Guideline

Maintenance minimisation for walking and cycling facilities

August 2020

Queensland Government

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1 Purpose and scope

The purpose of this guideline is to provide operational and best practice guidance on minimising maintenance on walking and cycling facilities. Design guidance is provided in the Transport and Main Roads *Road Planning and Design Manual* Volume 3, Part 6A.

This guideline provides advice for the design of walking and cycling facilities to minimise ongoing maintenance and encourage future cost sustainability. The guideline highlights common issues associated with cycling facilities and provides guidance on concepts and methods to reduce the likelihood of these issues occurring during the life of the facility.

This guideline draws on existing knowledge and current practice in national and international planning, design and maintenance of cycling facilities so that information is readily accessible to the key personnel involved in each of these phases of facilities' life cycle.

This guideline complements, and is to be used in conjunction with, existing design guides highlighting ‘best practice’ and does not supersede any existing standards.

1.1 Introduction and background

Asset management in the department is aimed at providing, within available funds, facilities such as pedestrian paths and bikeways that meet an agreed level of service for the community, including safety, at minimum whole-of-life cost. This requires that initial cost versus maintenance and operating cost trade-off decisions minimise the total cost of the facility over its life.

This approach benefits the community by offering a level of service that meets community expectations of maximum availability, safety, and ride quality at minimum cost.

Providing appropriate pedestrian and bicycle infrastructure often requires a substantial capital investment and an adequate program to maintain these facilities and minimise future maintenance. Where the department retains ownership of bicycle and pedestrian infrastructure, the facilities should be included in the department’s asset management program, as roads are, for safe and useable facilities that avoid asset degradation and the associated increased cost of maintenance or reconstruction.

Where ownership of these facilities is passed to local government, this principle should also be applied to the management of bicycle and pedestrian infrastructure. User safety is a critical part of an asset management system and this guideline emphasises addressing safety-related maintenance issues in a timely manner to prevent accidents involving injury to the public.

Smooth, debris-free surfaces with adequate friction are a fundamental requirement for the safety of people riding bikes. Most bicycles have no suspension or shock absorbers, and many have relatively thin tires inflated to high pressures. As some people riding bikes using bikeways travel at speeds of around 30 km/h on flat grades and up to about 50 km/hr on downhill grades, a rough, low friction or potholed surface can be particularly hazardous. Factors that adversely affect the quality of the riding surface should be given a high priority in maintenance programs, as should trip hazards on paths used by people walking.

As well as minimising life cycle costs and maximising user safety, timely maintenance has the added benefits of:

- maintaining user comfort and minimising travel times
- improving availability and reliability of the facility as a means of travel, by reducing closures and restrictions induced by damage and maintenance, and
- promoting facility use and the associated health benefits.

Over the life cycle of a pedestrian or bicycle facility, asset managers will plan, design, build, operate, monitor, maintain and dispose of the asset. This guide is structured to discuss maintenance minimisation considerations during the planning, design, and maintenance phases of the life cycle.

The following major maintenance issues were identified and are covered in this guideline:

- vegetation issues
- debris
- root infiltration / pavement lifting
- defective surfaces
- drainage
- utility and service access covers
- vehicle damage
- cracking
- markings and signage
- lighting
- vandalism, and
- erosion.

1.2 Related documents

This guideline should be read in conjunction with the documents listed in Table 1.2. The *Active transport guidelines references* lists documents of interest to readers of this guideline.

Table 1.2 – Related documents

Document title	Publisher
Australian Standard AS 1428.1 *Design for access and mobility*	Standards Australia
Australian Standard AS 1742 *Manual of Uniform Traffic Control Devices*	
Australian Standard AS 3727 *Guide to Residential Pavements*	
Australian Standard AS 3996 *Access covers and grates*	
Bridge / Culvert Servicing Manual	Transport and Main Roads
Crime Prevention through Environmental Design – Guidelines for Queensland, Part A – Essential Features for Safer Places	Queensland Government

Document title	Publisher
Guide to Pavement Technology, Part 5: Pavement Evaluation and Treatment Design	Austroads
Guide to Pavement Technology, Part 6: Unsealed Pavements	
Guide to Pavement Technology Part 7: Pavement Maintenance	
Guide to Traffic Management Part 10: Transport Control – Types of Devices	
Intelligent Transport Systems and Electrical Approved Products and Suppliers list. http://www.tmr.qld.gov.au/business-industry/Technical-standards-publications/Approved-products-and-suppliers/Intelligent-transport-systems-and-electrical-approved-products-and-suppliers.aspx.	Transport and Main Roads
Queensland Manual of Uniform Traffic Control Devices Part 9 Bicycle Facilities	
Road Drainage Manual	
Road Landscape Manual	
Road Planning and Design Manual, Volume 3 Guide to Road Design Part 6A Paths for Walking and Cycling	
Traffic and Road Use Management Manual Volume 1 Guide to Traffic Management, Part 10 Traffic control and communication devices	
Traffic and Road Use Management Manual Volume 3 Signing and Pavement Marking Part 2 Pavement marking usage	

2 Maintenance minimisation

A common issue in the transport sector is the decline of Queensland roads due to inadequate investment in maintenance and renewals; this likely also applies to pedestrian and bicycle facilities.

Queensland's bicycle network will need routine maintenance and future renewal. Government investment may not keep pace with this growing need, so it is critical that maximum value is gained from finite maintenance funding made available.

The key methods of maximising the quality of the existing infrastructure for the available funds are by:

- minimising the maintenance required, and
- maximising the amount of maintenance delivered for the available investment.

This guideline does not cover ways to maximise the amount of maintenance delivered for the available investment as this requires knowledge of the specific maintenance required and the facility components involved.

To minimise maintenance, there are four key issues which affect bicycle and pedestrian facilities:

- pathway pavement
- vegetation and landscape
- associated facilities, and
- facility management.

This guideline identifies common defects (that is, aspects requiring maintenance) for each of these key areas and provides guidance on how these defects can be minimised through adequate consideration during facility planning, design, and maintenance. The earlier in the life cycle of a facility that future maintenance is considered, the better.

It is vital to consider site characteristics that will influence:

- the life and availability of the facility such as rainfall, runoff, possible flooding, soil types, vegetation, possible geotechnical instability and slopes in selecting an alignment
- accessibility for maintenance of the facility and surrounding infrastructure including services, and
- the future use of the site, including traffic and long-term adjacent land use.

Designers and asset managers are key in ensuring that:

- the facility can carry the planned loads, including maintenance vehicles
- appropriate materials and features are included in the design to minimise maintenance, and facilitate accessibility for maintenance activities
- landscaping and drainage complement the design and minimise future maintenance issues, and
- the design incorporates features that address any adverse site conditions.

In the construction phase of a facility, construction details and works procedures must be specified and supervised adequately so detailed designs are implemented correctly, ensuring a quality product.

2.1 Pathway pavement

The pavement surfacing of the walking or cycling facility can be made of various materials, including concrete, asphalt, pavers, chip seal or unsealed granular material while, under the surfacing, there may be another structural layer of asphalt, granular or cement bound material. On-road facilities will typically have pavements that are the same as the existing roadway; however, off-road facilities offer the opportunity to explore appropriate surfacing and structural pavement materials based on the site and demand.

The smoothness of the riding surface affects the comfort, safety and speed of people riding bikes. Pavement surfaces should be smooth, and the pavement should be uniform in width. Asphalt and concrete are the preferred riding surface.

Wide cracks, joints or drop-offs at the edge of a travelled way parallel to travelled direction can trap a bicycle wheel and cause loss of control, while holes and bumps can cause people riding bikes to swerve into the path of other traffic (for example, other people riding, people walking or motor vehicles). Path defects may reduce operating speed, reduced operating speed below a bike rider's comfort level reduces stability.

As pavements age, it may be necessary to fill joints or cracks, adjust utility covers or even overlay the pavement to keep the surface suitable for cycling.

Maintenance minimisation concepts for the path pavement can be grouped into:

- pavement surface defects
- drainage
- surface transitions
- vehicle damage
- root infiltration, and
- cracking.

2.1.1 Pavement surface defects

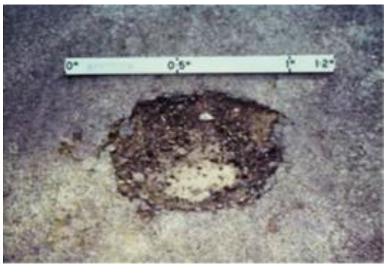
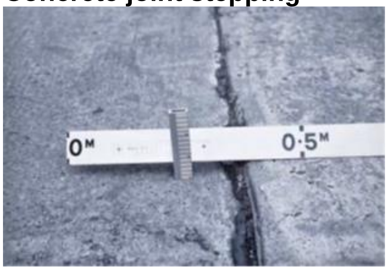
Surface defects allow water to ingress into the pavement material or support material and accelerate deterioration of the pavement. Defects increase ride roughness and can become a hazard to bicycle wheels and a trip hazard to people walking.

To minimise further pavement damage, surface defects should be filled or resealed to reinstate waterproofing and evenness until pavements are programmed for more extensive maintenance such as full width resurfacing, rehabilitation or replacement.

The most common types of defects include cracking, potholes and joint separation. These are illustrated in the following table, along with a description of the likely cause and repair methods. Many defects are a result of poor sub-grade preparation, inadequate drainage or design details that do not suit cycling facilities.

Table 2.1.1 – Most common pavement path surface defects, description, cause and repair

Typical distress	Typical repair	Description and cause
Asphalt cracking 	Small cracks can be sealed with bitumen.	**Description**: Interconnected cracks form a series of blocks approximately rectangular in shape. **Causes**: Asphalt cracking on bicycle paths is due to tree root infiltration, fatigue from vehicle traffic and/or sub-grade expansion or weakening, usually due to water infiltration.
Concrete structural cracking 	Slab replacement is usually required.	**Description**: Active cracking extends through the full depth of the slab. **Causes**: A lack of sub-grade support and/or vehicle overloading.

Typical distress	Typical repair	Description and cause
Potholes 	Potholes are usually patched with hot or cold asphalt mix.	**Description**: A steep-sided or bowl-shaped cavity extends into layers below the wearing course. **Causes**: Potholes in bituminous surfacing are caused by water entering cracks and causing pieces of the pavement to be broken out of the pavement.
Concrete joint stepping 	Grinding or profiling to correct ride quality. Resealing of joints.	**Description**: The two slabs on either side of a joint separate vertically and permanently. **Causes**: • inadequate sub-base / sub-grade support • moisture movement in expansive clay sub-grades • curling and warping of slabs, and • tree root uplift.

Source: Austroads *Guide to Pavement Technology* Part 5: *Pavement Evaluation and Treatment*.

2.1.1.1 Planning phase

Refer to the department's *Road Planning and Design Manual Volume 3, Part 6A* for maintenance consideration in the planning phase. Additional considerations for the planning phase include:

- Consider the conditions and likelihood of flooding events and, where necessary, consider the appropriate pavement structure, surfacing material and design details to resist the harmful effects of inundation. Concrete is typically more resistant to periodic flooding events than other surfacing options.
- Future activities in the area within the design life of the surface material may accelerate deterioration. In planning, consider future developments and construction works which may affect the facility, such as road widening in areas of high traffic growth. The provision or maintenance of underground utilities (for example, water, sewer) may also affect pavement condition.
- Avoid alignments on areas with poor soil characteristic such as expansive clays or known issues related to geotechnical stability such as settlement in estuarine areas. Unreinforced rigid pavements can perform poorly and are more difficult to repair than flexible pavements where there is sub-grade movement.

2.1.1.2 Detailed design phase

Refer to the department's *Road Planning and Design Manual Volume 3, Part 6A* for maintenance consideration in the detailed design phase. Additional considerations for the detailed design phase include:

- Use a recognised pavement thickness design system or catalogue of bicycle way pavements to avoid under-design of the path pavement. The most comprehensive Australian bicycle path pavement design information is given in the South Australian Department of Planning, Transport and Infrastructure, Safety and Service Division *Guide to Bikeway Pavement Design Construction and Maintenance for South Australia.*

- Consider the in-service design loads of the pavement including maintenance vehicles, sweepers and typical users.
- Ensure that joints are located appropriately for the terrain and conditions.
- Where root infiltration may be an ongoing issue, the use of articulated joint systems between rigid pavement slabs or 600 mm deep, high density polyethylene (HDPE) root barriers along the pavement edge for protection from root infiltration is recommended.
- Specify grubbing, sub-grade preparation and compaction, and the use of geotextiles to reduce effects that may accelerate crack propagation and other defect development.
- Ensure adequate curing is specified and early trafficking is limited where concrete is used.
- Ensure surface asphalt and concrete mix designs include angular silica sand as the sand size fraction for better surface friction.

2.1.1.3 Maintenance phase

- Austroads' *Guide to Pavement Technology Part 7: Pavement Maintenance* and *Part 6: Unsealed Pavements* provide detailed guidance on the maintenance of pavements.
- Immediately repair all cracks to reduce the likelihood of further crack propagation, water ingress and accelerated deterioration.
- Where possible and cost effective, identify and remove the cause of the cracking.
- Crack repairs and propagation minimisation methods should not reduce the level of service to the user.
- Ensure all rigid pavement sealed joints are resealed as required.
- Ensure pavement repairs provide adequate skid resistance and similar friction coefficients to the surrounding surface in both wet and dry conditions for the route.
- When patch repairs are undertaken, ensure contractors reinstate surface levels of the repair to match with existing finished levels and the patch is even. Preference should be given to slab replacement rather than patching of concrete pavement.
- Crack sealing with bitumen products should be gritted with angular sand after application and swept to ensure adequate surface friction.

2.1.2 Drainage management

The effective design and maintenance of drainage will assist in the provision of a safe and comfortable surface for bicycle travel. It does this by reducing the rate of pavement deterioration where water is a factor, reducing erosion around the path and waterborne deposition of soil on the surface. Facilities prone to flooding or ponding are less attractive to commuters. Water ponding on the path can also mask potential hazards to users (for example, potholes).

The department's *Road Drainage Manual* provides guidance in relation to the planning, design, construction, maintenance and operation of road drainage structures in all urban and rural environments. It is applicable to bicycle and pedestrian facilities. The maintenance of drainage facilities is also described in Austroads' *Guide to Pavement Technology Part 7 Pavement Maintenance*.

2.1.2.1 Planning phase

- Consider commuting users when choosing the facility alignment because they may use the path even when conditions are not favourable, such as during adverse weather events.
- Where a short section of path may be subjected to inundation (for example, path adjacent to a watercourse and under a road bridge to achieve grade separation), ensure a safe alternative at grade crossing is available for use during flooding of the path.
- Where opportunity and space exist, consider implementing water-sensitive urban design principles to manage rain events. Consider the water catchment area after the design is complete.
- Identify future activities in the area within the catchment of the facility that may change runoff characteristics.
- Avoid path alignments through areas where drainage is already known to be an issue or ensure that the path is raised on a structure or embankment that avoids frequent inundation.
- Include space for catch and side drains on steep slopes to avoid water flowing over the path surface.
- Consider potential future changes in sea levels when selecting alignments near tidal water bodies.

2.1.2.2 Detailed design phase

- Ensure drainage pipes are large enough to allow cleaning and have sufficient fall to achieve water velocities for self-cleaning to reduce blocking of drains.
- Ensure path surface height at the lower edge where it meets a grassed area is slightly higher than the verge level, so drainage is maintained once the grass grows. As a general principle, path pavements should be raised above the natural surface to prevent ponding on the surface and debris washing onto the surface.
- Crossfall of 2.0–4.0% should be adequate to dispose of surface water effectively on sealed surfaces, and 5.0% may be required on unsealed surfaces. Unsealed surfaces will require monitoring after heavy rainfall to identify when they require grading. One-way crossfall is preferred for bicycle paths. AS 1428.1 *Design for Access and Mobility* requirements specifies a maximum crossfall of 2.5%. A minimum of 1.0% crossfall is adequate in most situations.
- Extend adjacent road drainage under the path to avoid discharge near or onto the path alignment.
- Where no alternative exists, consider the use of porous pavements surfacing such as open graded asphalt to reduce ponding events. Open-graded surfacing will require edge drains or a free lower edge to allow water to drain from the pavement surfacing.

- Ensure any mature vegetation over 3.5 m tall is set back 2.0 m from drainage and 6.0 m from a sump.
- Design side draining gullies for on-road bicycle facilities.
- Use dome grates on large gully pits away from the path to avoid grates being blocked by debris.

2.1.2.3 Maintenance phase

Figure 2.1.2.3(a) – Maintaining drainage of pathway pavement

		
Concrete edge drain on slope to remove path and cutting runoff fitted with fence to catch rocks falling from batter	Above ground cages over drainage pits reduce build-up of debris	Drainage needs cleaning as well as mowing

- Develop an event based inspection program for high-risk facilities. Where appropriate, consider programmed maintenance after first and second flush events where debris levels may be higher.
- Maintain batters and verge vegetation and remove litter to ensure stability and reduce litter in run off.
- Repair any areas adjacent to the path that pond water by draining or filling to reduce infiltration into the path pavement or sub-grade.
- Where possible, direct discharge from mowers and slashers away from drains and gutters to reduce damming caused by the build-up of vegetative matter.
- Ensure grass and other debris does not build up along the pavement margin; thereby preventing surface runoff.

Figure 2.1.2.3(b) – Examples of maintenance issues with pathway pavement drainage

			
Water crossing the path has deposited debris	Standing water on the path due to a blocked gully pit	Water ponding on path can mask potholes and other hazards to people riding bikes	Flush drain grates can become blocked with debris

2.1.3 Surface transitions

Refer to the department's *Road Planning and Design Manual Volume 3, Part 6A* for design information on transitions from one surface to another.

2.1.3.1 Planning phase

Choose an alignment for paths that minimise the number of transitions between the path and bridges and roadways, and changes in materials, especially on curves.

2.1.3.2 Detailed design phase

- Minimise changes in path surface type.
- Ensure rigid pathways are attached flush to bridges or roads via the use of departmental Standard Drawings and that articulated, tied or dowelled joints are used as appropriate. Ensure all expansion joints are sealed.
- Design as smooth a transition as possible both horizontally and vertically for the best safety outcome. Sharp bumpy curves in which the pavement type changes is the worst possible outcome for users.
- Do not include any vertical lip on ramps or driveways.
- Consider reducing the number of changes of surface type by overlay with the most common material if possible.
- Avoid rounded stone exposed aggregate finishes for concrete pathways because of potential lower wet friction properties.

2.1.3.3 Maintenance phase

- Replace failed joints in concrete pavements at transitions, articulated or tied joints.
- Grind, fill or overlay trip hazards promptly to minimise user trip risks.
- Prioritise bridge inspections on pedestrian and bicycle routes, paying particular attention to ramps and joints.

Figure 2.1.3.3 – Maintenance of surface transitions in pathway pavement

			
Join at transition has been ground to remove a step due to differential movement; this could have been limited by tying the two slabs together during construction	Transition from off-road to on-road at a sharp angle and change of surfacing	Shape of concrete transition between on-road and off-road paths needs to be widened to facilitate movement between paths	Service pit repairs can create unwanted surface transitions

2.1.4 Root infiltration management

When trees are grown too close to a path, are of the wrong species or no measures are put in place to prevent roots infiltrating pavement, the roots can lift the pavement, creating discontinuities at the joints and cracking. This results in an uneven surface and allows rain water to enter the pavement, weakening the sub-grade. These disruptions also become trip hazards and create an unpleasant ride. The department's *Road Landscape Manual* has guidance on setbacks and clearances for bicycle ways in Appendix 4.

2.1.4.1 Planning phase

- Select a new path alignment which avoids existing mature trees that are to be retained.
- On sections of new path where significant existing problem vegetation cannot be avoided by path alignment, include allowance in the planning cost estimates for the installation of root barriers along the pavement edge for protection.

2.1.4.2 Detailed design phase

- Non-frangible vegetation greater than 15 m in height is to be set back 10 m. Provide a 1.0 m clear runoff area beside the path, turf is the preferred treatment.
- Information on limb dropping species or heavy fruiting / flowering species may be found in the department's *Road Landscape Manual Appendix 4 Table*.
- Locate replacement trees more than 1.0 m from the path (to provide shade).
- Specify planting techniques that encourage deep root growth, rather than lateral growth towards the bikeway such as deep ripping prior to planting to break up heavy soil and regular and thorough watering during the establishment period (one to two years).
- Improve the growing conditions of vegetation and root growth in the opposite direction to the pathway in conjunction with creating a hostile area for root growth under the path by creating a sub-grade material with no oxygen, moisture or nutrient holding capacity. Well compacted, bound materials are preferred.

- Select replacement tree species whose mature root systems 'fit' the available volume of soil, moisture, drainage and nutrients in a given area.
- Select species that are proven to have less vigorous root systems.
- On sections of new path where significant existing problem vegetation cannot be avoided by path alignment, include 600 mm deep, high density polyethylene (HDPE) root barriers along the pavement edge in the design for protection from root infiltration. Install sodium bentonite or similar root growth inhibitor to base of root barrier and at all joints.

2.1.4.3 Maintenance phase

- Deem a certain pavement vertical displacement unacceptable, undertake inspections and implement appropriate action. Bikeway surfaces should not have a step parallel to the direction of travel greater than 10 mm or perpendicular to the direction of travel of 20 mm or a groove wider than 12 mm parallel to the direction of travel.
- 'Make safe' with asphalt ramps as a short-term solution.
- Replace lifted section of path, remove tree or trim roots and install articulated joints or root barriers to prevent or delay future lifting. Consult an arborist when trimming roots.
- Grind the raised section of the trip hazard in conjunction with cutting back roots and/or installing root barriers where tree roots are the cause.
- As well as removing invasive trees, repair the pavement, and replace trees with more suitable species with compact root systems further from the path if possible.

Figure 2.1.4.3 (a) – Examples of maintenance of root infiltration in pathway pavement

		
'Make safe' treatment using asphalt ramp	Grinding of path to remove raised trip hazard	Short section (three panels) replaced to remove damaged path section or trip hazard

Source: Brisbane City Council, 2008 *Internal Memorandum Progress Report: TripStop Concrete path Jointing System.*

Step-faulting in concrete paths

Where step-faulting of the footpath is likely to occur due to nearby large shrubs and trees, isolate the footpath from the roots by placing a 600 mm-deep vertical root-barrier alongside the path, or create some form of sheer connection between slabs to preserve the surface alignment.

Traditionally, this has been done in thick concrete slabs by using:

- forming devices such as keyed joints, which are restricted to slabs of 100 mm or more in thickness
- dowels, which have large cover requirements and which, in thin slabs, are vulnerable to spalling due to differential movement, or
- continuous reinforcing mesh which also requires cover and is likely to rust at shrinkage cracks.

Proprietary jointing systems, more recently the use of proprietary jointing systems, has shown positive results.

2.1.5 Cracking

Cracking may occur in any bound pavement material used for a pedestrian and/or bicycle facility. There are numerous causes of cracking including poor edge support, root infiltration, thermal effects, expansion or shrinkage of the sub-grade under the pavement, maintenance vehicles overloading the pavement and bitumen ageing. Narrow cracks may allow water into the sub-base or sub-grade, accelerating further deterioration. Wide cracks not only accelerate deterioration of the pavement but also pose a safety risk as bicycle tyres can get caught in them and they can be a catch point and trip hazard for people walking.

2.1.5.1 Planning phase

- Adhere to planning maintenance minimisation considerations for vehicle damage issues as this will minimise the potential for cracks to be induced by vehicle traffic (Section 2.4.1).
- Avoid alignments on areas with poor soil characteristic such expansive clays or known issues related to geotechnical stability such as settlement in estuarine areas.
- Where poor soils cannot be avoided, pavement type selection should consider continuously reinforced concrete to withstand movement, or a flexible pavement with either a bitumen stone seal or thin asphalt surface that can be repaired easily.
- Edge thickening of concrete paths can reduce edge break of slabs.
- Establish likely pavement loading including maintenance vehicles.

2.1.5.2 Detailed design phase

- Incorporate contraction and expansion joints into the design of concrete pathways at recommended intervals to reduce cracking due to thermal effects and concrete shrinkage.
- Incorporate 600 mm high density polyethylene (HDPE) root barrier along pavement edges or articulated joint formers at joints where adjacent trees are likely to infiltrate the pavement and cause cracking. Also, install sodium bentonite or similar root growth inhibitor to base of root barrier and at all joints.
- Use a geotextile separating layer as a construction expedient. The geotextile prevents soft ground contaminating the sub-base.
- Edge thickening of concrete paths can reduce edge break of slabs.
- Provide edge support for asphalt surfaced pavements to prevent edge break due to vehicular traffic. Include concrete edge strips / kerbs or extend underlying granular pavement beyond the edge of the asphalt surfacing and provide a compacted granular shoulder of 0.5 m.

- Identify and use correct design loads for the pathway design. If maintenance, service or emergency vehicles will cross or travel along the path, these become the design loads. Using correct design loads will prevent structural failure of the path which creates surface defects.
- Design sufficient drainage cross slopes to prevent ponding of water on the path surface, damaging the path or allowing water into the sub-base and accelerating deterioration.
- Adhere to detailed design maintenance minimisation considerations for vehicle damage issues (Section 2.4.1), as this will minimise the potential for cracks to occur.
- For an asphalt overlay of a concrete pathway ensure that the design includes a bitumen strain alleviating membrane interlayer (SAMI) layer beneath the surfacing to delay reflective cracking.
- Include grubbing in path site stripping of topsoil to remove all vegetation, including roots, from the projected pathway site and prevent weed growth through joints. Consult an arborist for root trimming.
- Specify sub-grade compaction and, where adequate compaction cannot be achieved, require sub-grade improvement or replacement for adequate compaction support of the pavement layers.
- Consider geotextile fabric placed on sub-grade to prevent weed growth through joints in plain concrete paths.

2.1.5.3 Maintenance phase

- Cracks in asphalt pavements should be filled with hot polymer modified bituminous crack filler, sanded to provide waterproofing and surface friction, and swept to remove debris.
- Cracks in concrete pavements should be routed and filled with epoxy filler to maintain pavement strength and a flexible silicone sealant should be used to seal expansion or isolation joints that have opened up.
- A modified binder sprayed reseal may be used to improve the resistance to crack reflection. Paving fabric may also be placed for crack interception and additional waterproofing.
- Where cracks are over 15 mm wide or the damage is extensive, replace the entire section of path pavement. Investigate the cause of the cracking and remove or treat if possible.

Figure 2.1.5.3 – Maintenance of cracking in pathway pavement

	
Cracking in asphalt due to tree roots	Concrete cracking due to edge loading by vehicles – the cracks have been ground to improve evenness

2.2 Vegetation and landscape

Refer to the department's *Road Planning and Design Manual Volume 3, Part 6A* for vegetation and maintenance problems.

Additional considerations may include:

- overhanging limbs intruding into the user envelopes of people walking and bike riding (the department's *Road Landscape Manual*)
- vegetation growth through joints in the path, in turn causing deterioration of the joints
- ponding and damming of storm water on pathways and in bicycle lanes, and
- a build-up of humus facilitating weed growth and encroachment of grasses on the edges of pathways.

Many of these vegetation maintenance issues can be avoided by careful pathway alignment and/or vegetation placement and management. The department's *Road Landscape Manual* has guidance on setbacks and clearances for bicycle ways in Appendix 4.

2.2.1 Pathway alignment

Consider the proximity and type of existing vegetation close to the proposed pathway to reduce future maintenance such as trimming, root damage repair and debris removal.

Clearing and removal of adjacent vegetation depends on the proposed path alignment and the type, significance and location of the vegetation. In many urban situations, planning will involve a vegetation survey and community consultation.

2.2.1.1 Planning phase

- Locate pathway appropriately in relation to existing vegetation and adhere to all detailed design tolerance levels described in Section 2.2.1.2.
- Negotiate with local councils on contractual agreements for trimming and control of vegetation growth at a frequency consistent with the climate and local vegetation before installing the pathway.
- Make use of and sculpt from existing trees, rather than planting anew.
- Provide ease of access for mowing / slashing equipment by shaping lawn areas with clean flowing edge-lines and falls.
- Minimise weed growth along fence lines by integrating fence alignments into hardstand areas.
- Provide 1.0 m run-off as required by Austroads: hardstand or turf.
- Maintain sight visibility by accounting for the collective effect of vegetation in areas where bikeways rise, fall and curve.
- Maintain positive surface flows where there is existing vegetation on the low side of a proposed pathway crossfall to avoid damming of surface water.
- Minimise the need to trim edges by using any hardstand areas as garden / lawn edging and fence-line mowing strips.
- Replace small, narrow strips of garden or lawn areas which are difficult to maintain with hard surface treatments that contrast with the path surface material.
- Provide for edge strips on unsurfaced / granular paths.

2.2.1.2 Detailed design phase

- Design path surfaces to be slightly above ground level to delay the build-up of verge turf.
- Provide hard verges around sign supports to reduce grass cutting / trimming.
- Set back signs and other objects 1.0 m from the path to provide clearance.
- Provide 1.0 m run-off as required by Austroads: hardstand or turf.
- Seal path shoulders to adjacent walls or fences where these are closer than 1.0 m to path. This reduces weed growth.
- Design for the preferred minimum canopy clearance for bike riders and shared paths of 2.7 m as outlined in the department's *Road Landscape Manual Appendix 4*. Be aware that the branches of many tree species tend to droop when wet.
- Place path edges at least 1.0 m away from the centre of the trunk of all non-frangible vegetation.
- Place path edges 0.5 m or half diameter (whichever is greater) to the edge of frangible vegetation.
- Place path at ideally least 10 m away from the centre of the trunk of non-frangible vegetation greater than 15 m in height. The distance should be guided by the type of tree, particularly if it has low branches.

- Do not use trees which have a reputation of limb drop or large seed / flower drop / deciduous (for example, Eucalyptus species) or with known root issues (for example, Ficus and Melaleuca species). Where possible, set back paths more than 1.0 m from trees or 1.5 times the mature height or twice the mature canopy width of the tree (when unsure if non-frangible or frangible). This mitigates the risk of trees, limbs, branches and large seeds falling on people walking / people riding bikes areas and nodes and reduces the potential for tree root damage and shortening of pavement surface life.
- Specify the grubbing / removal of all vegetation from the path pavement footprint to prevent vegetation growth through joints.
- On sections of new path where significant existing problem vegetation cannot be avoided by path placement, include 600 mm deep HDPE root barriers along the pavement edge adjacent to trees for protection from root infiltration. Also install sodium bentonite or similar.

2.2.1.3 Maintenance phase

Where there is significant recurring path maintenance due to the proximity of a path to vegetation, either remove the vegetation or realign the path. The decision to remove the vegetation, realign the path or do nothing should be made after consideration of the cost of each option, any vegetation protection orders and community consultation.

Figure 2.2.1.3 – Maintenance of pathway alignment in vegetation and landscape

			
Hard surfacing up to wall to remove narrow mowing strip and weed growth	Narrow strip of grass between path and drain requires mowing	Isolated small areas of landscaping provided with hard surface to reduce maintenance	Turf at edge of path should be lower than path as it will prevent path drainage and cause debris build-up

2.2.2 Vegetation placement

Landscaping of the pathway surroundings can enhance the walking / riding experience and shield users from adjacent traffic noise and fumes; however, this landscaping should be chosen and placed so it does not create a future maintenance issue for the path through the generation of debris or damage to the facility. The department's *Road Landscape Manual* has guidance on setbacks and clearances for bicycle ways in Appendix 4.

2.2.2.1 Planning phase

- Minimise complication of construction and maintenance activities by selecting and mass planting randomly a few proven species for ease of supply and replacement over time.
- Plant bushes that will NOT grow tall enough to obstruct sight distances on the inside of curves.

- Negotiate contractual agreements for regular trimming and control of vegetation growth with local councils before installing the pathway with the frequency dependant on the climate and local vegetation.
- Minimise pruning of vegetation by selecting species that, once mature, 'fit' into the width of corridor to maintain the appropriate riding and walking envelope at all times in accordance with Austroads guidelines and the 2.7 m recommended canopy clearance height in accordance with the department's *Road Landscape Manual*.
- Minimise maintenance by using medium to large shrubs wherever possible. This will shade the maximum ground area to reduce installation and maintenance costs and weed growth and erosion with fewer plants per square metre.
- Maintain positive surface flows where there is existing vegetation on the low side of a proposed pathway crossfall to avoid damming of surface water.
- Use hardstand areas to minimise the need to trim edges that function as garden / lawn edging and fence-line mowing strips.

2.2.2.2 Detailed design phase

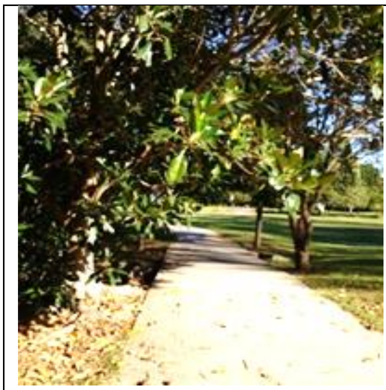
- Locate trees away from critical points on bicycle routes (bends, turns, bus stops).
- Choose evergreen trees / bushes to reduce the accumulation of debris on the pathway.
- Design for the preferred minimum canopy clearance for people riding bikes and shared paths of 2.7 m.
- Place path edges at least 1.0 m away from the edge of the mature trunk of all non-frangible vegetation.
- Place path edges 0.5 m or half diameter (whichever is greater) to the edge of frangible vegetation.
- Place path at least 10 m away from the centre of the trunk of non-frangible vegetation greater than 15 m in height.
- Specify the grubbing / removal of all vegetation from the path pavement footprint to prevent vegetation growth through joints.
- Non-frangible vegetation >15 m in height to be set back 10 m from the path.
- Where possible, set trees more than 1.0 m from the path (to allow shade) or 1.5 times the mature height or twice the mature canopy width of the tree (when unsure if non-frangible or frangible). Refer to *Guide to Bikeway Pavement Design Construction and Maintenance for South Australia*.
- Select plants based on suitability to local climate, soils, rainfall and temperature.
- Specify minimum setback distances from pathways for herbaceous plants based on plant diameter at maturity.

- Specify soil media and mulches free of weed seeds and vegetative matter to avoid contamination of landscaped areas.
- Do not use plants with thorns in landscaping adjacent to paths to reduce the risk of tire punctures.
- Do not use plants with round seeds or hard round fruit (for example, Quandong) in landscaping adjacent to paths to reduce the risk of crashes.
- Do not use deciduous trees or trees with large flower drop or trees which have a reputation of limb drop.
- Do not use climbing / trailing plants next to the path.
- Minimise hazards, pruning and damage to tree stock by specifying stock that has been grown / pruned specifically to accommodate branch clearances in accordance with the department's *Road Landscape Manual* and Austroads cycling and walking envelopes.

2.2.2.3 Maintenance phase

- Inspect for and deal with weed infestations such as Siratro species early to limit their spread, particularly on the handover of new construction.
- Program regular sweeping and mowing routines with increased frequency of mechanical sweeping during the high growth periods and autumn and early winter in areas where there is deciduous vegetation.
- Undertake inspections to assess effectiveness of sweeping.
- Control growth of trees, shrubs and vegetation with particular attention to bends, turns, and transitions.
- Trimming of trees, grass, overhanging branches and shrubs to maintain safe clearances (riding envelope) and sight distances.
- Include the bicycle paths in weed spraying programs, concentrating on the edge of the path, weeds in joints and weed growth in landscaped areas and sight lines.
- Spray and remove weeds that have thorns or spiked seeds such as Calthrop species and prickly weeds that could puncture bicycle tires.
- Program vegetation inspection and trimming.
- Cut back vegetation to the trunk to prevent encroachment.
- Have land owners and authorities control vegetation so the appropriate riding and walking envelope is maintained in accordance with Austroads guidelines and a 2.7 m minimum or the 3.0 m recommended canopy clearance height in accordance with the department's *Road Landscape Manual*.
- Trim back vegetation to allow 1.0 m clearance between the edge of the path pavement and the vegetation.
- Where verge grass stops water draining from the path, regrade verge to restore drainage line.
- Ensure path is swept clean after vegetation close to the path undergoes maintenance.

Figure 2.2.2.3 – Examples of vegetation placement causing maintenance issues



Inappropriate vegetation planted too close to path

Avenue of trees needed to be planted further from path

Overhanging vegetation needs constant trimming

Even grass-like vegetation planted too close to a path can be a hazard and reduce operating space

Vegetation encroachment across path

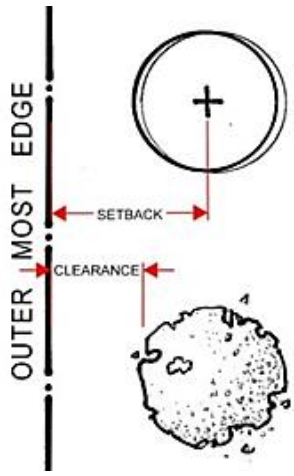
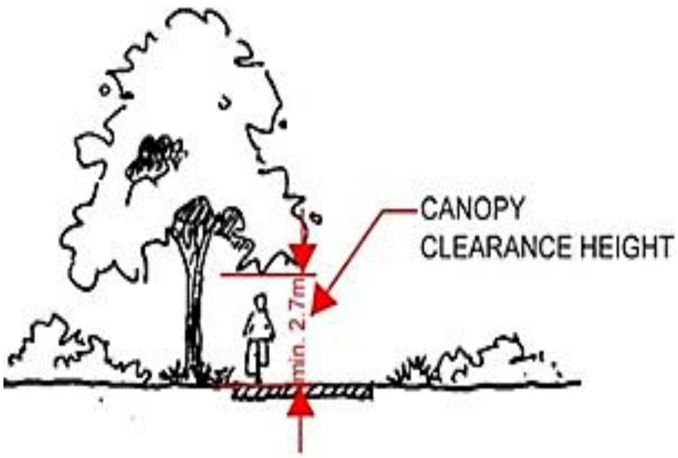


Illustration of the difference between setback and clearance



Recommended canopy clearance height is 2.7 metres for cycleways

2.3 Associated facilities

Modern infrastructure for people walking or bike riding includes a growing range of associated facilities which require maintenance such as markings, signs, lighting, counters, vehicle control barriers, and services.

2.3.1 Pavement markings

Pavement markings deteriorate due to neglect, debris accumulation, water damage, ultraviolet light, traffic and vandalism. Road line visibility is an important contributor to the legibility of a design and worn markings will be less visible in the dark and in wet conditions. Deterioration of markings is also hazardous due to the increased chance of collision between people riding bikes and people walking, or vehicles.

Pavement markings which include glass beads can have reduced wet surface friction. The department's *Traffic and Road Use management (TRUM) manual Volume 3 Part 2* sets out markings required for on-road bicycle facilities and discusses the preferred marking materials. The department's supplement to Austroads' *Guide to Traffic Management* TRUM Volume 1 *Part 10* provides guidance on the warrants for use of green coloured surface treatments for bicycle lanes. It outlines why, when and where coloured surfaces should be used on cycle facilities based on a scored warrant system.

2.3.1.1 Planning phase

- Adhere to all planning maintenance minimisation considerations for vegetation control so vegetation does not contribute to debris which can cover pavement markings on paths (Section 2.2).
- Ensure ponding / standing water does not cover markings on the path in accordance with drainage issue minimisation considerations (Section 2.1.2).
- Adhere to planning maintenance minimisation considerations for vandalism issues as this will minimise the potential for vandalism of markings (Section 2.4.2).
- Thermoplastic lines delaminate, break up and litter the roadway. Line markers must prepare the surface properly, so paint or thermoplastic is less likely to stick incorrectly and come off prematurely.

2.3.1.2 Detailed design phase

- Use durable and high-quality products for markings on paths in accordance with departmental specifications and approved supplier lists.
- Require the road surface to be in good condition for application of green epoxy resin: dry, free of oil and dirt, and with sufficient texture as these products tend to delaminate early if the surface is not adequately prepared.
- Use quality thermoplastic line markings as they last longer than paint in most circumstances and thus reduce maintenance.
- Thermoplastic markings should have chamfered edges to improve ride quality for people riding bikes and a gritted surface to improve friction.
- Select marking materials that do not become slippery when wet.

2.3.1.3 Maintenance phase

- Establish a regular inspection schedule and undertake programmed and reactive maintenance of markings.
- Surface markings, including symbols, should be renewed when legibility becomes poor, and the pavement surface cleaned before application.
- Replace marking if they are damaged during pavement maintenance.

Figure 2.3.1.3 – Examples of maintenance issues in pavement markings

			
Pavement markings damaged by vehicle traffic	Lines need to be reinstated after maintenance	Delamination of an epoxy surface colour	Mow edges and clean path before line marking

2.3.2 Utility and services

Utility and service access covers and pits that are not installed or maintained properly pose a major safety issue for people walking and people riding bikes. They pose the risks of tripping hazards, slippery surfaces and potential for catching bicycle wheels. Service pits generally can only be raised or repositioned by the asset owner which adds considerable time and cost to the installation of a pathway.

The issues that arise from poorly located gullies and lids are that gully slots run parallel to bicycle wheel tracks, and differential settlement, poor placement of covers and poor installation and construction of service covers that fail cause surface unevenness. Pits located in concrete pavements often result in unplanned cracks radiating from the corners of the pit and odd shaped slabs around the pit that crack and become uneven.

Where services are located under or adjacent to pathways, their maintenance may involve excavation of the pathway and the later settlement of patches that cause unevenness and change in path surface.

Minimum vegetation setbacks for underground services and pits are contained in the department's *Road Landscape Manual*, *Appendix 4*.

2.3.2.1 Planning phase

- Consider locations and accesses of existing infrastructure located under or near the proposed path location and separate pathways and services if possible.
- Position service access lids away from bicycle and pedestrian routes, particularly from bends.
- Developments proposed near a facility may require new utility access points at a later date. Check with councils during the planning stage for proposed developments.
- Apply a setback distance of 1.0 m between service access covers and vegetation with a mature height less than 5.0 m for maintenance access to pits and inspection points.

- Apply a setback distance of 4.0 metres between underground services and vegetation with a mature height greater than 3.5 metres so tree roots do not affect underground infrastructure. This setback will vary with species characteristics; that is, greater setbacks are required for species with vigorous growth or that are known to have invasive root systems.

2.3.2.2 Detailed design phase

- Specify that recessed manhole lids must be finished in a surface layer material that matches the friction provided by the path.
- Concrete infill lids may provide more durable friction supply compared to lids with painted surface treatments.
- Choose side draining gullies / kerb arrangements over channel located gullies. Choose flat grill gullies in preference to slotted gullies.
- Restrict the use of steel plates on paths or roads. A high friction surface treatment must be applied to steel plates, even where they are used temporarily, for a smooth transition from existing road through the plate and back to the original surface again. Include warning signs to slow users when approaching such temporary measures.
- Bicycle safe grates conforming to AS 3996 shall be used; for example, grates and grills 90 degrees to the bicycle wheel and grates that will not cause bicycle wheels to become trapped.
- Install an isolation joint around service pits that provides joint patterns to reduce unplanned cracking. Start crack control joints from corners in preference to sides, and/or reinforce the slab containing the service pit, tying the upper steel edge of the pit into the reinforcing.

2.3.2.3 Maintenance phase

- Inspect service access points as part of routine / programmed inspections.
- Reset broken, loose or poorly aligned gullies or manhole covers or lids as required.
- Raise service access points as part of path or on-road lane overlay to maintain evenness.
- Reset catch basin grates flush with pavement.
- Replace sections of path completely and relocate service accesses in dangerous, high-traffic sections or problematic areas with ongoing safety or maintenance issues.
- Encourage the service owners to restore the path after trenching across it to:
  - provide adequate compaction for the full depth of the filled trench
  - replace the complete slab on a concrete path with a matching concrete slab, or
  - patch an asphalt path with compacted hot mix asphalt to match the existing.

Figure 2.3.2.3 – Examples of maintenance issues in utility and services

			
Service pits create odd shaped slabs which are prone to cracking and a variety of surfaces, some of which can be slippery when wet	Ideally service pits should be located off the path	Poor service trench reinstatement causing uneven surface	Settlement around service pits can create unevenness and trip or wheel trap hazards
			
Gap in steel covers on service trench could trap bicycle wheel and are slippery when wet	Cracks radiating from corners of pit can be designed out by jointing from corners	Concrete infill lids are preferred to steel lids	Trench repairs often require ongoing maintenance better to replace slab

2.3.3 Lighting

Lighting is an important element of facilities used by people walking or bike riding for personal safety issues such as criminal attacks, collisions between people walking and bike riding, and people riding bikes crashing due to poor visibility. Lighting maintenance issues include bulbs failure, vandalism, initial installation of poor lighting products, poor placement of lighting structures, damage to structures and hazardous positioning of lighting structures.

2.3.3.1 Planning phase

- Choose high-quality products to minimise maintenance of lighting fixtures / structures.
- Ensure lighting is of sufficient quality and intensity to illuminate a path for people riding bikes.
- Shield lights sufficiently so they do not shine unnecessarily into people’s windows, as this can result in complaints and resistance to lighting on other pathways.
- Set back trees from the line of street lights – do not plant trees within 10 m (or outside illumination zone) of the front of the lighting assembly.
- Consider placing lighting columns in verges to facilitate bulb changes.

2.3.3.2 Detailed design phase

- Where the facility for people walking or bike riding is located alongside an existing road that is lit, integrate lighting into the existing service to reduce the number of poles and power costs.
- Concrete paths are more visible in low light.
- Incorporate concrete edges or edge lines into the design of asphalt paths as this is helpful for people riding bikes in low light conditions.
- Add lighting fixtures such as solar powered illuminated pavement markers where paths change in direction, especially on bicycle paths.
- Set back trees from the line of street lights and choose shorter trees / bushes to minimise shadows.
- Specify lighting equipment from the department’s Intelligent Transport Systems and Electrical Approved Products and Suppliers list.
- Ensure lighting poles do not encroach into the user envelopes of people walking or bike riding.
- Screen adjacent properties from unwanted light.

2.3.3.3 Maintenance phase

- Include bicycle routes as priority routes for lighting inspections.
- Prioritise lighting inspections on collector routes, where there are higher traffic speeds and volumes, in curves or bends, in dangerous areas.
- Based on inspection, cut back encroaching trees at known points that shield paths from the light sources.
- Undertake reactive maintenance for replacing broken or damaged bulbs in accordance with inspections.
- Replace or repair of broken or damaged lighting structures.
- Establish a cyclic lamp replacement program to reduce outages and call out costs.
- Inspect electrical wiring components at six-yearly intervals or as required.
- Insect columns for corrosion / damage at six-yearly intervals.
- Replace diffusers every 15 years.

Figure 2.3.3.3 – Maintaining lighting

		
Use spillover from adjacent road lighting wherever possible	Setback lighting from path edge	

2.3.4 Signage

Cycleway signage deteriorates due to ageing, traffic accidents, debris, storms, ultraviolet light and vandalism. Deterioration of signage reduces its effectiveness to warn people walking and people riding bikes of hazards which can create a safety issue. The absence of effective directional signage can lead people riding bikes into hazardous areas. Australian Standard AS 1742, the Queensland *Manual of Uniform Traffic Control Devices* Part 9 and Transport and Main Roads Traffic Control (TC) signs suite details regulatory, warning, guide and direction sign treatments for on-road and off-road bicycle facilities.

2.3.4.1 Planning phase

- Adhere to all planning maintenance minimisation considerations for vegetation control so signs will not be exposed to deterioration from vegetation (Section 2.2).
- Adhere to all planning maintenance minimisation considerations for vegetation control so vegetation will not cover signage on paths (Section 2.2).
- Create sufficient horizontal and vertical clearance from the path (minimum setback of 1.0 m) so signs do not become obstructions in relation to a pathway or a safety hazard to people riding bikes.
- Specify a minimum height of 2.5 m for signs to prevent the signs becoming easy targets for graffiti.
- Adhere to planning maintenance minimisation considerations for vandalism issues as this will minimise the potential for vandalism of signs (Section 2.4.2).
- Maximise visibility to signage. Do not plant large plants within a 75 m long area directly in front of road signage or choose plants that will not grow high enough to hide the sign.

2.3.4.2 Detailed design phase

- Use durable and high-quality products for signs from the approved supplier list for Traffic Engineering and Road Safety Approved Products – Retroreflective Sheeting Material.
- Use rotation-resistant fixings on all free-standing signs.
- Use flexible sign supports for signage in locations experiencing regular damage by errant vehicles (for example KEEP LEFT signage on refuge islands), as damaged poles can be a spearing hazard to people riding bikes and motorbikes.
- Harden verges in close proximity to sign support structures to reduce grass cutting.
- Adhere to detailed design maintenance minimisation considerations for vegetation issues as they will minimise deterioration and maximise visibility of signs (Section 2.2).
- Adhere to detailed design maintenance minimisation considerations for vandalism issues as this will minimise damage to and maximise visibility of signs (Section 2.4.2).

2.3.4.3 Maintenance phase

- Establish a regular inspection schedule and undertake programmed and reactive maintenance of signage.
- Clean, repair or replace defective or damaged signs immediately after inspections.
- Replace rigid steel poles with flexible sign supports where signage is regularly damaged by errant vehicles (for example KEEP LEFT signage on refuge islands), as damaged poles can be a spearing hazard to people riding bikes and motorbikes.
- Clean, repair or replace vandalised signs, dependent on severity of damage; when replacing damaged sign poles, ensure that the poles are not placed in the travel path.

Figure 2.3.4.3 – Maintaining signage

2.3.5 Bridges

As they deteriorate, bridge decks and their surfacing develop rough or slippery surfaces or gaps in the deck, particularly when made of timber. There can also be alignment issues with ramps and barriers on the approaches that are hazardous to users.

The department has different types of structures on the bicycle network constructed with a variety of materials, all of which require ongoing maintenance. As these structures tend to have common components, the department's *Bridge / Culvert Servicing Manual* contains a set of standardised servicing requirements that have been prepared for the following component groups:

- deck surface
- bridge substructure
- bridge superstructure
- timber bridges
- culverts
- guardrail and bridge rail
- sign and delineation
- waterway, and
- approach embankment.

These servicing requirements include preventative and reactive maintenance requirements that need to be followed to ensure future maintenance is minimised.

2.3.5.1 Planning phase

- Align the facility in relation to existing bridges, ensuring a smooth transition.
- Examine alternative material types with a view to minimising maintenance when planning bridge structures.
- Where hydraulic and economic considerations allow, plan for a culvert in preference to a bridge.
- Decide if the bridge is to carry vehicles and define the design loading.

2.3.5.2 Detailed design phase

- Attach pathways flush to bridges via the use of the department's Standard Drawings.
- Install bicycle-friendly ramp approaches from pathways to bridges for easier transition.
- Install warning signs if transitions include a sharp turn, or steep slope.
- Follow Standard Drawings and design procedures outlined by the department for kerb ramps and guardrail placement.
- Ensure all expansion joints are sufficiently sealed and joints are flush.
- Ensure bridge design allows for easy inspection of structural components, including any bearings.

- Select durable, low-maintenance materials for bridge design; for example, concrete and/or galvanised steel.
- Ensure design loads reflect the intended use and that overloads from vehicles are physically excluded if possible.
- When detailing access control devices for use on bridges, use elements / materials that will not rust.

2.3.5.3 Maintenance phase

- Observe the requirements of the department's *Bridge / Culvert Servicing Manual*.
- Cover bridge surface material in poor condition; for example, cover timber planks in asphalt or appropriate non-slip surface material. The type of existing structure may determine if concrete or asphalt may or may not be used for resurfacing, depending on the allowable dead load.
- Ramp trip hazards at pedestrian and bicycle facilities connections to bridges as a temporary measure.
- Grind any concrete trip hazards but not where structural reinforcing steel is likely to be uncovered.
- Ensure bitumen ridges at expansion joints are regularly ground flush.
- Replace existing failed joints.
- Prioritise bridge inspections on pedestrian and bicycle routes, paying particular attention to decks, deck drainage, barriers, ramps and joints.
- Clean off and paint rusting steel components as early as possible to minimise structural damage.
- Trim vegetation back from bridge to allow easy access for inspection and maintenance and prevent fire damage.
- Establish that maintenance vehicles will not overload bridge structure before use.
- Carry out routine maintenance to ensure internal mechanisms of bollards do not rust or seize.
- Clean bridge deck drainage including scuppers and clear dirt from decking.
- Only resurface a timber deck with asphalt if the structure can support the additional dead load.
- Repair any gaps in timber decking that could trap bicycle wheels.
- Do not use concrete or bitumen ridges to direct stormwater off the road.

Figure 2.3.5.3 – Examples of maintenance issues in bridges

			
Joint in bridge deck needs resealing	Timber kerb and deck damaged by guardrail displacement	Temporary plywood repair to timber deck	Gap in decking due to wood rot

2.4 Facility management

2.4.1 Vehicle access management

Vehicle damage refers to the deterioration and failure of pedestrian and bicycle facilities due to loading or effect by vehicles such as maintenance and emergency vehicles. Often, maintenance vehicles such as mowing support trucks or tractor slashers are the cause of pavement damage. This can result in safety issues for people riding bikes and people walking due to cracking, sub-base failure and missing sections of the facility at points where the vehicles cross or drive along a path. Maintenance vehicles must have access to bicycle facilities so that maintenance can be performed efficiently, and this should be accommodated in the planning and design.

2.4.1.1 Planning phase

- Limit the types of vehicles that may access the path through design and by installing regulatory signs.
- Plan for adequate width and access points so maintenance vehicles may enter and exit path corridors without damaging the facility.
- Determine the types of vehicles using the path during and after construction.
- Identify points of access that are convenient and easily traversed by maintenance and service vehicles.
- Provide regular shapes of the surrounding environment to allow proper mowing.
- Provide ease of access for mowing / slashing equipment by shaping lawn areas with clean flowing edge lines and safe slopes. A slope of 1 in 4 is traversable by mechanised maintenance. Steeper slopes require maintenance by people using hand tools.

  Slopes steeper than 1 in 2 should be considered unmaintainable and be treated with low maintenance plantings.

2.4.1.2 Detailed design phase

- Ensure correct design loads are used for the pathway. Using correct design loads will prevent structural failure of the path and associated surface defects.
- Limit inadvertent public vehicle access with control devices only if use by private vehicles is likely and infrastructure such as lightweight bridges might collapse under vehicle loading.

  Access control devices such as bollards and deflection rails are a safety hazard to path users and limit path capacity. When in doubt, leave access control devices out.
- Specify adequate compaction of sub-grade and pavement materials.
- Ensure widths and access points are available and adequate for maintenance vehicles.
- Locate access points that are convenient for maintenance personnel and easily traversed by maintenance and service vehicles to minimise the need for vehicles to cross pathways.
- Where vehicles are likely to cross the path, create a crossing point with stronger pavement design.
- When detailing bollards, gates or banana bars use elements / materials that will not rust.

2.4.1.3 Maintenance phase

- Enforce and prevent unauthorized vehicles from using path.
- If unauthorized access is an ongoing issue, establish access controls such as garden beds, fences, bollards or deflection rails. Access management should be located on straight sections of path.
- Repair any damage caused by maintenance vehicles as soon as possible if damage occurs. Immediately provide signs and barriers to protect people riding bikes and people walking from hazardous situations that result from the damage.
- Use a regular inspection schedule to check for damage caused by vehicles after maintenance.
- Regularly maintain fences and access gate fixtures and fittings for consistent and reliable operation.
- Postpone maintenance using heavy equipment after heavy rain to allow the ground to dry out and properly support the path.
- Where possible, drive on the grass instead of the path. Grass is easier and cheaper to repair than damaged path.

Figure 2.4.1.3 – Maintaining vehicle access in facility management

Public vehicle access to path is limited by banana bars while a slide rail gate is provided for maintenance vehicles.

2.4.2 Vandalism

Vandalism of pedestrian and bicycle facilities can lead to broken or damaged signs and lighting structures, accumulation of debris on the pavement and visually unappealing paths. Vandalism is often facilitated by poor or concealed placement of facilities. Concealed locations allow vandals to damage facilities without being noticed by the public.

Vandalised routes can limit path patronage by making legitimate users feel insecure; the path is then avoided by users, allowing further vandalism to occur unchecked.

2.4.2.1 Planning phase

- Adhere to the design principles published in the Queensland Government *Crime Prevention Through Environmental Design – Guidelines for Queensland, Part A – Essential Features for Safer Places.* Also refer to the *Road Landscape Manual – Safety* chapter.
- Specify minimum sign heights of 2.5 m as signs that are hung too low are easy targets for graffiti.
- Maximise visibility of pathway by the general public where possible.
- Locate paths so that they are overlooked from open space.
- Define use and ownership of paths by erecting barriers such as fences or vegetation but do not conceal the paths from public view.

- Avoid areas which have poor surveillance and concealed access routes.
- Adopt neighbourhood and centre urban design layouts which do not separate routes for people walking or bike riding from the street network.
- Provide facilities to encourage legitimate use (for example, seating, play equipment, circuit training equipment, skate / BMX / terrain park facilities, legal street art walls).
- Avoid creating narrow paths hidden from view behind fencing or at the rear of buildings.

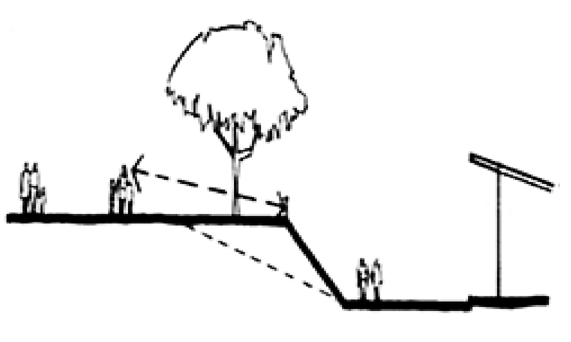
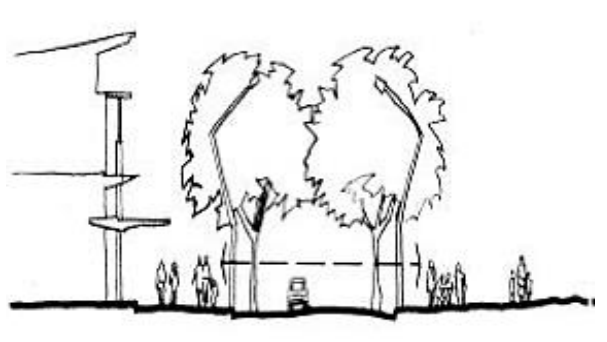
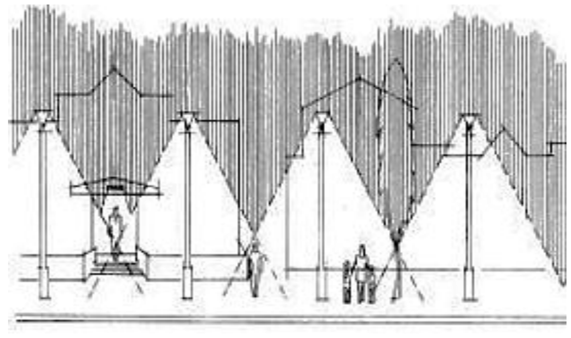
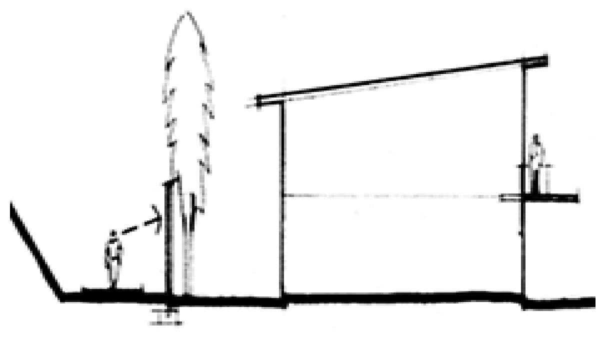
2.4.2.2 Detailed design phase

- Design paths to minimise sudden changes of grade and blind corners.
- Design landscapes to minimise interference with sightlines and create hidden areas.
- Use durable and high-quality products for path signs and markings that are graffiti-resistant.
- Use landscaping to reduce the appeal of surfaces for graffiti (for example, shrubs, creepers).
- Provide rotation resistant fixings for all new signs.

2.4.2.3 Maintenance phase

- Inspect path for vandalism.
- Clean or paint out graffitied sections of path without compromising path surface friction.
- Replace broken structures or signs.

Figure 2.4.2.3 (a) – Examples of maintenance issues attracting vandalism

	
Avoid sharp changes in grade	Design landscape to minimise interference with sight lines
	
Provide sufficient lighting	Do not locate paths in areas with poor surveillance and predictable root migration

Source: *Crime Prevention through Environmental Design (CPTED) Planning Scheme Policy*

Figure 2.4.2.3 (b) – Examples of vandalism requiring maintenance

Sign / map needs cleaning with suitable solvent	Graffiti on path should be removed promptly to discourage additional vandalism	Graffiti on walls needs to be painted out or removed promptly	Walls and signs are often targets

2.4.3 Debris

Refer to the department's *Road Planning and Design Manual* *Volume 3, Part 6A* for debris and maintenance considerations for paths.

Some debris may be seasonal (for example, Jacaranda flower litter) or event based (for example, storm events, broken glass after large public events such as firework displays, football grand finals).

Erosion is an issue that affects facilities for people walking or bike riding located next to steep terrain or where the landscape has been excavated to accommodate new infrastructure. In such terrain, well-designed batters and drainage is required to minimise erosion and deposition on the path.

2.4.3.1 Planning phase

- Locating the pathway further from vegetation, waterways, shops and high-use areas such as bus stops or with appropriate buffer zones will reduce the accumulation of litter and debris.
- Contractual agreements for programmed and reactive clearing of debris on the facility (for example, mechanical sweeping) should be set in place with local councils before installing the pathway.
- Check with councils during the planning stage for proposed developments that may be scheduled to occur near the facility which may create potential debris.
- Consider the need for litter bins, given likely path use and adjacent land use.
- Locate bus shelters away from a pedestrian and bicycle facility, including on-road bicycle facilities where possible.
- Adhere to planning maintenance minimisation considerations for vegetation issues as this will minimise debris caused by vegetation (Section 2.2).
- Provide adequate clearance between paths and the toe of batters so that material (for example, litter, mulch, soil) does not wash onto paths during rain storms.

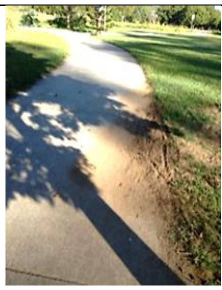
2.4.3.2 Detailed design phase

- Choose pavement surface materials that minimise debris as they age in high-use areas.
  - concrete will provide the hardest most durable surface with the longest lifespan but comes with higher construction costs
  - asphalt is more likely to produce debris (for example, loose stones) and requires maintenance to maintain a smooth surface, and
  - granular (unsurfaced) paths produce the most debris as well as being prone to washouts, rutting and erosion, and require regular maintenance for a consistent surface.
- Specify the quality, strength and durability of chosen materials in line with standard materials and suppliers from the Transport and Main Roads Technical Specifications where appropriate.
- Design path pavements for correct design loads, including maintenance vehicles.
- Specify failure reinstatement standards using non-granular material where possible.
- Design barriers or fences to stop falling rocks and debris from migrating onto paths where the pathway is located next to steep slopes and embankments.
- Require kerbing on the path edge at the base of steep slopes.
- Adhere to detailed design maintenance minimisation considerations for vegetation issues as this will minimise debris caused by vegetation (Section 2.2).
- Identify the best locations of litter bins to promote use and ease of litter collection; recommended bin placement locations include seating nodes, shelters, vista points, amenity blocks, carparks, near food outlets and in areas where other maintenance is required.
- Eliminate waterborne debris accumulation and avoid inundation from flow paths crossing path surfaces with adequate drainage of the path and surrounding area.
- Reduce the presence of loose gravel on roadway shoulders by paving adjoining accesses.

2.4.3.3 Maintenance phase

- Establish a regular sweeping schedule for routine, reactive and special sweeping needs (for example, high debris areas such as adjacent to food or liquor outlets. Give particular attention to bends, turns, transitions, and bus stops).
- Mechanically sweep paths during and after maintenance on the pathway, adjacent vegetation or infrastructure next to the pathway.
- Extend roadway sweeping regimes to the very edge of roads containing on-road bicycle lanes and ensure that debris is not swept into shoulder gullies.
- Undertake inspections to assess effectiveness of routine sweeping regimes.
- Provide additional bins where litter is a continuing problem.
- Undertake inspections following storm events for debris or fallen vegetation.
- Reduce the presence of loose gravel on roadway shoulders by sealing adjoining accesses.
- Grade back verge in areas where water-borne debris is deposited on the path to improve drainage and encourage deposition away from the path.

Figure 2.4.3.3 – Maintenance issues associated with debris

				
Debris on path from high tide	Sand from adjacent playground covering path	Park runoff depositing debris on path	Litter from road will wash on to path in next storm and should be picked up	Debris from vegetation maintenance left in drain

2.4.4 Preventative maintenance

The department has its maintenance work for assets including footpaths and cycleways divided into three programs:

- routine maintenance – reactive and cyclic interventions to repair damage, maintain safety, prevent further damage from deterioration and maintain amenity and appearance.
- program maintenance – primarily the resurfacing of bituminous pavement on a cyclic basis at around 10–15 years, depending on the type of surface, and
- rehabilitation – the refurbishment of the facility at the end-of-life of major components such as the pavement by overlay or reconstruction at around 20–40 years.

These maintenance programs are interdependent. The cycle of program maintenance and rehabilitation can be extended considerably by timely routine maintenance, including repairs, such as pothole patching crack sealing, and cyclic activities such as inspections, vegetation control, drainage cleaning and repair.

To gain maximum benefit from routine maintenance as well as fixing the damage, the underlying cause of the damage usually needs to be addressed to prevent recurrence and further routine maintenance in the same location.

Integrating routine maintenance of pedestrian and bicycle facilities into contracts for associated road facilities is one way for bicycle facility owners so routine reactive and minor preventative maintenance is not forgotten. Stand-alone facilities may warrant a separate maintenance contract or they can be appended to the list of roads to be maintained in an existing contract.

Regular inspections, timely repairs and programmed maintenance are required to minimise life cycle maintenance costs.

The most effective way to plan for pedestrian and cycleway asset maintenance and renewal over the long term at minimum cost is to include them in the department's asset management systems and prepare a comprehensive asset management plan for them.

2.4.4.1 Inspections and defect reporting

Bicycle path routine maintenance programs should include cyclic inspections of the facility to report any deficiency and generate a schedule of repairs for prioritisation and resourcing. In addition, inspections should be carried out after storms and flooding which are likely to create debris on the path or in drainage structures or other damage to the facility or associated vegetation.

Bridge, major culvert and electrical specialist inspection programs also need to be conducted at the required frequencies to ensure the safety of the facilities. Signage indicating an e-mail address or hotline for defect reporting should also be considered.

2.4.4.2 Timely repairs

Regular maintenance activities on paths and lanes should include:

- filling of pavement cracks and potholes
- milling or asphalt ramping of steps in the pavement at joints or cracks
- trimming or removal of grass so that it does not intrude into the path
- sweeping of paths to remove debris such as broken glass and fine gravel (including that arising from construction and maintenance activities such as crack sealing)
- repainting of pavement markings
- cleaning of signs
- restoration of vandalised facilities
- trimming of trees and shrubs to maintain safe clearances and sight lines
- patching of pavement surface to reinstate waterproofing, and
- root control.

2.4.4.3 Programmed maintenance

Bitumen oxidises and shrinks over time, resulting in cracks and/or ravelling of the bituminous pavement surface. Timely resurfacing of bitumen pavements will maintain waterproofing and minimise water-related damage to the structural pavement layer and debris (that is, loose stones, gravel, soil).

This periodic resurfacing by overlay or mill and overlay is categorised as programmed maintenance by the department and is essential to ensure the long-term integrity of the facility. With concrete pavements, sealed expansion joints should be resealed on a regular basis and any unplanned cracking repaired as it occurs.

Figure 2.4.4.3 – Programmed maintenance

3 Further information

For further information on this guideline, please contact:

Vulnerable Road Users, Traffic Engineering
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