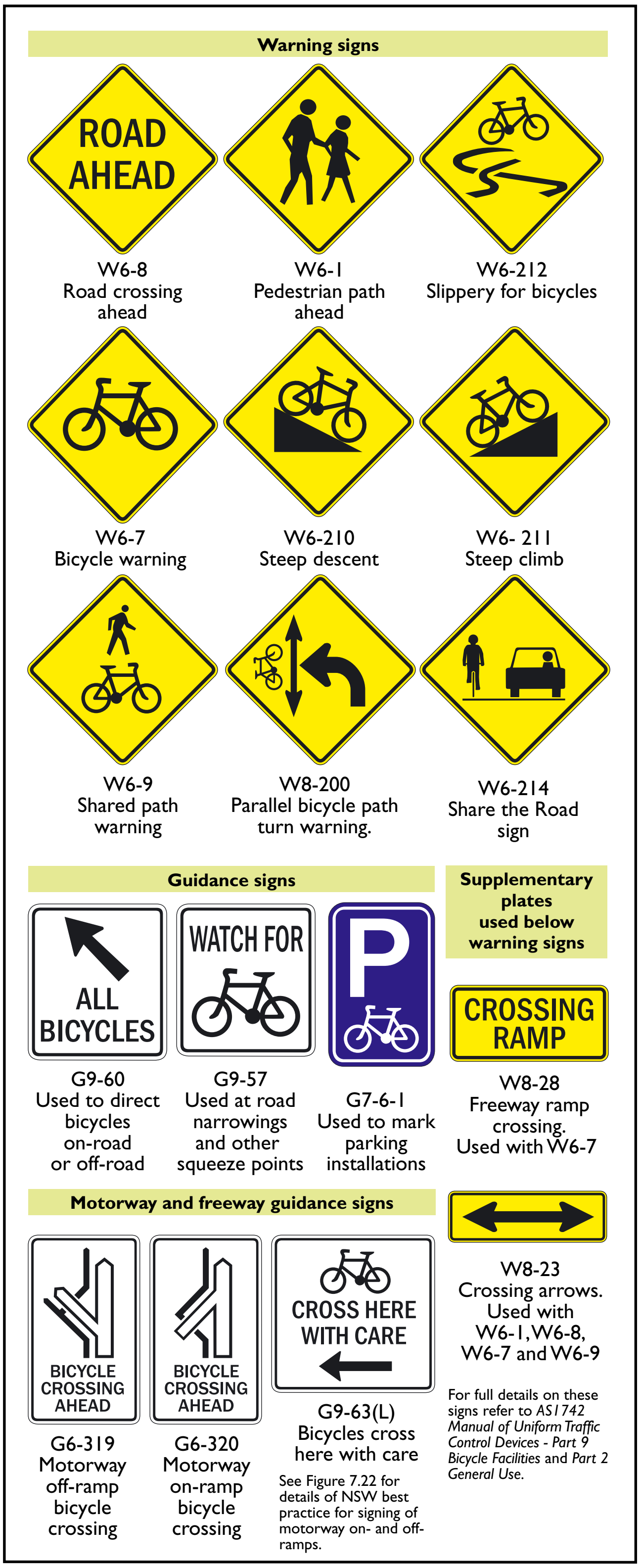


Figure 9.2 shows the most commonly used warning signs (and supplementary plates) for both bicycle network and general road network use.

Figure 9.2 also shows guidance signage to assist riders and to warn other road users of potential conflict situations.

Advisory signage to assist the safe use of shared paths is covered in Section 6.6 of these Guidelines. Figure 6.6 shows advisory signs currently in use on shared paths.

Application

All diagrams in these Guidelines depict typical warning and guidance signage recommended for use in relation to the provision of bicycle network facilities. Table 6.4 lists recommendations for a three level implementation process for shared path advisory signage.

Design notes

Warning and guidance signage should be located to provide advance indication of changed riding conditions or potential hazards. *Australian Standard AS1742.9 – Manual of Uniform Traffic Control Devices, Part 9 Bicycle Facilities* and *Part 2, Traffic Control Devices for General Use*, should be referred to for recommended siting distances where these are not provided in these Guidelines. The precise location for warning and guidance signage should be adjusted to suit the overall design of the intersection/road and bicycle facility.

9.1.3 Directional signage

The most important function of directional signposting is to help the users find their way around the system. Directional signposting also reinforces system connectivity and coherence and gives high visibility and recognition to the collection of through routes which make up any network.

In the modern traffic environment there are many directional signs provided for road users to guide them to their destinations. This general road and highway directional signage is usually attuned to motorised traffic and does not adequately serve the bicycle rider, when a separate or parallel bicycle network is in existence.

In order to avoid ambiguity and conflict for both motorised road users and bicycle riders alike, a completely independent system of signing should always be used.

Photo 9.1. Example of regulatory signage for bicycle lane at Birrell St, Bondi Junction.

Application

Australian Standard AS1742.9 – Manual of Uniform Traffic Control Devices, Part 2 Traffic Control Devices for General Use (Section 2.10 Guide Signs) should be used for general directional signage principles supplemented by the recommendations provided below. Figure 9.4 shows the recommended system of directional signage for marked bicycle routes within the network. Figure 9.3 shows the layout and placement of these signs at a typical intersection. For reasons of graphical clarity, directional signage has not been shown in the figures contained in these Guidelines, though in practice this type of signage should always be included in the overall signage system for bicycle route facilities.

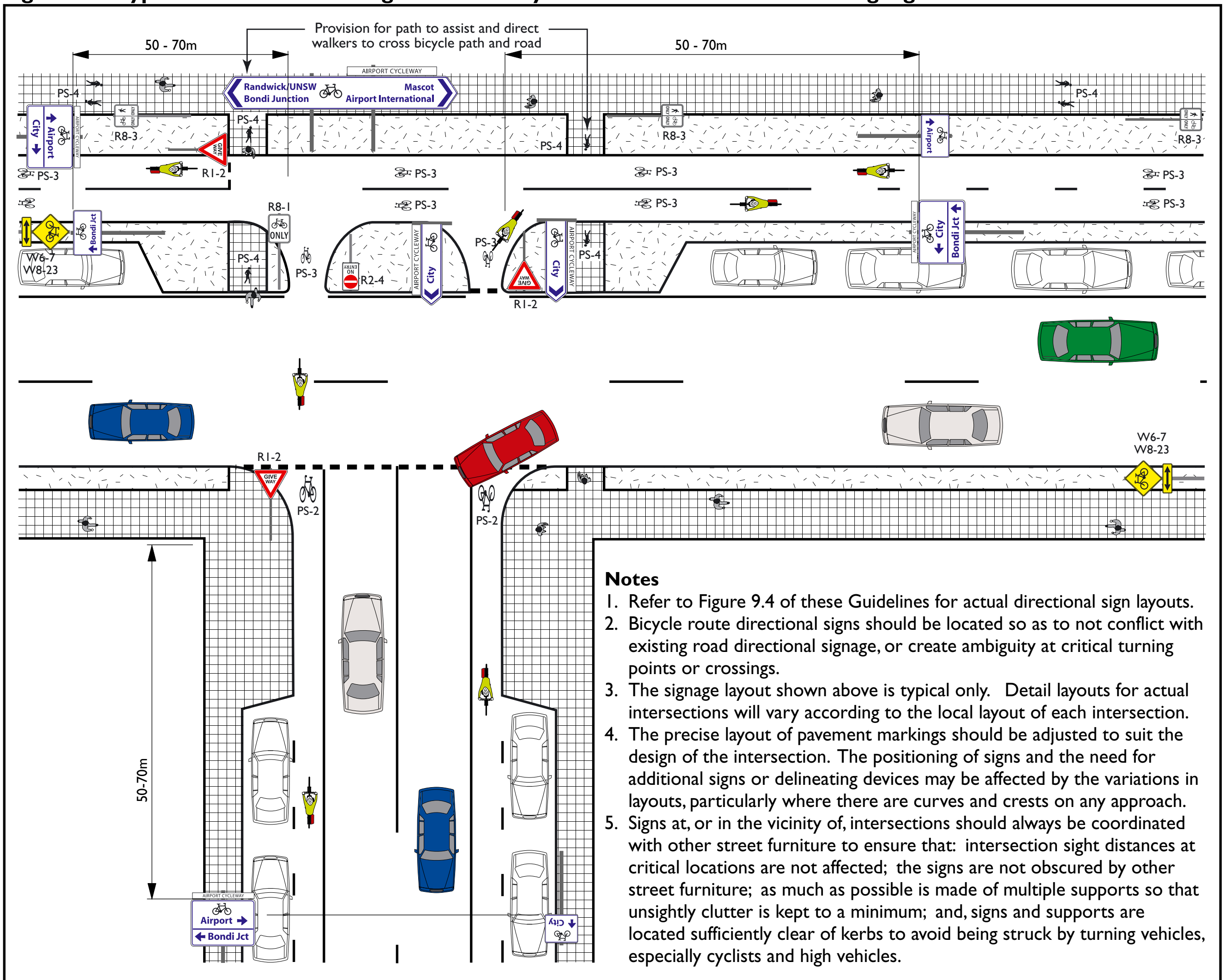
Design notes

At all intersections and other decision points, directional signage should be positioned so that bicycle riders can safely and comfortably follow their chosen route. The directional signage system should be closed. Once a destination has been used on a sign, it should appear on all subsequent signs, until that particular destination has been reached. Destinations mentioned on previous signs are therefore given priority and should appear in strict order with the closest appearing at the top of any sequence listing.

Photo 9.2: Example bicycle route directional signage. Meadowbank Cycle/Pedestrian Bridge, Rhodes.

The advice of the RTA Bicycle Network Manager should be sought to determine suitable destinations to be used in any route signage system. Destinations which should be signposted are all cities, towns and regional centres. Within urbanised areas sub-regional or district centres and the city centre should also be indicated along with identifiable city precincts; key public transport interchanges or branch line junctions and important recreational or other destinations

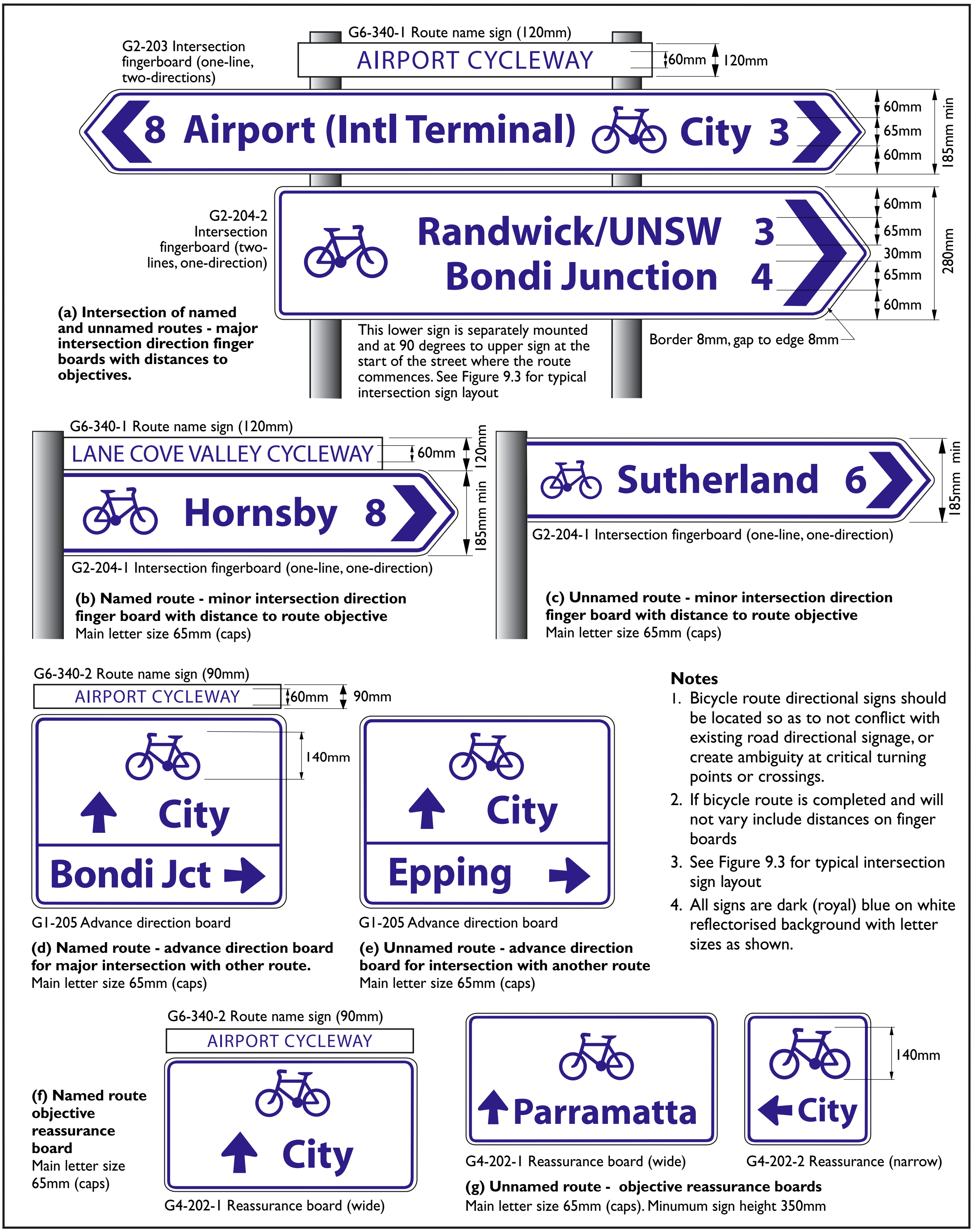
Figure 9.3: Typical intersection arrangement for bicycle network route directional signage.



Notes

1. Refer to Figure 9.4 of these Guidelines for actual directional sign layouts.
2. Bicycle route directional signs should be located so as to not conflict with existing road directional signage, or create ambiguity at critical turning points or crossings.
3. The signage layout shown above is typical only. Detail layouts for actual intersections will vary according to the local layout of each intersection.
4. The precise layout of pavement markings should be adjusted to suit the design of the intersection. The positioning of signs and the need for additional signs or delineating devices may be affected by the variations in layouts, particularly where there are curves and crests on any approach.
5. Signs at, or in the vicinity of, intersections should always be coordinated with other street furniture to ensure that: intersection sight distances at critical locations are not affected; the signs are not obscured by other street furniture; as much as possible is made of multiple supports so that unsightly clutter is kept to a minimum; and, signs and supports are located sufficiently clear of kerbs to avoid being struck by turning vehicles, especially cyclists and high vehicles.

Figure 9.4: Bicycle network route directional signage.



(major parks etc). Key centres should have priority in any signage system but where space permits other relevant and important destinations for bike riders may also be indicated. These may be: universities and educational institutions; hospitals; tourist attractions; bike parking stations; bike hire depots; shopping centres; sporting and recreational centres.

Indication of destination distances is important and can be either applied to fingerboard signs located at intersections or provided on destination reassurance boards located immediately following bicycle network junctions.

This distances stated on bicycle network direction signage are given in kilometres rounded up or down. The distances should be measured from the first signpost concerned to a point on the network route closest to the actual destination. For instance, a route indicating a particular town centre as a destination may not actually travel through the centre but deviate around it a short distance from it. In this instance distances should be measured to the intersection where the rider will need to leave the route to reach the actual town centre.

On proposing a system of directional signage, Council officers should consult with bicycle network officers of the RTA and adjacent councils to ensure a consistent, logical and usable set of destinations are selected for use. This is particularly important where a number of owning or operating authorities are involved.

Direction signage should be clearly visible in either day or night conditions. For this reason it is advisable to locate this signage under, or adjacent to, overhead lighting.

Street plans and network route plans can be very useful aids to navigation especially when placed at key entry and exit points to a built up area. These plans should be easily accessible from the bicycle route. If plans are located on a side path or rest area, they should be indicated with additional signs.

9.2 Network and route mapping

Accurate and comprehensive information is essential for the operation of any transport system. Bicycle route maps and network maps are an important tool to aid bicycle riders find their way around the network and to assist them to get safely to their destinations. Route and network mapping is also a good means of promoting use of the system and to encourage cycling within the community.

Application

Even when few route facilities exist, maps can be a good way of indicating routes with low traffic volumes suitable for cycling and short cuts not easily found without local knowledge.

The scope of route and network maps can be local or regional but should always adopt a network approach and aim to present through-routes and access solutions that will enable riders to use their bicycles comprehensively within the area covered.

Network maps can be made available in a number of easily accessible formats: sign boards can be erected at key route intersections, where a number of routes converge or at a prominent destination; maps can be downloaded in electronic format from web sites; and maps can be made available from bicycle shops, cafes and other prominent points of interest located along network routes.

Comments

Figure 9.5 shows an example of a bicycle network map which illustrates the key issues which bicycle network maps should always attempt to address:

- the two level bicycle network route hierarchy is depicted (regional routes and local routes can be indicated by using different colours);
- on-road and off-road route facilities are shown using a different line type;
- a whole network is shown so that riders may make meaningful trips around the system (incomplete sections should be clearly depicted to warn and direct users);
- the bicycle network is superimposed over a depiction of the existing road network which indicates the function of the road network (ie major roads are shown thicker than minor roads);
- all important destinations relevant to bicycle riders are shown; and,
- streets and roads used by bicycle network routes are named.

Graphical solutions for showing missing links in the system are very important to the user, as the network and its component routes are often incomplete at any one time.

Figure 9.5: Example of bicycle network mapping.

10. Maintenance and provision at worksites

Table 10.1: Scope of Section 10.

Type of facility	Coverage in *Austroads - Part 14*	Coverage in these Guidelines
Maintenance	8. Construction and maintenance	10.1 Maintenance of bicycle network facilities 10.1.1 Road/path defect reporting systems 10.1.2 Mechanical sweeping of bicycle paths
Provision for cyclists at worksites	8.4 Provision at works Appendix B - Signing and Delineation of Works	10.2 Provision for bicycle lanes at worksites

Photo 10.1: Inspection of an off-road path in Western Sydney by an RTA maintenance inspector.

Bicycles as vehicles are generally more susceptible to pavement cracking, gaps between road joints and the build up of debris than other types of vehicles. *Austroads Guide to Traffic Engineering Practice, Part 14 – Bicycles* (Section 8, Construction and Maintenance of Roads), covers the issues associated with bicycle path and bicycle lane maintenance. This section provides additional advice on the maintenance of off-road bicycle paths and on-road bicycle lanes.

10.1 Maintenance of bicycle network facilities

In order for paths and on-road bicycle lanes to deliver optimum level of service to riders, regular maintenance should be carried out. This is also important to preserve the substantial capital investment made in these facilities.

On bicycle routes, a regular program of sweeping and inspection for surface damage is advisable to ensure the riding surface is maintained in good condition. Landscaping and signposting should be inspected on a regular basis. At least once per year an experienced officer (see Photo 10.1) of the asset-owning organisation should inspect the structural elements of the route.

Quality assessments can be based on subjective or objective reports from regular maintenance and asset-owning technical staff or from user feedback. A number of Australian state authorities and councils have road/path defect reporting mechanisms in place which are either stand-alone (serving the bicycle network only) or integrated with general road defect reporting systems.

10.1.1 Road/path user facility defect reporting systems

While it is important for asset-owning authorities to plan regular maintenance checks of bicycle network facilities, management systems should also provide for the reporting of defects which develop on bicycle lanes and paths in between regular maintenance checks. Bicycle riders who use the network on a daily basis can be encouraged to participate in the upkeep of the network by notifying asset maintenance authorities of surface and other defects.

Figure 10.1 Sample bicycle facility defect report form

Bicycle Facility Defect Report

Location of bicycle facility or road defect

☐ Road ☐ Off-road path ☐ Other

Road or street name: ____________________

Suburb or locality: ____________________

Precise location on street or road *(house number, nearby landmark, power pole number, intersecting road and distance from it):* ____________________

Side of road/path or travel direction. ____________________

Type of bicycle facility or road defect

☐ **Road surface** (pothole, surface roughness or cracking, loose gravel, linemarking, excessive lip on kerb ramp etc)

☐ **Debris on the path or road** (glass, gravel, vehicle debris, fallen trees, overhanging branches etc)

☐ **Roadside/pathside furniture and fittings** (signs, guard fencing, holding rails, bridge railings, lighting etc)

☐ **Lights and crossings** (activation of traffic signals, visibility of lights, lamps not functioning etc)

☐ **Drainage** (water ponding, drainage grate, running water across path etc)

☐ **Squeeze points** (speed humps, chicanes, turn lanes etc)

☐ **Other -** please provide details below:

____

Comments or suggestions: ____________________

Defect reported by: **Date reported:** / /

Your name: ____________________

Address: ____________________

Locality/postcode: ____________________

Email address: ____________________

Phone (H): ( ) ____________ Phone (W): ( ) ____________

Application

Figure 10.1 shows a sample bicycle network hazard report form which is similar to forms issued by road authorities in West Australia, South Australia, Queensland and in a number of municipalities throughout the country. The RTA provides a similar service through its road hazard reporting telephone hotline.

Forms can be filled out and submitted through the authorities' Web sites or given verbally via an advertised road hazard reporting hotline.

Comments

It is essential that sound management procedures support this system so that the data submitted via these forms (including Web submissions and phone calls) is entered into the asset-owner's short term maintenance program and that critical defects are quickly identified, assessed and rectified through normal maintenance procedures.

10.1.2 Mechanical sweeping of paths

Regular sweeping of bicycle paths is essential if bicycle network facilities are to be maintained in good condition and provide a high level of service to the users. Where the municipal authorities have made substantial long term investments in bicycle network infrastructure, special mechanical sweeping machines have been acquired to undertake regular programmed maintenance of routes.

Application

Photo 10.2 shows a small mechanical sweeping vehicle which carries out regular sweeping of bicycle paths and footpaths. Where networks of mostly off-road paths have been developed authorities have found it necessary to invest in specialised machine of this type in order to clean paths not easily accessed by road sweeping vehicles.

This machine is less than 2.0m wide and is designed to operate on off-road paths. Network path terminal treatments, intersections and mid block sections should be designed in a standardised manner to permit easy access by this type of vehicle.

Photo 10.2: Bicycle path sweeping machine. Anzac Bridge Cycleway, Rozelle.

Comments

Bicycle network paths can be programmed to be swept on a regular cycle twice a month with extra sweeping required at specific locations due to broken glass from revellers, heavy tree leaf build up in Autumn and debris accumulation following storm activity.

10.2 Provision for bicycle lanes at worksites

Provision for the safe passage, comfort and convenience of bicycle riders should always be made where road construction and maintenance disrupts or severs existing bicycle route facilities. As bicycles need a smooth and even road surface to operate, roadworks can often add difficulties for riders regardless of whether they are on- or off-road.

Austroads Guide to Traffic Engineering Practice, Part 14 – Bicycles (Appendix B Signing and Delineation of Works) provides detailed advice on the provision for bicycle route continuity and rider safety at worksites. Recommendations provided below are additional to this advice.

Application

Figure 10.2 provides guidance for the diversion due to roadworks for on-road bicycle lanes in situations where both road traffic volumes and bicycle use are high. This diagram is additional to Figures B-1, B-2 and B-3 shown in *Austroads – Part 14* (Appendix B).

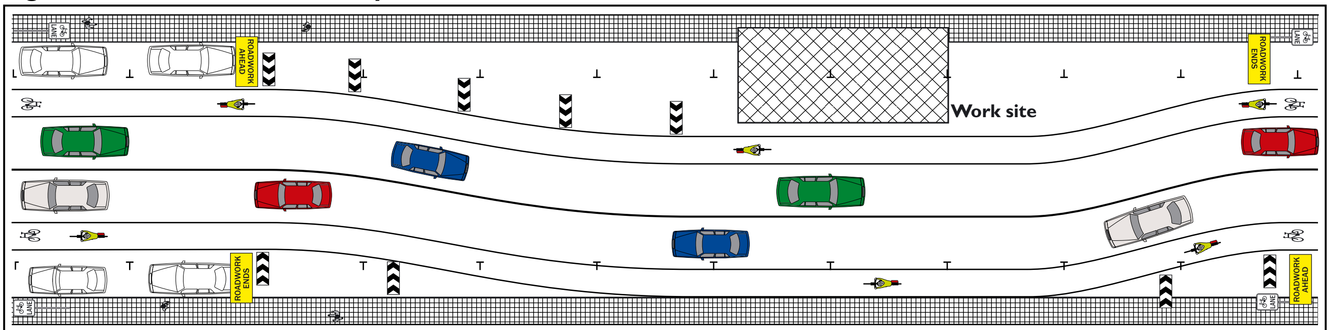
Design notes

Table 10.2 shows recommendations for the application of these treatments depending on the prevailing traffic volume on the adjacent road.

Table 10.2 Selection of appropriate treatments for bicycle route facilities at work sites

Speed - 85 percentile *Refer Figure 3.2*	Type of bicycle facility	Traffic volumes	Recommended treatment * See *Austroads - Part 14,* Appendix B
> 60 km/h	Physically separated	> 10,000	Figure B-2 or B-3*
40 - 60 km/h	Physically separated	5,000 to 10,000	Figure B-2 or B-3*
40 - 60 km/h	Visually separated	5,000 to 10,000	Figure 10.2 or B-1*
< 40 km/h	Visually separated or mixed traffic	< 5,000	Mixed traffic

Figure 10.2: Works on roads - bicycle lane on-road diversion.



Notes: This diagram compliments Figures B-1, B-2 and B-3 in Appendix B of *Austroads Guide to Traffic Engineering Practice, Part 14 - Bicycles.*
For full details on signing and deliniation provisions for this treatment refer to Standards Australia *AS 1742.3 Traffic Control Devices for Works on Roads.*

Treatment shown is for long term roadworks. Refer to *AS1742.3* for short term signing and delineation.
Speed limits on approaches and beyond the work site may be significantly different to the prevailing speed limit. Refer *AS 1742.3.*

11. Bicycle parking and access to public transport interchanges

Table 11.1: Scope of Section 11.

Type of facility	Coverage in *Austroads - Part 14*	Coverage in these Guidelines
Bicycle parking facilities	10.3.5 Types of parking devices	11.1 High volume on-street bicycle parking installations
Bicycle network access to public transport stations and interchanges		11.2 Bicycle network access to public transport stations and interchanges

Section 10 of *Austroads Guide to Traffic Engineering Practice, Part 14 – Bicycles* and the *Australian Standard AS2890.3* provide general coverage on bicycle parking and end of trip facilities and installations suitable for low volume parking installations (less than 10 U-rail racks) suitable for most main street and trip generating locations.

The section below provides additional coverage for bicycle parking provision at large shopping centres, schools, railway stations, public transport interchanges where the bicycle-train/transit combination is actively promoted and encouraged and a higher demand for parking is expected.

A coverage of the issues relating to the provision of bicycle parking facilities and network routes to feed public transport interchanges is also provided at the end of this section.

11.1 Medium volume bicycle parking installations

In situations where there is a medium volume demand for bicycle parking (10-20 bike parking spaces), and space is at a premium, alternative arrangements and guidance to that provided by *AS2890.3* and *Austroads – Part 14* should be considered. This is particularly applicable in urban areas and in developments such as undercover parking stations, shopping centres schools, educational institutions, sporting complexes and at bus or rail interchanges where the floor space available for bicycle parking is limited and user demand is substantial.

Application

In medium demand locations, the generous mounting centres recommended by *AS2890.3* and *Austroads – Part*

Figure 11.1: Medium volume bicycle parking installation.

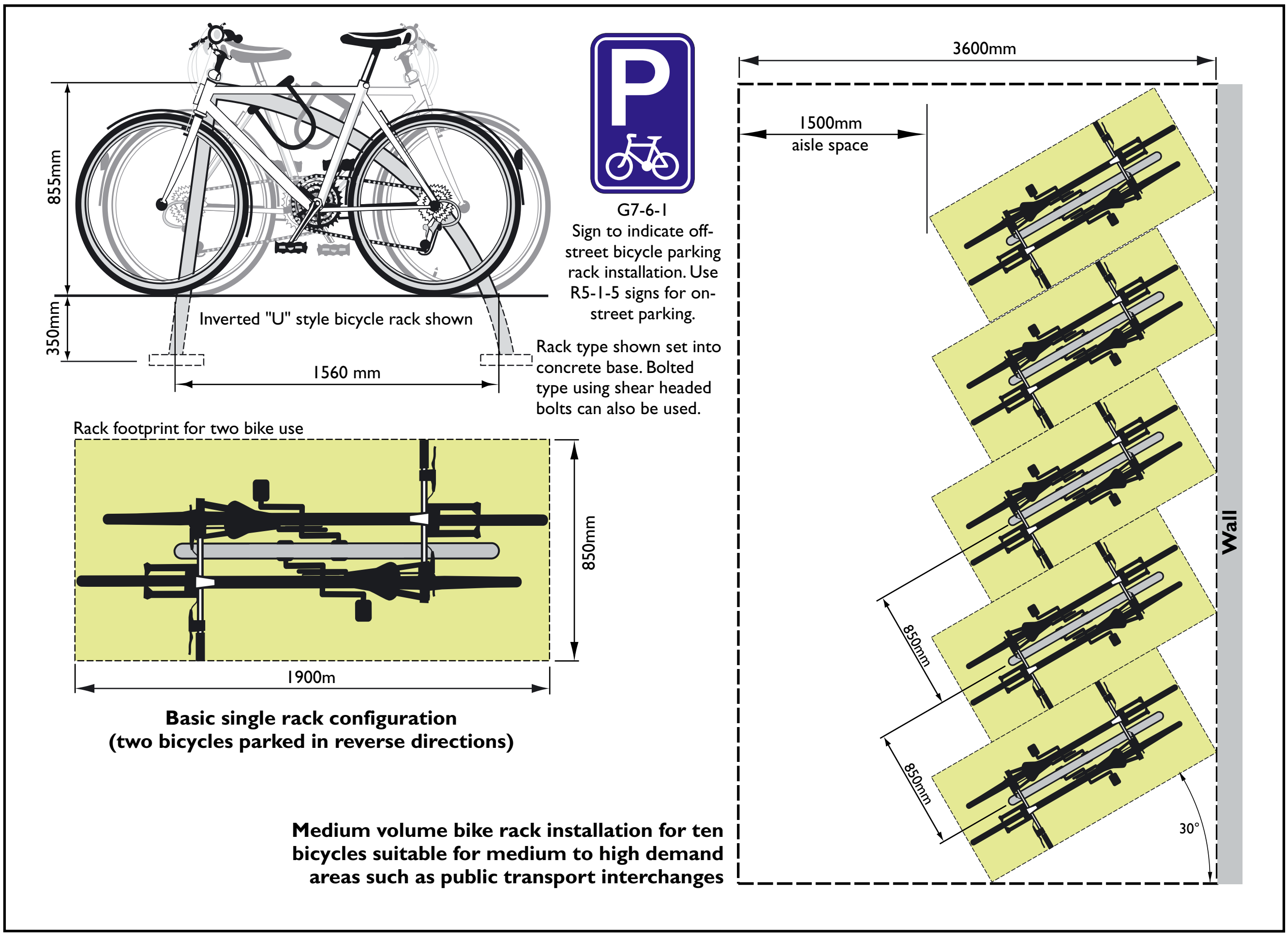
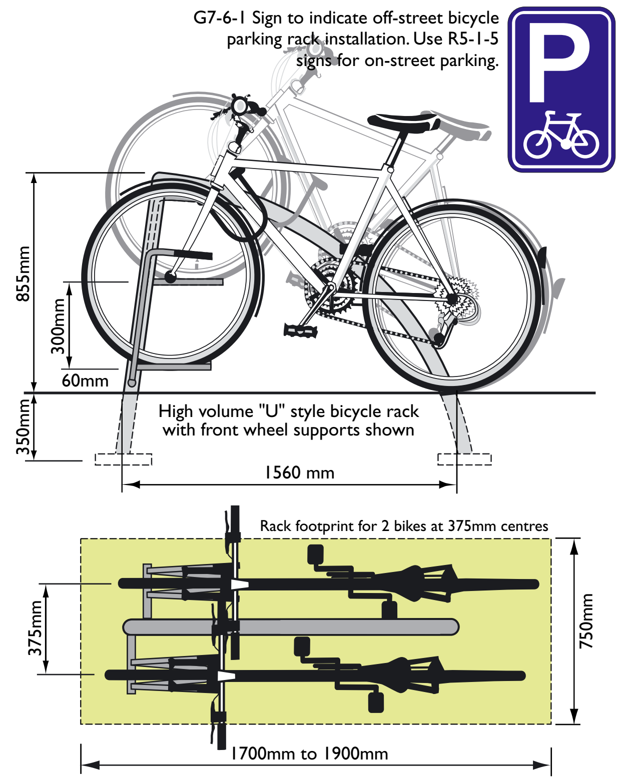
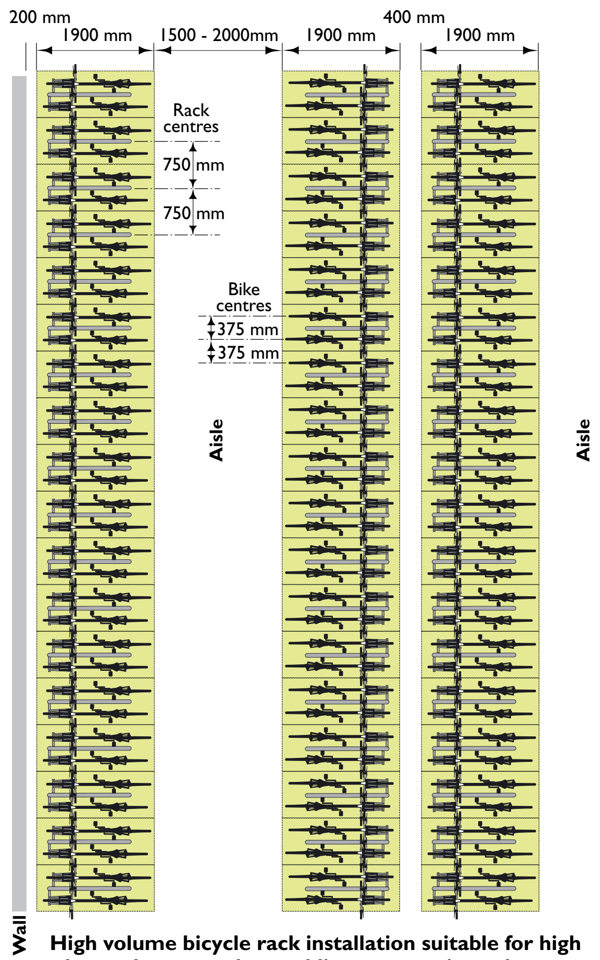


Figure 11.2: High volume bicycle parking installation.



Basic single rack configuration (two bicycles in front wheel supports - one up and one down)



High volume bicycle rack installation suitable for high demand areas such as public transport interchanges

14 for U-rails and other types of bicycle rack systems may result in a shortfall in the provision of parking facilities or an excessive or wasteful use of floor space.

Design notes

Figure 11.1 shows recommended 850mm mounting centres and layout arrangement for a bicycle parking installation suitable for medium demand bicycle parking installations (10-20 bicycle parking spaces). This type of rack mounting configuration allows the user to securely lock the bike frame and at least one wheel to the rack using a high security U-lock or cable.

An essential requirement of this type of installation is that the racks be mounted at angles of between 15 and 45 degrees. This angled mounting reduces conflicts between adjacent handlebars and pedals. Angle mounting of the bicycle racks also reduces the depth of this footprint and enables more bicycles to be stored within a given space.

This bicycle rack mounting layout method uses approximately 30% less space than standard U-rails mounted at 1200mm centres.

11.2 Bicycle parking installations at transport interchanges

In high demand locations (more than 20 bicycle parking spaces) such as railway stations, bus transit stations and other types of public transport interchanges, the wide mounting centres recommended by *AS2890.3* and *Austroads – Part 14* for bicycle rack systems may result in a shortfall in the provision of parking facilities or an excessive or wasteful use of floor space.

Design notes

Figure 11.2 shows recommended mounting centres and layout arrangement for a high volume bicycle parking installation suitable for railway stations and transport interchanges. This type of storage method is commonly used in European stations and public transport interchanges and allows the user to securely lock the bike frame and at least one wheel to the rack using a high security U-lock or cable.

For parked bicycles to be effectively stored using this scheme, a special type of rack must be used. These racks are mounted at 750mm centres and support the front bicycle wheels above the ground. Each alternative bicycle is mounted higher than the one next to it. This arrangement ensures that handlebars do not conflict. Due to the closeness of storage centres, angle-mounting of bikes is not recommended as it makes the racks difficult to use.

This bicycle rack mounting layout method uses approximately 40% less space than standard U-rails mounted at 1200mm centres.

11.3 Bicycle network access to public transport stations and interchanges

Public transport cannot function effectively without some other method of transport before and after transit as very few transit patrons live right at their origin stop, or travel to a destination next to their final stop or station. The purpose

Photo 11.1: Bicycle locker installation at Liverpool Railway Station.

of providing for bicycle-plus-train travel should be to make it easier for a person to access the station from a greater distance than by walking. People living within a comfortable walking distance are unlikely to use a bike to get to the station, as their trip is quicker and simpler without a bike. Using a bicycle for shorter trips (under 5 minutes) involves comparatively extra effort (adjusting clothing for riding, securing luggage, fitting helmet, lights at night, wheeling out of garage or house, getting into parking area, finding vacant rack or locker, locking bike and securing belongings etc) compared with walking.

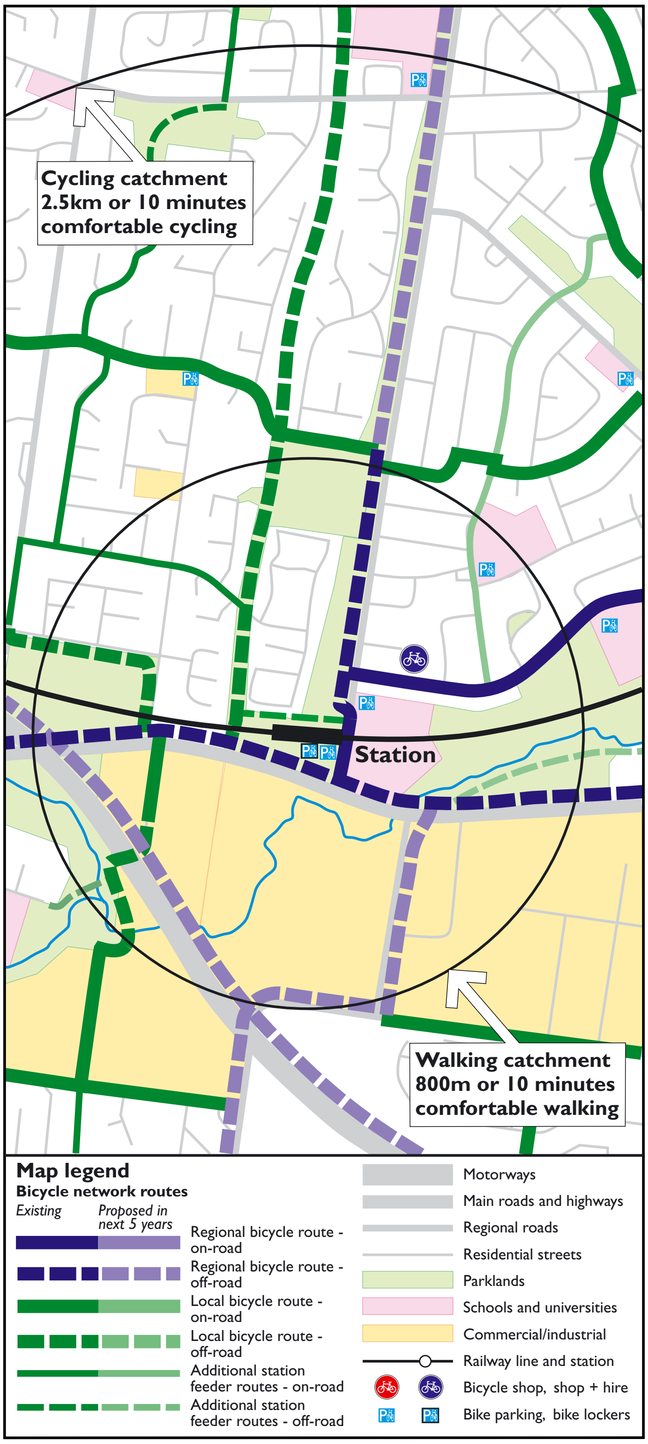
However, riding a bicycle over about 5 minutes to a station involves less physical effort than walking, so the decision to ride to the station is a trade-off and is only made when the advantage of travelling the extra distance for less physical effort outweighs the other aspects of bicycle usage. Therefore it is important to consider all these aspects so that the bicycle park 'n' ride experience is made as easy, comfortable and convenient as possible.

Design features of good bicycle parking

The major issues relating to the provision and location of bicycle park 'n' ride facilities at public transport interchanges stations are:

- Storage areas need to be open and attractive and in easily supervised areas that feel safe and non-threatening and have good active and passive public surveillance to deter acts of vandalism and theft (away from roadways and dead-ends);
- Bicycle parking facilities need to be sited as close as possible to the station platform entrance(s) with a maximum walking distance from parking facilities to station entrance less than 100m;
- Bicycle facilities need to relate to the travel requirements of the user (lockers for regular commuter use and racks for rapid access short term use);
- Bicycle parking racks need to be located under cover and out of the weather;
- Bicycle parking facilities need to be easy to find, well signed and marked;
- Racks and lockers need to be easy to use and have helpful signage to assist new users to understand the method of use;
- Bicycle parking areas need to be well lit and ventilated;
- Bicycle riders need to be able to access the parking facilities easily and quickly from bicycle network feeder routes;
- Bicycle parking areas need to be designed for quick and easy maintenance and kept clean along with surrounding station areas on a regular basis; and,
- Bike storage areas should not obstruct traffic flows from either pedestrians or motor vehicles.

Figure 11.3: Bicycle network feeding public transport.



Where bicycle parking facilities are located on the opposite side of the railway line to the main station entry/exit, underpasses or overpasses should be designed to provide a well-lit and attractive passageway preferably with ramped access. If existing stairways are used these should be fitted with grooved wheeling ramps at both edges to facilitate bicycle access.

Recommendations for provision of bicycle parking facilities

Design phase

- Cycle parking should be located where there is good active or passive public surveillance. The prime concern of users is theft and damage. If a rider has their bicycle stolen or vandalised at a station parking area it is highly likely that they will abandon this form of use of the system.
- Cycle parking should be coordinated and planned as part of local and regional bicycle networks. Additional local routes should be developed to connect stations to established regional and major local routes on the bicycle network, as well as to local trip attractors and popular destinations.
- Access to bicycle parking facilities from local and regional bicycle routes should be planned to enable safe and easy travel from anywhere within the station cycling catchment (see Figure 11.3);
- Cycle parking should 'look' like it is an integral part of the system. It should appear to the user that they are encouraged to ride to transitway stations and are a welcomed user of the system.

Operational phase

- Supervision of the bicycle parking area should be considered as an integral part of the overall station precinct security.
- Bicycle parking should be promoted as a key element of the transport system and cycling to stations as an attractive and 'smart' way of accessing the system.
- Train/bus timetable, route information etc should show the location of bicycle parking facilities and on the racks themselves, an explanation of how to use these facilities.
- During the initial 'ramp-up' operational period the use of bicycle parking facilities should be monitored and additional demand met quickly if this is within predicted future capacity.
- Regular monitoring, cleaning and maintenance of bicycle facilities should be undertaken as part of the normal security and upkeep operations of the stations and their environs.

12. Safety audits and the selection and evaluation of bicycle network facilities

Table 12.1: Scope of Section 12.

Type of issue	Coverage in *Austroads - Part 14*	Coverage in these Guidelines
Bicycle safety audits	Appendix A - Example of a road safety audit checklist	12.1 Bicycle road safety audits
Bicycle route selection		12.2 Selection of bicycle routes
Economic evaluation of bicycle facilities		12.3 Economic evaluation of bicycle facilities

This section deals with the evaluation of bicycle network facilities. Two key issues are considered: safety and route performance. The main premise is that bicycles and their riders are vulnerable road users. They have no protection against physical impacts (other than helmets) and are powered by a human engine.

Austroads Guide to Traffic Engineering Practice, Part 14 – Bicycles and the 2002 *Austroads Road Safety Audit Manual* already provide extensive documentation on road safety audits and on how these apply to bicycles. Accordingly, the advice in these Guidelines is limited to two supplementary issues.

Sections 12.2 and 12.3 of these Guidelines provide detailed advice on route selection and economic evaluation of bicycle infrastructure. The methods included here are subject to further refinement and feedback to RTA's Bicycle and Pedestrian Network Branch is encouraged.

12.1 Bicycle road safety audits

Both *Austroads Part 14* and the revised *Austroads Road Safety Audit Manual* provide extensive information on bicycle road safety audits and risk assessment procedures.

Particular reference is made to *Austroads Part 14,* Appendix A, Example of a bicycle audit safety checklist and to Sections 8.3 and 9.8, which specifically address cycling issues. Importantly, the 2000 *Austroads Road Safety Audit Manual* includes a detailed checklist, which encourages auditors to consider bicycles whenever audits are done.

With a view to the vulnerability of cyclists, the audit process of bicycle facilities should look beyond specific road safety concerns. Comfort, convenience, consistency and continuity are critical elements of bicycle infrastructure.

Lack of attention to even small details at just one location can render an entire route inaccessible to large groups of potential users. The most important of these issues are quantified in the following sections on route selection and route performance.

12.2 Selection of bicycle routes

As with other road network infrastructure projects, the selection of the most suitable route out of a multitude of potential options is a complex process that involves the evaluation of many factors such as costs, benefits, environmental impacts, surrounding landuse, accessibility, etc. The *RTA Economic Analysis Manual* provides a detailed overview of the various techniques and methods, many of which can also be applied to the selection of bicycle routes.

These generic processes, however, provide little guidance on specific bicycling issues such as:

- **absolute distance** ie the energy required to complete the task
- **route quality (on- or off-road)** ie the intrinsic safety of the route and its suitability to different user groups
- **vertical alignment** ie long or steep grades require additional energy input compared to flat terrain
- **sharp turns and stops** ie stopping and braking impose a loss of energy, which has to be re-generated by a cyclist

While to some extent these factors could be objectively calculated (eg changes in energy inputs), there is considerable fluctuation between individual cyclists and to a large extent they require subjective considerations. Sensitivity testing is essential.

The case study of a the route selection process for a regional bicycle route in northern Sydney provides a useful example of parameters, sensitivity tests and qualitative considerations.

12.3 Economic evaluation of bicycle facilities

The *RTA Economic Analysis Manual* is the primary reference for the economic evaluation of road infrastructure projects in NSW, including bicycle facilities. It provides clearly explained general concepts, practices and procedures as well detailed information on many analysis methods, including worked examples. Input parameters such as the cost of travel time and crashes are updated annually.

The *Manual* provides detailed information on the financial costs of three elements that are frequently used as the main basis for determining the benefit - cost ratios for infrastructure projects, including:

- Travel time costs
- Vehicle operating costs
- Crash costs

The *RTA Economic Analysis Manual* also indicates the need to consider other factors that influence the benefits and costs of infrastructure projects, such as externalities and intangibles. The manual specifically addresses the evaluation of bicycle facilities and bicycle travel.

Case study: North Sydney and Macquarie University regional route selection.

Context

The Sydney Harbour Bridge to Macquarie University bicycle route forms part of RTA's regional bicycle network through four northern Sydney Local Government Areas: North Sydney; Lane Cove; Willoughby; Ryde.

On the one hand, the topography and built-up nature of the area greatly restrict the opportunities for route development. On the other, the need for drainage has ensured that there are numerous green corridors throughout the study area, generally following the creek gullies.

Criteria

The route development process included saddle surveys and detailed mapping analysis of a total of 50 short links of potential bicycle routes, which combined into a total of 21 route options to Macquarie University and 5 routes to Chatswood. Each of the links were rated based on the following criteria:

- 1 score point for every 100m of absolute distance
- 1 additional score point for every 100m of on-road facility
- 1 additional score point for every 10m in elevation (in one direction only, to avoid double counting)
- 1 additional score point for every stop or tight turn (eg major road crossings, turns at intersections)

Table 12.2 shows the scores of the three short-listed routes.

Sensitivity tests

The following sensitivity tests were conducted:

- absolute distance only
- zero stop/turn and on-road penalty (ie distance and climb penalty only)
- half the weight of on-road sections (ie 1 additional point for every 200m)
- proportion of off-road path

Route Selection

Based on the scores and corresponding ranking and sensitivity analysis either Route 1 or Route 2 would be preferred. However, land tenure issue prevented these routes from being further considered, including the need for additional rail capacity on Route 1 (thus limiting availability of space for the route) and the need for access to a golf course for Route 2. Route 2 also required the construction of a substantial new bridge, which had significant cost implications.

Accordingly, Route 3 was recommended as the preferred route. Further qualitative reviews of the remaining route options confirmed the preference for this route.

This case study is based on the report (JF/STC/CW 1998) prepared for the RTA.

Table 12.2: Route selection case study.

Criteria	Route 1		Route 2		Route 3	
	Score	Rank	Score	Rank	Score	Rank
Total Distance	165	--	150	--	151	--
On-road distance	38.5	--	44.5	--	54.5	--
Climbs	24	--	29	--	28	--
Turns/Stops	33	--	37	--	35	--
Total	**260.5**	**1**	**260.5**	**1**	**268.5**	**3**
Sensitivity Tests						
Total Distance Only	165	13	150	1	151	2
No turn and on-road penalty	189	10	179	1	179	1
Reduced on-road weighting	241.25	2	238.25	1	241.25	2
% off Road	77%	1	70%	3	64%	10

Table 12.3: Route performance criteria.

Principle	Criteria	Regional route	Local route	Local access
Directness	Operating/design speed	50 km/h	30 km/h	N/A
	Delay time	<15 sec/km	<20 sec/km	<20 sec/km
	Detour factor*	<20%	<30%	<40%
Comfort	Need to stop**	<0.5 stops/km	<1.0 stops/km	<1.5 stops/km

Notes

* Detour factor relates to shortest distance between two points, ie as the crow flies. A detour factor of 20% thus indicates an additional 200m for every kilometre of distance in a straight line, ie 1.2km instead of 1.0km.

** Total stopping/delay time averaged over the length of the route, ie one intersection may require more than 30 seconds of stopping /delay time, which may be recovered on the approaches, depending on the total length of the route.

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Symbols

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