PART C

Chapter 5
Safety

June 2013

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Chapter 5 Amendments – June 2013

Revision Register

Issue / Revision No	Reference Section	Description of Revision	Authorised by	Date
1	-	Initial Release of 2nd Edition of Manual	Steering Committee	Jun 2013

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5.1 Introduction

The Department's primary objective is to provide safer roads to support safer communities. This is supported through the department's key policy documents. This section promotes safe function of the road network for all users; including, pedestrians, cyclists, local motorists, commuters, tourists and maintenance personnel. Landscape Architect's and Urban Designers need to be involved throughout all safety design processes for projects.

Safety must be considered throughout the design life of the project. This mitigates the risk of serious road accidents and contributes positively to a safe road corridor.

Safety considerations include, yet are not limited to resolution of clear zones, sight lines, sight distance requirements, vehicular, pedestrian and cyclist safety. The road landscape needs to be safe for all road users and should be designed to improve road safety, mitigate accidents and/or hazards, and where possible, encourage safer road user behaviour.

This chapter provides guidance and supportive instruction on safety requirements for design projects. These requirements shall be adhered to when reviewing and designing landscape and urban design proposals for new roads or existing road landscape upgrades. The Departments *Road Planning and Design Manual* must also be consulted in determining relevant clear zone and sight distance parameters.

All landscape and urban design documentation is to be developed under the supervision of a RPEQ. Landscape and urban design drawings and reports require review and certification by a RPEQ to ensure designs comply with relevant standards and do not negatively impact on civil and structural components of the project. The RPEQ, in consultation with the Landscape Architect, shall review the drawings and understand the impacts of the landscape treatments on the civil and structural design components. The signature on the drawings demonstrates the RPEQ's responsibility to direct, oversee and evaluate the work of others providing input to the project has been complied with as per the legislation.

This chapter contains:

- **Crime Prevention Through Environmental Design (CPTED)**
  Promoting a safe and secure environment for all users through design mitigation of public safety risks.
- **Road Safety and Landscape Design**
  Providing a safe and hazard free road landscape.

5.2 Benefits

The benefits of integrating safety within the road landscape are:

- reduced incidence of serious accident;
- creation of visual cues to improve legibility, awareness and reduce fatigue related accident;

- positive driver behaviour;
- safe work environments for TMR maintenance personnel; and
- improved user safety in pedestrian and cyclist zones.

5.3 Crime Prevention Through Environmental Design

The practice of CPTED is an important consideration in reducing the incidence of crime against people and infrastructure within or adjacent to road corridors. Utilising the broad strategic concepts of CPTED can improve public safety by applying a range of site specific principles into the design and management of the road landscape. The overarching premise of CPTED within the road landscape is that appropriate design can minimise and discourage the physical opportunity for criminal incidents. This leads to a reduced fear of crime and increases an individual's perception of personal safety. Enhanced public safety ultimately improves the enjoyment of the road landscape by the community.

CPTED can be applied within the road corridor by utilising design principles and visual cues to highlight the boundaries and purpose/s of particular spaces. Specific design treatments and components can also be used to influence the perceptions and behaviour of users. Implementation of CPTED principles define appropriate and acceptable behaviour, encourage legitimate use of the site and create feelings of security for users.

5.3.1 Concepts and Principles

The three main concepts are:

- crimes against people and infrastructure are less likely to occur if other people are around to intervene if illegitimate uses of spaces occurs;
- passive surveillance: the presence of people in adjoining buildings and spaces plays a major role in being able to see, monitor and report what is happening in the public realm; and
- giving people safe choices about where to be, how to anticipate and respond to potential threats, improves personal safety.

These concepts provide a broad basis for design within the public realm, including road corridors. Specific principles provide guidance on the planning and design of public spaces, as well as the interface with private space.

The six principles of CPTED are:

- surveillance;
- legibility;
- territoriality;
- ownership;
- management; and
- vulnerability.

These principles are complementary to each other. They need to be applied holistically, not in isolation. This ensures balance between them. These principles need to be considered throughout all stages of a road project. When applied to the physical and functional context, the optimum public safety enhancements may be achieved.

Consultation with local authorities, the Queensland Police Service, local schools and community groups may also facilitate awareness of key target areas. This can lead to the formation of informal

working groups or partnerships to achieve common CPTED goals. It also assists in selection of measures being taken to reduce the likelihood and incidence of crime in a given area.

These principles should be applied to any open and/or enclosed publicly accessible space within the road corridor. This includes:

- parking areas;
- pedestrian walkways;
- cycle routes;
- rest areas;
- bridge overpasses;
- pedestrian underpasses; and
- bus shelters/ platforms.

The siting of all of these facilities have the potential to impact road geometry and significantly change civil design parameters. The design team should investigate alternatives which can minimise the safety risks associated with these spaces.

5.3.1.1 Surveillance

Maintaining natural surveillance is a key to reducing risk. Natural surveillance relates to publicly accessible areas being under observation by users of the adjacent spaces, residents and businesses. A sense of safety is created when users are under observation. A perception of risk or detection for potential offenders is also produced. Public spaces within the road corridor should be designed and managed to maximise the potential natural surveillance opportunities from surrounding areas (Figure C5-1).

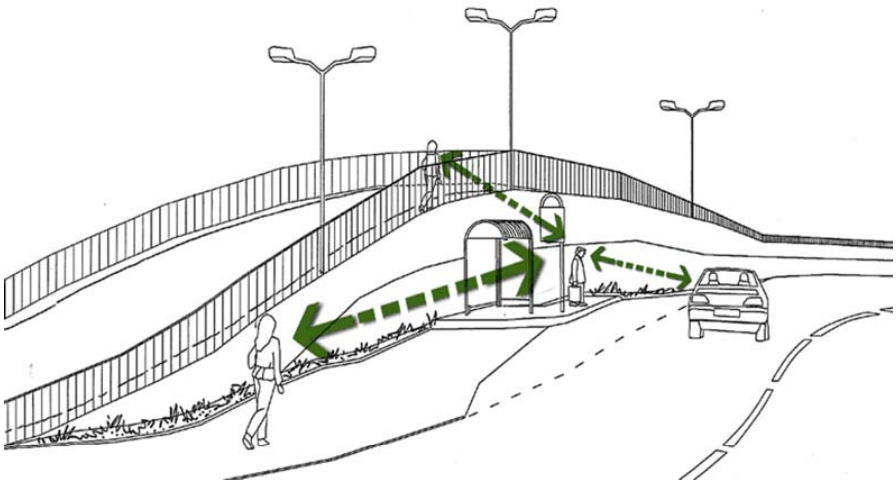


Figure C5-1: Maximise clear sightlines

Road landscape and urban design responses to support ***surveillance*** are:

- providing and maintaining unimpeded sightlines (Figure C5-1 and C5-5);
- avoiding blind spots, creating greater opportunities to see and be seen (Figure C5-5);
- utilising usually permeable materials that improve surveillance (Figure C5-3);
- providing well designed useable space that support natural surveillance (Figure C5-4)
- distinguishing differences in day and night usage of spaces and capacities for surveillance;

- providing spaces that are visible prior to entering and on exiting;
- using adequate lighting to avoid shadows and glare; and
- facilitating and encouraging legitimate community and/or individual activities and uses.

Figure C5-2: Improved surveillance through open style fencing

Figure C5-3: Improved surveillance through open weave wire mesh material selection

Figure C5-4: Improved surveillance through well designed useable and clearly defined space

Figure C5-5: Improved surveillance through transparent panels enabling multiple cross views to and from bridge

5.3.1.2 Legibility

Road landscapes should be designed and managed with a high degree of legibility, particularly pedestrian and cyclist areas (Figure C5-6). This ensures that users:

- may identify important or appropriate safe routes to take;
- may identify which places or routes are most likely to be frequented by other users; and

- are unlikely to become lost.

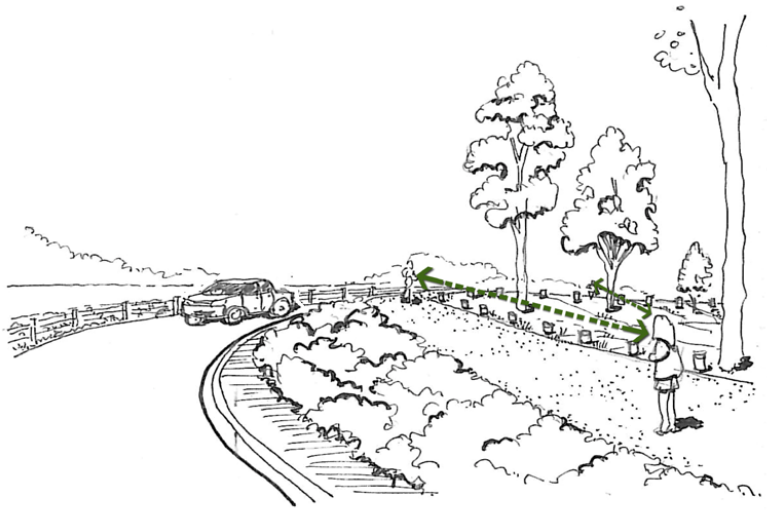


Figure C5-6: Improved surveillance through legible open design

Road landscape and urban design responses that support ***legibility*** are:

- spaces that are simple to navigate (Figure C5-7);
- boundaries are defined and functional use is easy to interpret;
- access to services (such as bus stops) that are both visible to users and in a logical position;
- building upon existing or creating new features that form landmarks, aid legibility and create space (Figure C5-8);
- clear entrances and exits which are easily identifiable both day and night; and
- clear signage identifying elements such as streets, and directions to services and/ or help areas.

Figure C5-7: Improved safety through legible design that is simple to navigate

Figure C5-8: Improved legibility through features that form landmarks

5.3.1.3 Territoriality

Territoriality is related to the instinctive desire to protect an area used or maintained by an individual and/or group. It relies on the principle of ownership in which individuals respond by protecting their territory. When designing and maintaining territorial spaces, it is necessary to balance unclear delineation between private and public space, with definite boundaries (Figure C5-9). This can be achieved by the use of both physical and visual boundaries.

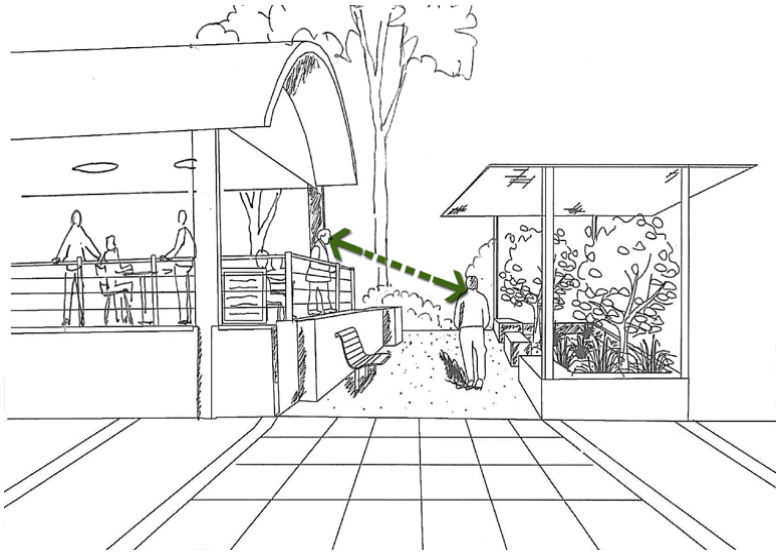


Figure C5-9: Improved safety through clearly defined private boundaries

Safety is improved by clearly defining boundaries between private, semi-private and public space. Ensure that security and natural surveillance into and out of a given area are maintained by defining of boundaries. Territoriality should be defined without significant compromise to surveillance opportunities. The need for surveillance must be balanced with territorial features in the design of the road landscape (Figure C5-10). Acknowledging the need for surveillance even in external private areas is important, particularly where they are physically accessible from publicly shared spaces.

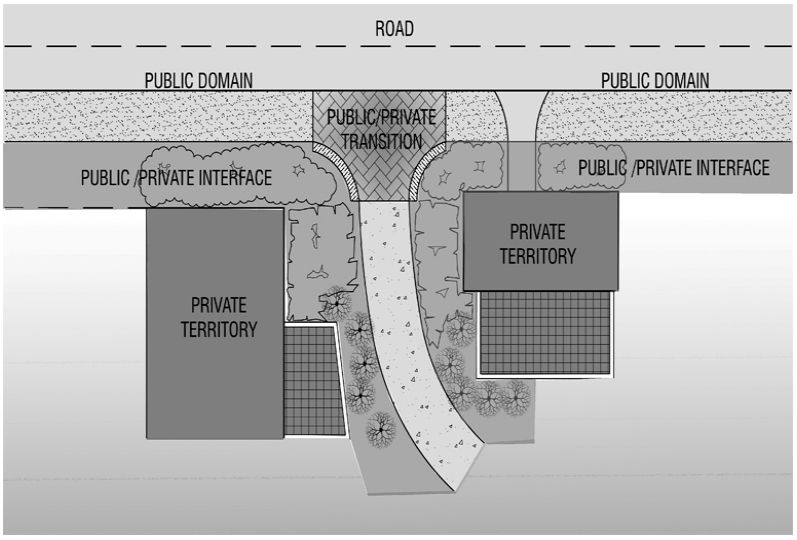


Figure C5-10: Improved safety through clearly defined territorial boundaries

Road landscape and urban design responses that support ***territoriality*** are:

- defining boundaries without using harsh devices such as walls, high fences and keep out signs; instead utilising subtle changes in paving, furniture and vegetation to delineate boundaries; and
- utilising design components such as changes in texture and material, planting, changes of level, artwork and signage to define public versus private spaces (Figures C5-11).

Figure C5-11: Territoriality reinforced through material selection

5.3.1.4 Ownership

A community's sense of ownership of an area enhances their response to criminal behaviour and increases the effectiveness of natural surveillance. Ownership increases the sense of respect for one's own property, reducing the incidence of crime. It also fosters pride in local surroundings, ensuring ongoing care and maintenance of the road landscape. A sense of community encourages individual ownership as well as shared responsibility for personal security. Urban design elements such as paving and retaining walls designed to reinforce community values and create a sense of place improves ownership of public spaces (Figure C5-12 and Figure C5-13).

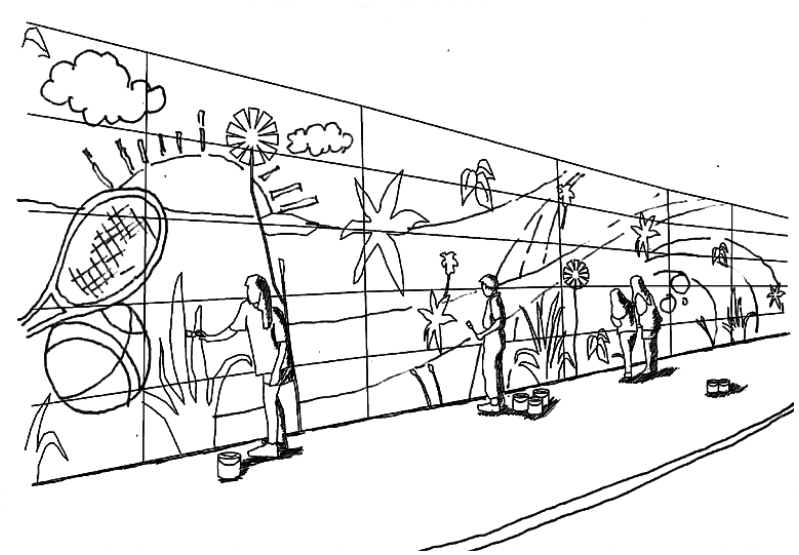


Figure C5-12: Improved ownership of public space through sensitive design

Road landscape and urban design responses that support ***ownership*** are:

- involving the community in decision making processes where proposed changes impact on their immediate surroundings;
- developing alliances with key agencies and stakeholders who have responsibility for the development and management of safety strategies and long term community ownership;
- recognising the needs, aspirations and cultural values of various groups within the community through consultation processes; and
- encouraging the involvement of the community in implementation of local enhancement works, particularly on sites or areas where a sense of pride, attachment and frequent use is present.

Figure C5-13: Improved ownership through subtle artwork

5.3.1.5 Management

Spaces need to be maintained; this inturn preserves the quality of its visual appearance and protect its legitimacy as a community area. Sound management principles contribute to economic sustainability, ensuring a space is used as intended. Well maintained spaces convey messages to potential offenders that the community cares about the image of the place. Routine maintenance and auditing systems need to be incorporated into the road corridor management practices.

Road landscapes must be designed to minimise undue maintenance and damage by vandals (Figure C5-14). The functional and aesthetic qualities that make the place attractive to the community should not be compromised. Routine maintenance practices and repairs are to be implemented to maintain the public amenity of places. A regular auditing scheme of CPTED issues should also be implemented.

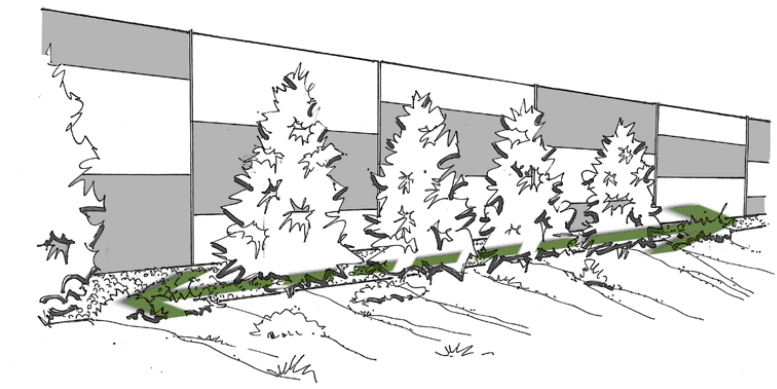


Figure C5-14: Strategic design that minimises maintenance management

Road landscape and urban design responses that support ***management*** are:

- using robust urban design fittings that are not easily removable, fragile or delicate (Figure C5-15);
- limiting graffiti opportunities through specifying resistant finishes, effective systems of quick replacement, cleaning and/ or repair;
- restricting vandalism through preventing access to susceptible areas; and
- implementing systems and procedures for regular long term maintenance and ongoing care of assets; not purely being the result of reactive responses to vandalism.

Figure C5-15: Maintenance management minimisation through robust material choice

5.3.1.6 Vulnerability

Poor spatial design can contribute to making public property and people more vulnerable to attack than others. Isolated places make people feel vulnerable. Maintaining visibility and access to other people in the immediate vicinity reduces the sense of vulnerability and improves safety (Figure C5-16). Designers must seek to reduce the potential vulnerability of a space at all times. The risk of assault is significantly reduced by providing well-lit, active and overlooked spaces. Reducing vulnerability through design should also be consistent with the differing uses and purpose of a place.

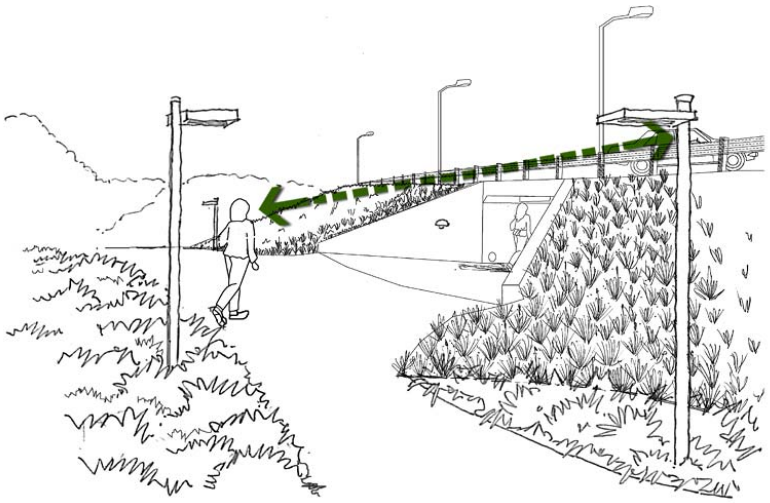


Figure C5-16: Improved safety through maintaining visual connections

Road landscape and urban design responses that addresses ***vulnerability*** are:

- eliminate personal harm by integrating throw screens; particularly on vehicular bridges and/or overpasses, and pedestrian/ cyclist footbridges to prevent objects being thrown onto the roadway;
- designing infrastructure components and spaces in a manner which avoids the creation of hidden places close to pedestrian and cycle travel routes, particularly at paths, blind spots or bends;
- improving urban design treatments to isolated and poorly lit places where movements and activities of people are easily predicted;
- improving the capacity for public response and access in highly concealed or entrapment areas;
- ensuring lighting is designed to improve visibility in spaces which have strong shadows and produce dark places;
- encouraging a mix of activities in a space;
- using visually permeable fencing and planting instead of walls and barriers, particularly in car parking and pedestrian facility situations;
- integrating pedestrian links with vehicular corridors wherever possible, ensuring pedestrian/cyclist bridges or tunnels allow adequate surveillance opportunities;
- limiting or preventing access to places that cannot be sufficiently monitored;
- providing design solutions that allow for increased surveillance (Figure C5-17);
- utilise materials that improve surveillance (Figure C5-18 and 19); and
- incorporating professional and/or mechanical surveillance systems in particularly vulnerable places.

Figure C5-17: Improved safety through designs that provide open areas that improve surveillance

Figure C5-18: Improved safety through careful design that improves surveillance

Figure C5-19: Improved safety through material selection

The Department's graffiti management policy should be referenced when implementing CPTED principles within the road landscape.

5.3.1.7 User Safety Perception

To maintain user perceptions of safety, openness versus enclosure must be balanced. Urban design detailing assists this perception when located close to pedestrian thoroughfares. Design features, particularly those that are relatively tall, solid and bulky can create a perception of enclosure. This can contribute to a sense of user discomfort and reduced perceptions of safety.

Selecting appropriate forms, colours and plant species relative to the overall profile of urban design components reduces user perceptions of enclosure. Reducing the perception of enclosure and scale can be achieved within the road landscape by implementing CPTED principles and appropriate design responses. This contributes toward visually permeable outcomes.

Using transparent urban design materials and plants with an open habit, or aesthetic detailing of bridge components are effective ways of improving user perceptions of safety.

The prospect and refuge theory is concerned with providing users views over the surrounding landscape, balanced with a degree of protection and enclosure. Applying this theory reduces a sense of exposure and safety fears. An example is on pedestrian footbridges, where views out from throw screens are optimised, yet perceived protection from potential attack is mitigated.

5.4 Road Safety and Landscape Design

5.4.1 Scope

The safety requirements for road landscape are unique to other elements within the road network, as the landscape construction medium is dynamic; it changes over time, due to natural forces or human intervention. It is for this reason, that whilst safety requirements for landscape works are calculated using the applications applied to civil design, the outcomes are specific to the landscape medium. For each new road scheme the safety requirements will be calculated by other disciplines (usually a civil designer), but it is the responsibility of the landscape designer to ensure landscape treatments do not impede or obstruct these safety requirements. The civil designer shall provide certification that the landscape design is compliant with relevant safety parameters.

5.4.2 Safety Analysis Process

The landscape designer must follow this safety analysis process. This process outlines the steps to assessing safety criteria. Each step refers to relevant sections within the manual which instruct the designer on the application and requirements of each criteria.

It is the intent of this section to provide a summary only of the relevant road safety design criteria that need to be determined, addressed and applied in road landscape design. For determining distances and offsets for road safety, designers are to refer to the Departments *Road Planning and Design Manual*.

Road project assessment: collates site specific information for the project.

- Clear zone: calculates clear zone requirements for all road types.
- Sight distance: calculates the requirements for all potential points of conflict.
- Clearance to other elements: calculates the vertical and horizontal clearances to all other elements.
- Pedestrian and cyclist safety: check and ensure landscape treatments comply with pedestrian and cyclist setback requirements.
- Functional planting for safety: consider landscape treatments are designed to assist in providing for a safe functioning road network.
- Maintenance: confirm landscape treatments are designed to satisfy road safety requirements without the use of maintenance.

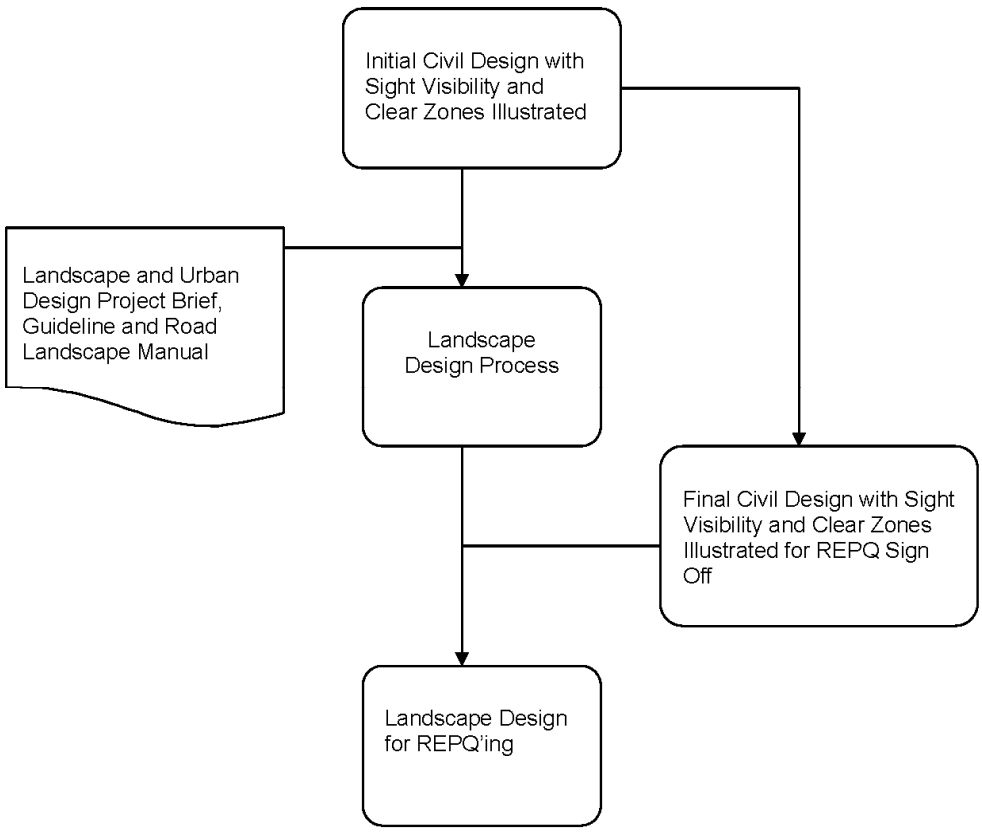


Figure C5-20: Safety analysis responsibilities

5.5 Road Project Assessment

Safety requirements are particular to each unique section of road. They are based on specific features within that section of road. In order to calculate safety requirements, an assessment of each proposed road project must be conducted to determine these features.

The road design information required on all road projects may include but not limited to:

- formation of the road; including details of median strips, interchanges, intersections, roundabouts;
- levels of service, including number of lanes and road users along this road section;
- design speeds of the major road/s, and all minor roads leading into junctions including the design speed on circulating carriageways and entry curves at roundabouts);
- traffic volumes, average annual daily traffic;
- road geometry, batter grades and configuration;
- road alignment, vertical and horizontal curvature of the road including curve radius, including sight triangles at intersection/conflict points;
- line markings, delineating lane lines, holding lines, stopping lines and turning lines;
- traffic signalisation and operational signage; and
- safety barriers and fencing.

Depending on the road project, the road design information should be requested from/ provided by the civil designer or the project manager. All detailed information must be supplied at the detailed design phase.

5.6 Clear Zone

The clear zone is a width (Figures C5-21 and C5-22) measured perpendicular to the road from the edge of the outside carriageway lane. It varies depending on several factors noted in the Road Planning Design Manual. It functions to provide space for the driver of an errant vehicle to regain control, while sustaining minimum damage to the vehicle and its occupants.

5.6.1 Landscape Requirements of Clear Zones

Clear zones shall be free of non-frangible objects, to minimise damage to errant vehicles and the occupants.

A non frangible object is a fixed rigid object which on impact does not breakaway or apart.

Landscape works occurring within clear zone areas are subject to restrictions on the types of treatments that can be applied to prevent landscape works becoming fixed roadside hazards. These restrictions also apply to medians and splitter islands due to their proximity to the carriageway which are subject to clear zone requirements. Clear zones should:

- be kept free of all large, fixed (non-frangible) landscape structures such as rigid support posts, street furniture, fencing and retaining walls;
- containing any tree and shrub planting having a maximum mature trunk diameter of 70-100 mm. (Frangible species are often formed by plants with slender stems, which give way, break or uproot on impact);
- maintain the above standards even if the landscape treatment is to be accomplished by seeding; and
- be applied to the deflection zone of safety barriers.

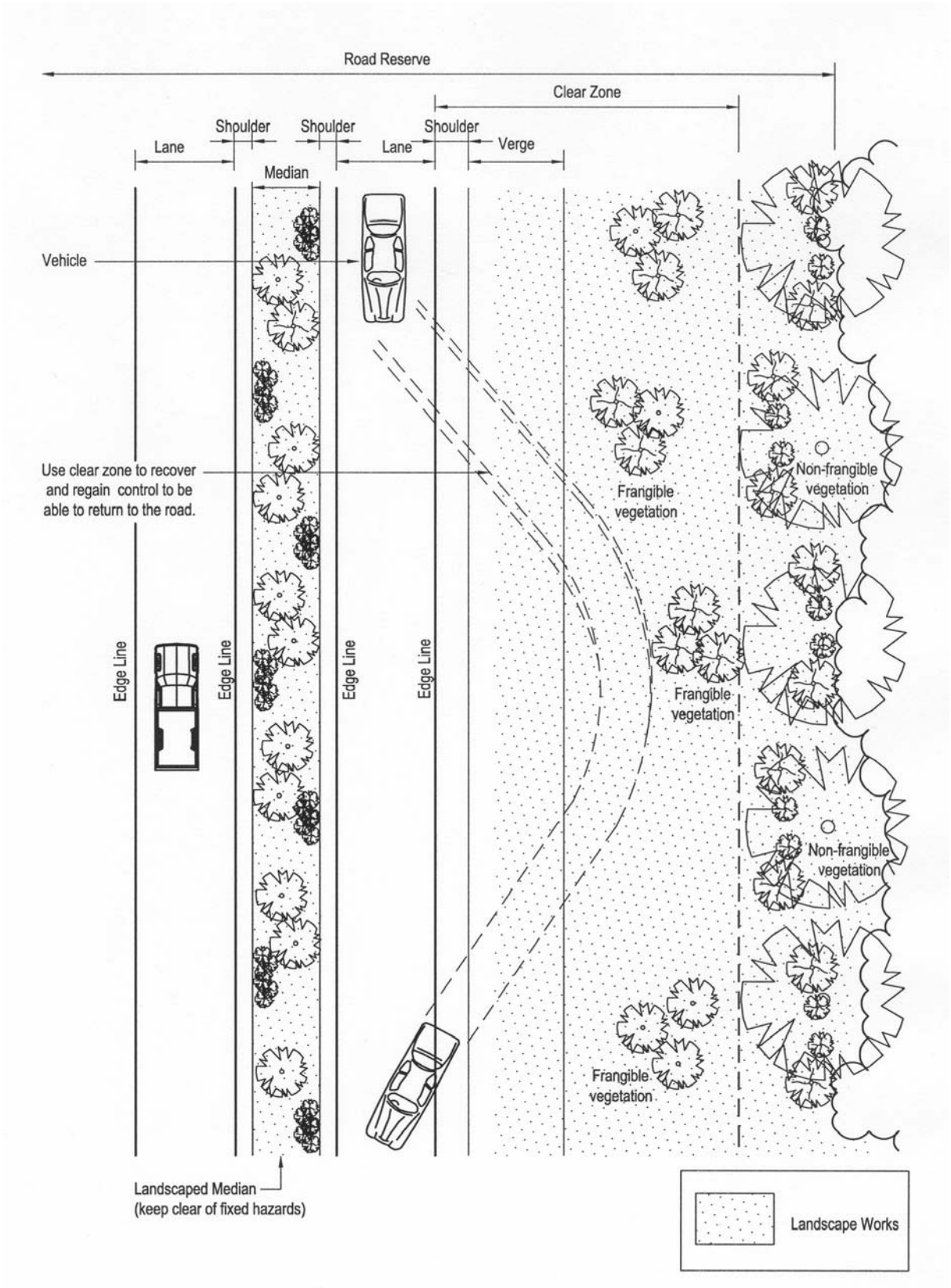


Figure C5-21: Clear Zone –Illustrative Plan

Source: Main Roads 2006

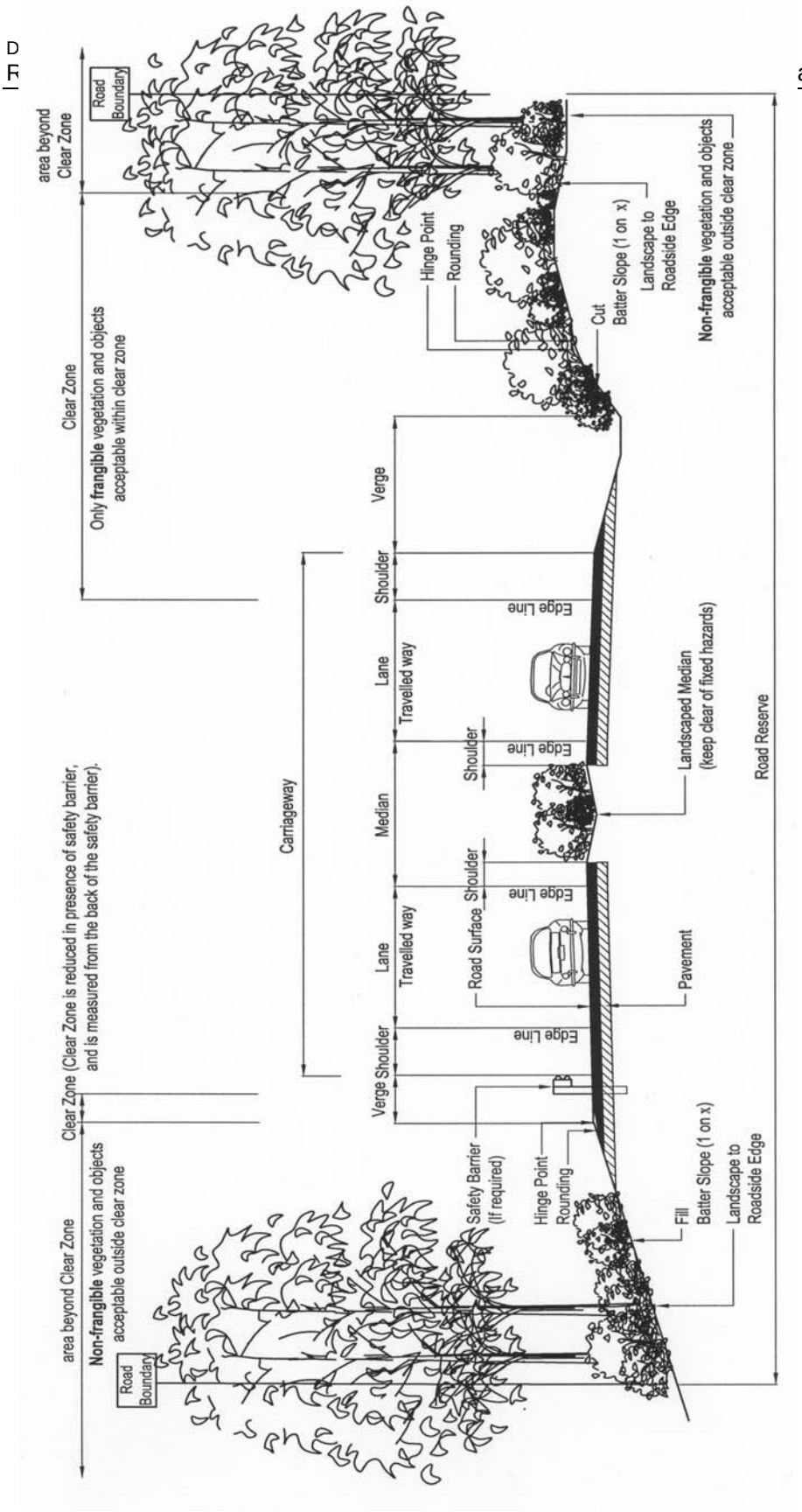


Figure C5-22: Clear Zone – Section

Source: Main Roads 2006

Where a stand of natural vegetation exists with high public amenity, environmental and cultural values *"which may preclude its removal or modification to fit within the clear zone requirements, then it should be treated like any other obstruction that cannot be reasonably removed and provided with a protective safety barrier. Such a decision should only be made after due consideration to the probability of accidents and likely costs".* (National Association of Australian State Road Authorities, 1984:18).

5.6.2 Calculating Clear Zones

To calculate clear zone(s) for a proposed road section refer to the Departments *Road Planning and Design Manual*.

The setbacks for non-frangible landscape works are significantly reduced when a safety barrier system is installed. Further guidance on the minimum setbacks for barrier systems is provided in the Road Planning and Design Manual.

5.6.3 Complex Clear Zones

Clear zones apply to all road sections, including the junctions of these roads or when site conditions are outside the parameters shown in the graphs and tables within the Road Planning and Design Manual. Where clear zones intersect, overlap or join each other, the clear zones simply join. Calculation of these complex clear zones is clarified below:

5.6.3.1 Intersection clear zones

Clear zones are calculated according to the design speed of each leg (road) involved in the intersection. At the intersection of these roads, clear zones (Figure C5-23) will also intersect to form an enclosed area, which is subject to the clear zone requirements. In the case of a tapered lane, the clear zone is determined by the design speed of the through road.

5.6.3.2 Interchange Clear Zones

Clear zones are calculated according to the speed environment of each through road (Figure C5-24), on-ramp and off-ramp as though they were stand alone roads.

5.6.3.3 Roundabout clear zones

Clear zones are calculated according to the design speed of each leg (road) entering the roundabout (Figure C5-25). Where these roads connect at the roundabout the clear zones will also intersect to form an enclosed area which is subject to clear zone requirements. Clear zones are also calculated for the central island using the design speed for the circulating carriageway. Clear zones are highly critical at roundabouts due to the increased number of single vehicle accident rates caused by *"a number of relatively small radius horizontal curves"* (Main Roads, (QLD) 2006:14-49).

5.6.3.4 Clear zones where site–specific features are outside typical parameters

Site-specific data such as the slope of the batter being steeper than 1:3 or the design speed greater than 100km/hr may be outside the typical parameters used to calculate the clear zone.

5.6.3.5 Other rigid objects in the clear zone

Regardless of the existence of other non-frangible objects within the clear zone (such as a power pole), the landscape designer has a duty of care to ensure that the outcomes of landscape treatments do not increase the potential of hazardous objects within the required area.

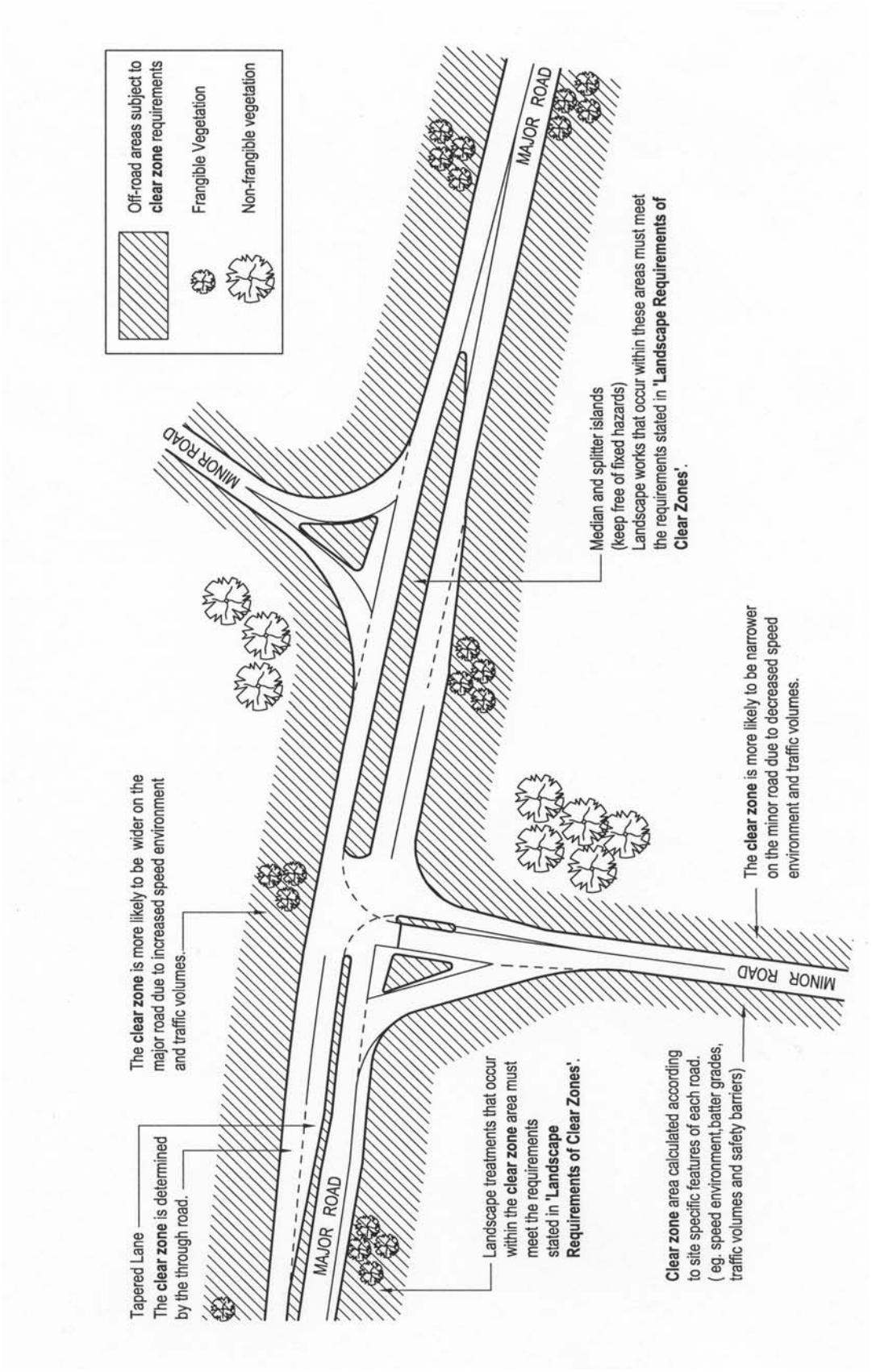


Figure C5-23: Off-road areas subject to clear zone requirements at an intersection – Plan

Source: Main Roads 2006

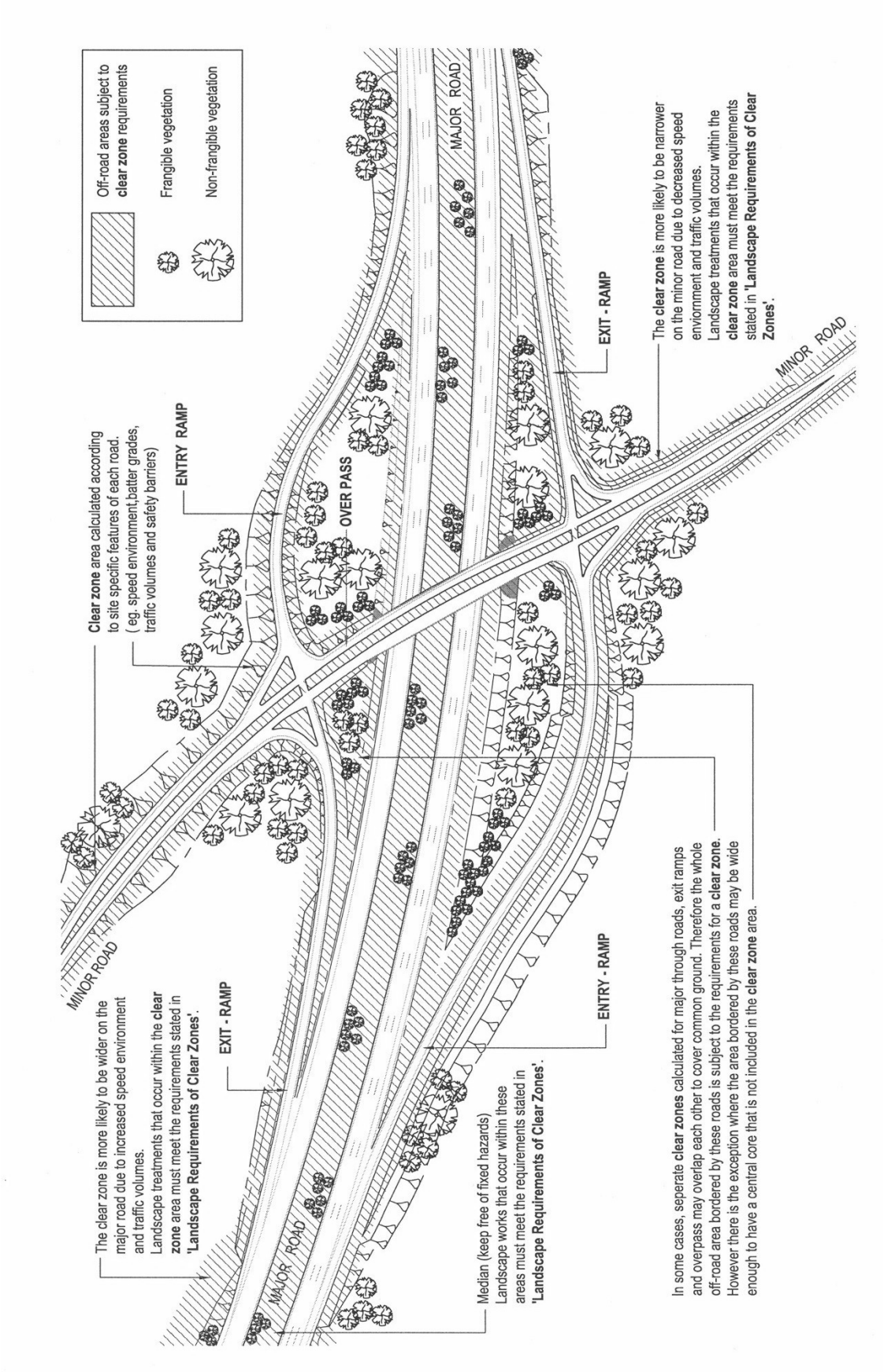


Figure C5-24: Off-road areas subject to clear zone requirements at an interchange – Plan

Source: Main Roads 2006

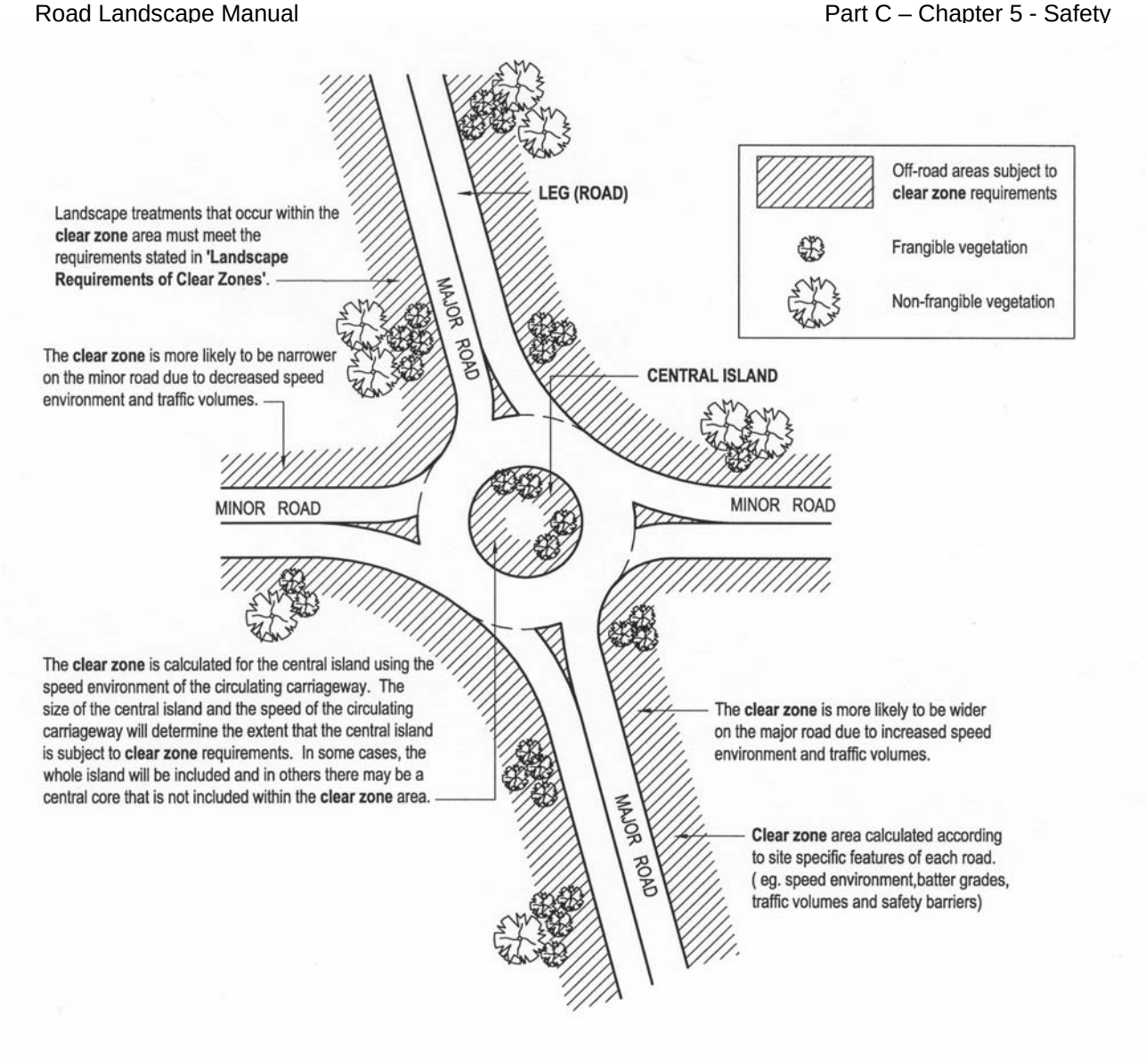


Figure C5-25: Off-road areas subject to clear zone requirements at a roundabout – Plan

Source: Main Roads 2006

5.7 Sight Distance

Sight Distance is the broad term given to all sight related safety issues in road design. *"Sufficient sight distance must be provided to enable drivers to control their vehicles to avoid collisions with other vehicles or objects on the road"* (Main Roads, (QLD) 2002:9.1). The landscape component can be both a vertical and horizontal element within the road corridor and can therefore have a significant impact on sight visibility.

The landscape requirements within sight distance zones (sight triangles) can only be achieved through an understanding of the safety requirements discussed in this section.

5.7.1 Landscape Requirements of Sight Distance

The sight distance triangle should have clear sight visibility across the entire triangle, both horizontally and vertically to allow time for a driver to assess, negotiate, manoeuvre and/or stop to avoid points of conflict with other vehicles or objects.

The landscape works which occur within the sight distance triangle are subject to restrictions. This is to ensure treatments do not obstruct sight visibility.

Landscape requirements within sight distance triangles include:

- landscape treatments and structures should not obstruct any sight line within a sight triangle that is required by for any vehicle or pedestrian moving along a designated pathway of the road network;
- plantings in these zones should provide a clear visibility both horizontally and vertically when the eye height and the target height are considered. This means that proposed mature plantings and landform combination heights should be at least 100mm outside the vertical limits of the sight triangle;
- plant species should be selected and located for their mature growth form and size;
- for sag vertical curves, care should be taken to ensure that canopies of trees planted in the roadside embankment do not block the line of sight . (Figure C5-26);
- in the case of horizontal curves, ensure that a clear line of sight is maintained across the landscape works proposed on the embankment of the roadway; and
- in some cases it is deemed acceptable to allow momentary sightline obstructions of narrow vertical elements such as poles or clear tree trunks within or on the border of a sight distance area. However attention should be paid to the accumulated affect of these elements, as they may form a wall or blind spot for the driver.

5.7.2 Calculating Sight Distance

The sight distance requirements for each design component of the road section (i.e. major road, minor road, intersections, roundabouts, and interchanges) should all be determined and assessed in combination, in accordance with the Departments *Road Planning and Design Manual* by the Civil Designer. The resultant sight triangles for all components of the road section should then be adopted as the basis of the landscape design.

5.7.3 Sight Lines and Road Alignment

The road alignment can restrict sight visibility. *"Restrictions to visibility may occur on vertical curves and on horizontal curves"* to roadways (Main Roads (QLD), 2002:9.2). There are two types of restrictions on the road alignment that landscape works could potentially obstruct; sag vertical curves and horizontal curves

Sag Vertical Curve Restrictions

Visibility may be restricted on sag vertical curves due to an overhead obstruction. *"Care should be taken in the design of landscaping in these circumstances to avoid the creation of a vegetation canopy that restricts sight distance in a similar way to overhead bridges"* (Main Roads (QLD), 2002:9.2.2). This situation is most likely to occur on narrower roadways (single or double carriageways) or where there is design intent to create an effect of tree canopies overhanging the road (Figure C5-26).

Horizontal Curve Restrictions – *"visibility may be restricted on horizontal curves due to an obstruction on the inner side of the curve"* (Main Roads (QLD), 2002:9.2.3), (Figure C5-27).

Horizontal curve sightlines are most likely to affect the landscape treatment, as the clear line of sight required is directly across the embankment of the roadway; the area where landscape treatment is typically applied. In some instances, *"the cut batter in this location can be the obstruction and alternatives such as benching, or a larger curve radius, may have to be applied by the civil designer"* (Main Roads (QLD), 2002:9-5).

The vertical sight line must be considered in combination with the horizontal sight line.

In the case where the intersection is signalised, the sight distance requirements for landscape works should still be achieved to cater for safe conditions when traffic signals are not functioning. However when intersections are signalised there are additional stopping sight distances to consider, such as a clear line of sight to the traffic signal lanterns and the rear end of a vehicle at the back of a queue of stopped vehicles. For more information refer to the Departments *Road Planning and Design Manual*.

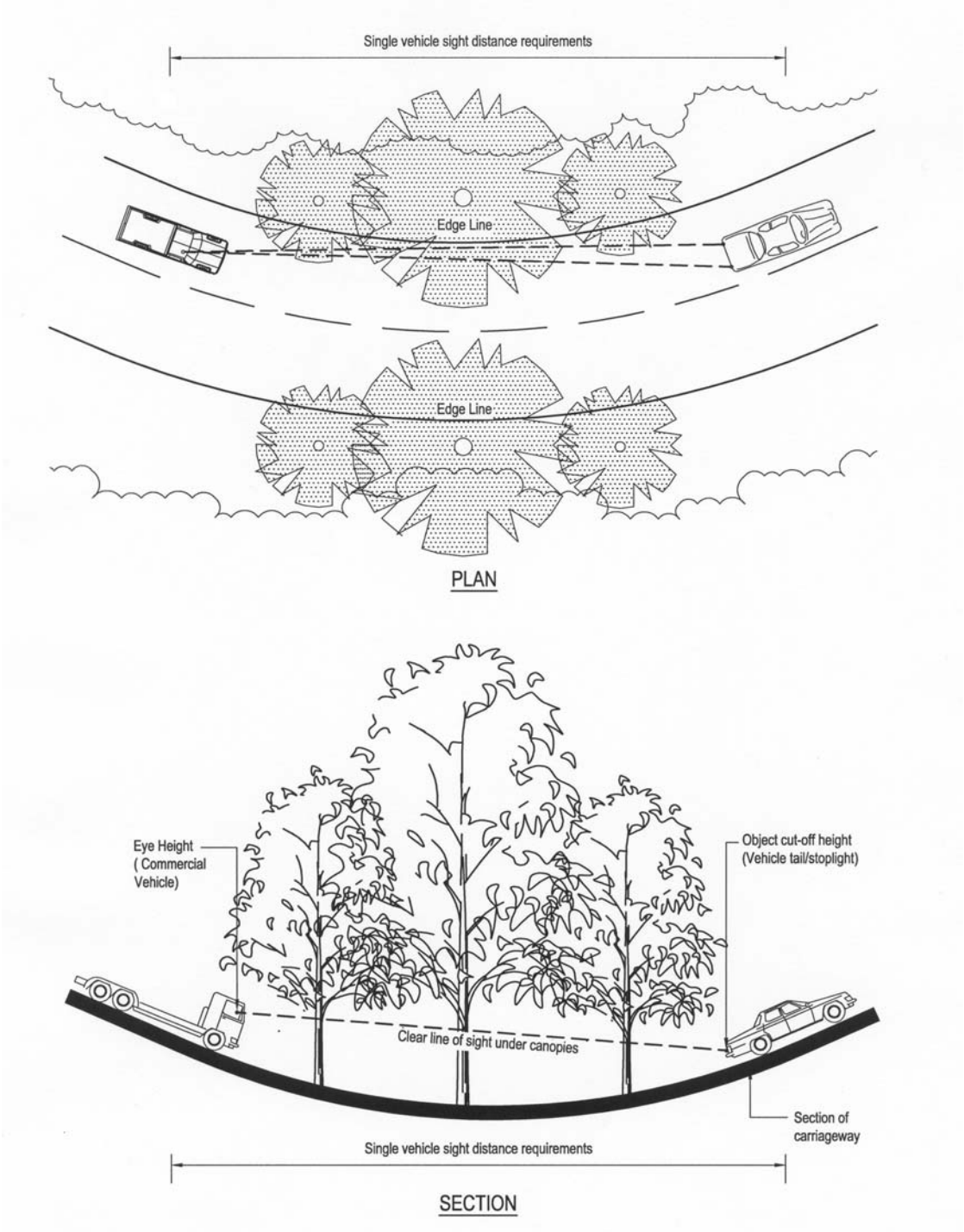


Figure C5-26: Sag vertical curve restrictions on landscape treatments to sight distance

Source: Information in Figure adapted from (Main Roads (QLD), 2002: Figure 9.2)

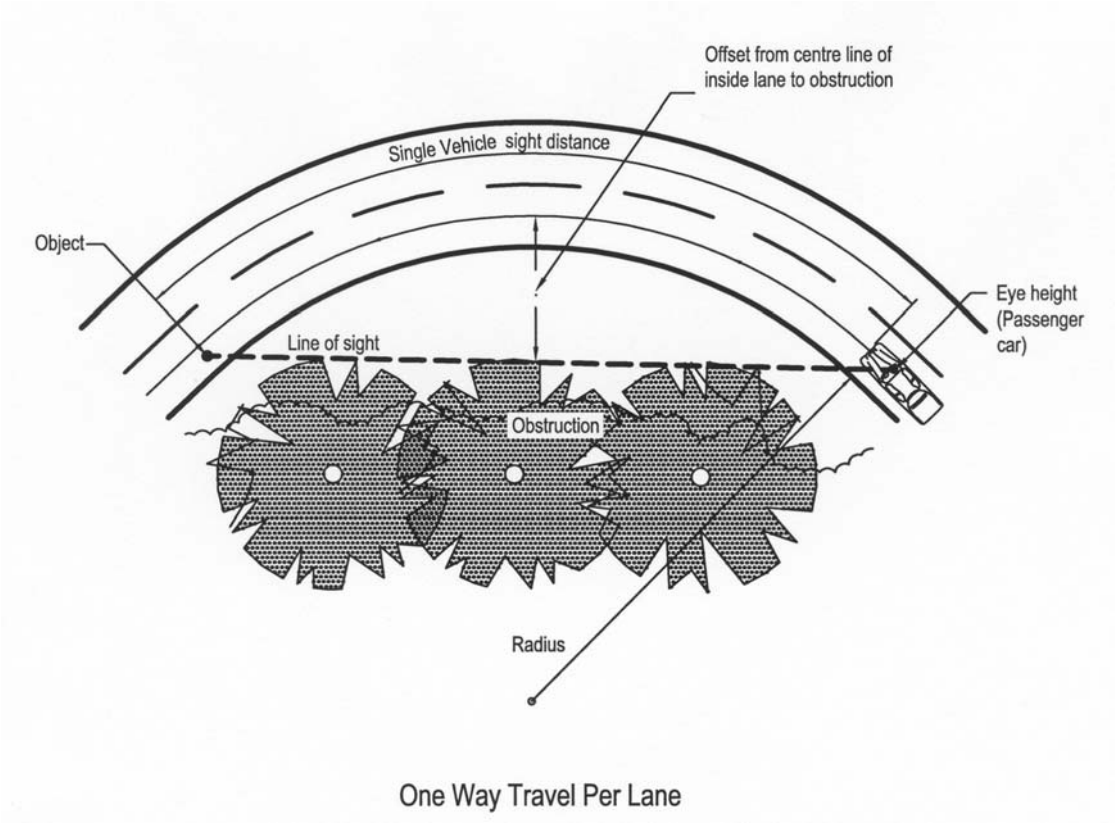


Figure C5-27: Horizontal curve restrictions to sight distance – Plan

Source: Information in Figure adapted from (Main Roads (QLD), 2002: Figure 9.3)

The difference between sight distance requirements for interchanges will be created by the overpass/underpass grade separation of two or more roads. All vertical landscape elements must be considered for roads that make up the interchange. For example, tree canopies that may not have affected the sight visibility at road level may affect an overpass that is above this road.

5.7.4 Sight Lines and Road Signage

Vegetation within the sight line triangle to operational signage shall have a mature height no higher than 500mm below the base of the sign (Figure C5-28).

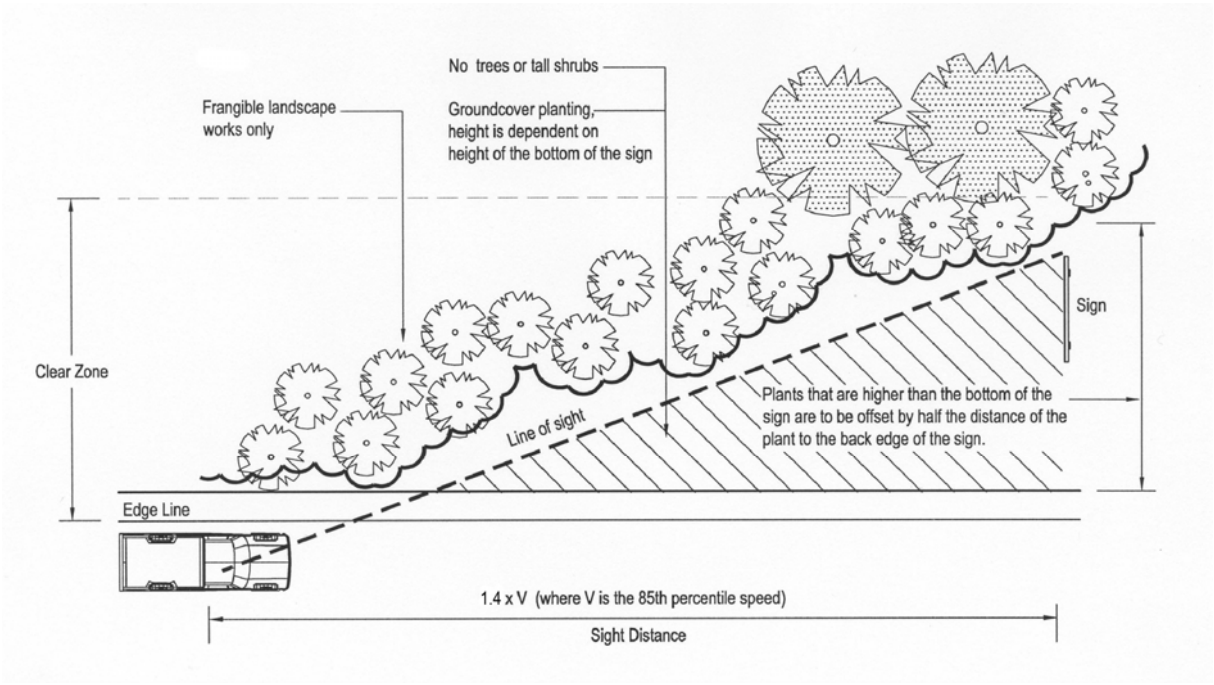


Figure C5-28: Restrictions on planting to allow sight distance to signage – Plan

Source: Information in figure referenced from (RCA, 1987: Technical Bulletin No. 36)

5.8 Vegetation Setbacks and Clearances

In addition to the safety requirements of clear zones and sight distance there are other setbacks and clearances (Appendix 4) to road landscape design components and other road elements that vegetation must comply with to ensure the safety of all users of the road network.

5.9 Pedestrian and Cyclist Safety

Areas and facilities that are developed for pedestrian and cyclist use must also comply with certain design standards so as to assist in the provision and maintenance of a safe road network. These facilities include:

- pedestrian footpaths;
- bicycle paths;
- footbridges and underpasses;
- pedestrian crossings, medians and refuges; and
- rest areas and off-road viewing locations.

The locations and design aspects of pedestrian and cyclist facilities within the road reserve must be developed by the civil designer. However, as with road safety requirements, the landscape designer must ensure that landscape treatments do not impede safety, and where possible, further promote the safety of all users.

The safety considerations and requirements for landscape works associated with pedestrians and cyclists facilities within the road reserve are listed below. For more information refer to the Departments *Road Planning and Design Manual.*

5.9.1 Clearances

Proposed landscape treatments must not impede the required horizontal and vertical clearances for pedestrian and cyclist facilities.

- **Horizontal clearances**
  No vegetation should hinder access and manoeuvrability of users by growing over or encroaching onto pathways. Refer to *the* Departments *Road Planning and Design Manual* for footpaths and cycle path horizontal width and clearance requirements.

- **Vertical clearances**
  No vegetation such as tree canopies and limbs, or landscape structures, should overhang pathways within the specified vertical clearances. For the specified vertical clearances on footpaths, cycle and shared paths, refer to the Departments *Road Planning and Design Manual.*

5.9.2 Sight Distance and Visibility

Landscape treatments such as vegetation, fencing or bollards shall not obstruct the motorist's sight lines and distance requirements to users of pedestrian and cyclist facilities, this includes:

- pedestrian refuges, medians and crossings, and
- junctions of footpaths, cycle paths, underpasses, and overpasses with the road.

Landscape treatments must not obstruct the pedestrian/ cyclist's line of sight and visibility providing and encouraging safety when using these facilities.

- Landscape works shall not block users/cyclists ability to see other users on the facility, allowing enough time for the user to stop or manoeuvre around an obstruction to prevent a collision. (Refer to the Departments *Road Planning and Design Manual*)

- Vegetation adjacent to facilities should be kept at a low height to allow visibility to and on facilities in order to:
  - provide a clear line of sight to signage which might warn users of changes ahead,
  - ensure lighting is not obstructed or creating shadows with the potential for hidden areas for undesirable activities, and
  - provide a perceived sense of safety and deter undesirable activities through encouraged viewer exposure.

5.10 Plant Selection

For planting in areas of high public exposure ”*care must be taken to select species that are not poisonous to humans and animals and do not have thorns”* or drop fruit and seeds or large quantities of flowers or leaves (slip risk), (California Transport, 2001:900-5).

5.11 Functional Use of Planting for Safety Factors

Landscape planting can be used to actively enhance safety objectives. Plant species selection must be based upon that species ability to achieve a specific design function.

5.11.1 Headlight Screen Planting

Planting can be an effective method to screen headlight glare from oncoming traffic, benefiting drivers and adjacent properties. The most common and effective application is to the medium strips of dual

carriageways, rural roads, roads adjoining railways lines, service roads and on horizontal curves (Figure C5-29). Dense shrubs and groundcovers with foliage to ground level are effective in preventing headlight glare.

5.11.2 Buffer Planting

Planting can be used as a safety buffer zone for "errant vehicles by cushioning the impact of the vehicle before it collides with more hazardous objects or other vehicles" (Grieves and Lloyd, 1984:98). Dense shrubs with trunks less than 70-100mm thick branches would best achieve this function.

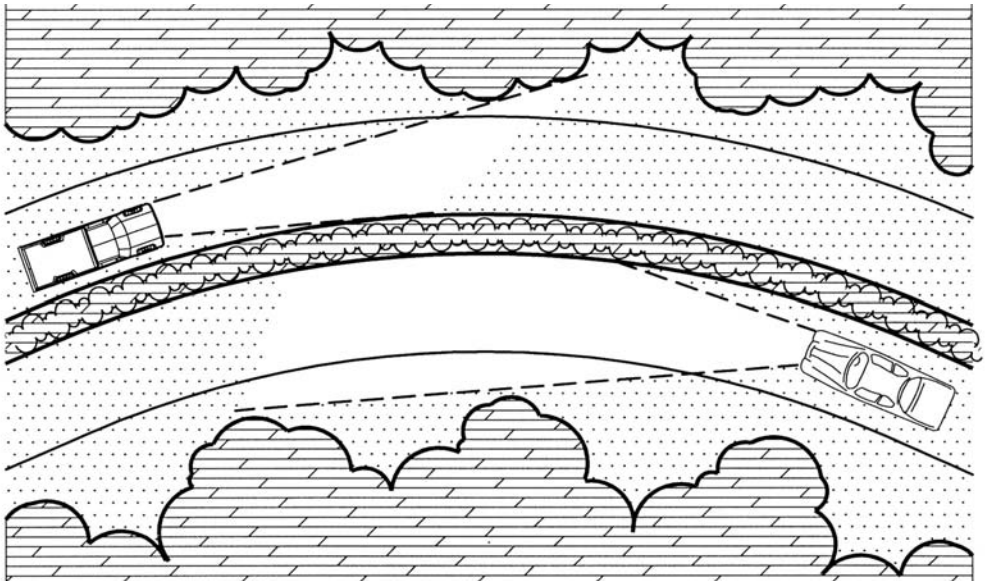


Figure C5-29: Median planting for headlight screening

Source: EDAW Pty Ltd

5.11.3 Visual Screening

Planting can be used to screen undesirable views both to and from the road, depending on the function required. It can prevent drivers from being distracted or be used to reduce driver monotony along stretches of road that do not call for changes of eye focus.

5.11.4 Public Amenity

The provision of public amenity can increase real and perceived safety within the road corridor. Landscape and urban design treatments are primary contributors to the creation of a sense of community and ownership that leads to safety improvements, as detailed in **'Crime Prevention Through Environmental Design (CPTED)'** Section.

5.11.5 Visual Guidance Planting

The road landscape can assist with the visual guidance of the driver *"when they are unfamiliar with the route or the visibility is affected (for example, through rain or heavy shadows)"* (Spooner, 1969:141). Planting can be used to exaggerate or provide these visual cues by:

- *"providing a visual backdrop against which the roadway can more easily be seen;*
- *highlighting an obstruction ahead such as a traffic island, or diverging roadway;*
- *screening disruptive features and views";*

- consistent use of contrasting planting at critical features in the road, such as intersections or roundabouts, to alert the driver of a change of movement;
- contrasting vegetation types, forms, textures and/or colours to help increase driver recognition of road delineation, such as the central island of a roundabout having vegetation that contrasts with the surrounding features;
- using plants, particularly shrubs, on the outside of curves to indicate and provide guidance to the change in alignment of the roadway. This is particularly effective on crests (Figure C5-30); and
- *"spacing of individual trees so that the successive interval between these vertical elements is indicative of the curved radius of the roadway"* (Department of Transport and Works - NT, 1988:68).

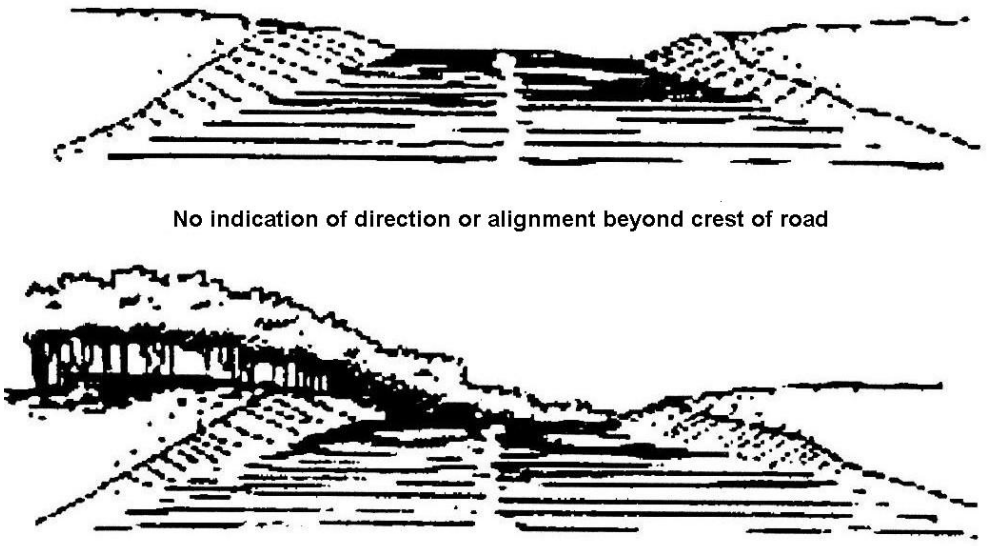


Figure C5-30: Visual guidance through planting

Source: Queensland Transport, 1993

5.11.6 User Perceptions of Speed

Trees and other types of planting can play a significant role in safety and traffic management. They contribute towards producing more positive and safer driver behaviour and increasing user perceptions of speed. Current research has also found that *"green roads compared to roads with no greening can assist in mitigating daily stress levels of drivers and their attitude to other drivers"* (Roads and Traffic Authority - NSW ii), 2009:p14).

Appropriate design, placement and spacing between trees and other types of planting within the road landscape, can assist in modifying driver speed; particularly when transitioning to a lower design speed. When trees are spaced in specific arrangements; such as planting trees increasingly closer together on the approach to a lower design speed, this can reduce driver speed through the perceptions created of travelling at a higher speed than actually occurring.

Transitioning to a different operating speed

The design of the road landscape can be useful in visually highlighting a change in the operating speed. It can also accentuate the progression to and transition from a higher operating speed to lower

operating speed road section. Distinguishing the speed progression and transition visually warns users well ahead of arrival what is beyond. It allows users to adjust from one situation or experience (such as a higher design speed section) to another (lower design speed section). The road landscape can be used to subtly signal speed progression and transition zones; enhancing user perceptions of an impending slow down point.

Planting design can be an effective visual indicator to control speed and improve safety. Varying plant spacing at set intervals can form a distinct pattern highlighting transitions and accentuating changes ahead in the road environment.

Methods and the means to warn travellers of approaching speed changes through road landscape design include:

- implementing a more ordered and formal planting approach at transitional locations, through changing planting arrangements, layouts, configuration or structure (Figure C5-31);

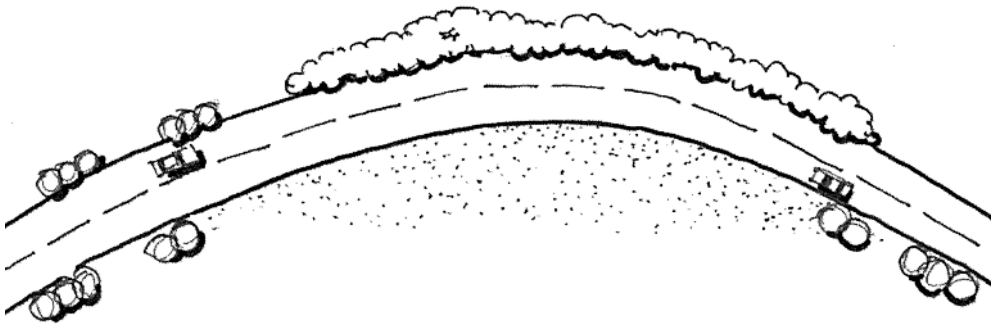


Figure C5-31: Changing planting structure form and species can influence driver behaviour

- changing the overall structural form and layering of the plant species selected for the planting palette (for example, size, scale and height);
- modifying the overall plant theme for the corridor or creating a subtle graduation of the theme (for example, changing from a native informal theme to native formal);
- imposing a direct visual response in the traveller in transition areas by providing breaks in continuity of planting;
- using visual channelling to create a greater sense of enclosure at transitions to low speed areas by framing the roadway with tree species (where frangibility not an issue) or larger shrub species; alerting drivers of upcoming slow speeds, then opening up again (through use of open, low planting) beyond the lower operating speed area, to indicate the higher operating speed transition;
- creating subtle visual differences, which still unite with the landscape theming of corridor through incorporating changes to boundaries/ edge treatments, designing the arrangement of edges to be visually stimulating, attract interest, attention and awareness by the user;
- creating a sequenced build up to a slow point through changing the perceived density or increasing the actual density of planting by using clustered planting arrangements rather than more open scatterings of plants (Figure C5-32);
- differentiating slow down points with visual cues to provide a sense of arrival through changing texture, colour and shapes of plant species; and
- defining slow points with markers, entrance statements and landmarks through using legible tree species (where frangibility is not an issue) as highlights to these markers/ landmarks to gateways.

Figure C5-32: Legible planting layouts can indicate a transition into a slower speed environment

Employing the concepts of the design principle legibility in planting design and planting layouts can also indicate a progression to lower speed areas. Legibility can improve awareness of speed transitions in road users; whilst also assisting in wayfinding. Visual cues within the road landscape heighten user perceptions and provide reinforcement of the behaviours required at transitional and slow down areas.

Some of the concepts of legibility which can be applied at transitional areas within the road landscape are:

- providing distinguished changes in planting layout (for example, distinct patterning or planting compositions with a clear, identifiable and obvious change in arrangement); promoting user comprehension of a transition in operating speed;
- providing unique points of reference for users through the use of clear and recognisable symbols (for example, incorporating symbolic devices such as local signature tree species); and
- providing node like planting arrangements (Figure C5-33), which acts as a focus point for travellers; notifying of slower speeds required.

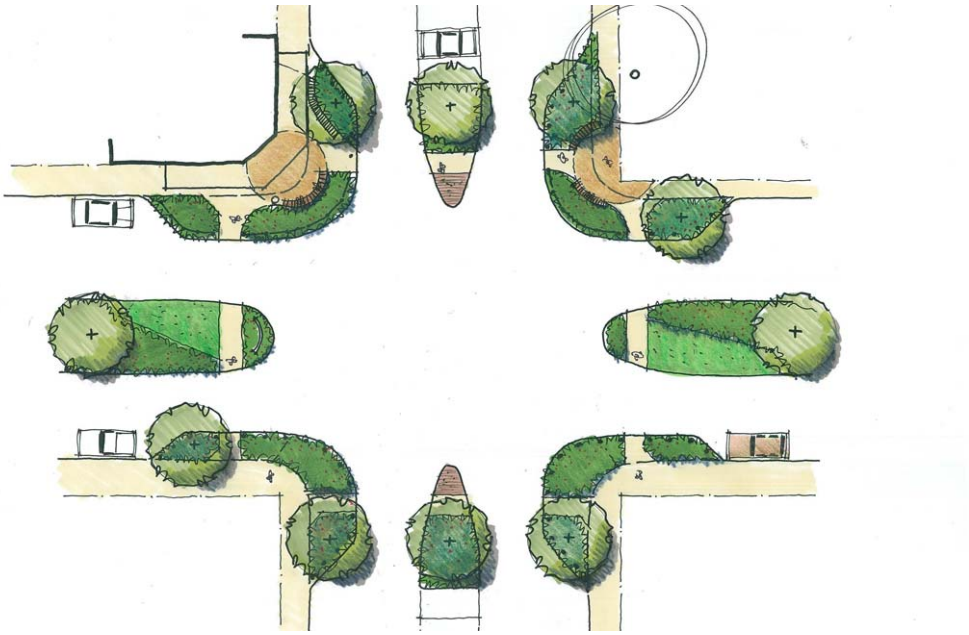


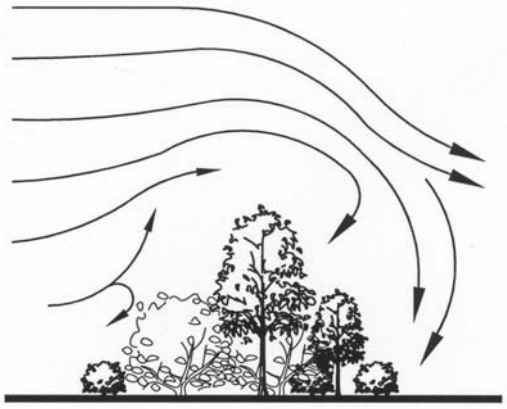
Figure C5-33: Changing planting structure at traffic nodes can influence driver behaviour

5.11.7 Glare Screen Planting

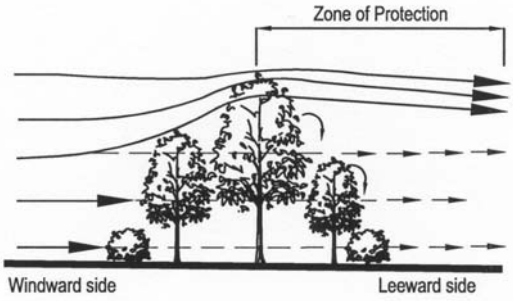
Many roads throughout Queensland experience strong glare due to the setting of the sun. This glare from low-angle sunlight can be reduced through carefully aligned planting. For north-south orientation of roads, the solution is to provide ridgeline screening on the western side of the road. *"When using planting to screen glare care should be taken not to create a strobing effect through transparent foliage, as this could be a bigger problem than the glare"* (Department of Transport and Works - NT, 1988:68).

5.11.8 Wind Break Planting

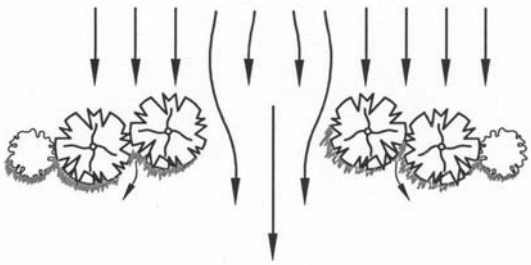
Wind gusts are often experienced in coastal, cyclonic and other areas where landform can channel winds. Wind can be stronger at the end of cut batters and at locations where wind is channelled across the road and may adversely effect vehicle stability, particularly high vehicles which may create more resistance. In such cases, planting can be used as a windbreak to stop the effect of crosswinds and stabilise loose material to limit the amount of dust blown across the road. Select species with moderately dense, fine foliage that extends to the ground to optimise disruption at channelled winds (Figure C5-34).



Dense windbreaks create turbulence



Windbreak with moderate permeability
and zone of protection



Wind tunnelling effect of gaps

Figure C5-34: Desirable characteristics in planting for windbreaks

Source: Department of Primary Industries, 1995

5.12 Maintenance

The safety requirements calculated for each new roadway must be maintained for the continued safe operation of the roadway. When these safety requirements are addressed and implemented correctly at the design and construction stages, the need to intervene and conduct these maintenance practices should be reduced.

Any vegetation, or portion of vegetation which is within, or encroaches into, safety restricted areas (clear zones, sight distance areas) must comply with safety requirements of that area. Where vegetation is non-complying then the following maintenance practices are recommended:

- **For existing vegetation** - it is recommended that the vegetation be trimmed or removed, dependent on significance of the vegetation. The action taken will be dependant on the whole of life maintenance costs and the significance or protection of the vegetation;
- **For establishing seeded vegetation** - non-complying species must be removed before they are considered a hazard. If this culling has a significant impact on the foliage coverage and/or design intent (in urban environments), an appropriate substitute species may be incorporated; and
- **For proposed vegetation** - container stock specified in areas affected by clear zone and sight visibility constraints must utilise compliant species and/or species which require rare reactive maintenance (species requiring routine maintenance to achieve compliance must not be used).

If needed, conduct general routine maintenance of vegetation in close proximity to areas of public access, (adjacent roads, pedestrian and cyclist facilities) to minimise the potential hazard of aged, deteriorated plants and debris falling in high winds and storms.

In the design stages of landscape works it must be considered that any maintenance regimes needed to ensure plants meet safety requirements (on a regular basis for the life of the plant) be built in to the whole of life design cost.