Network Technical Guideline (NTG)

Supplement to Austroads Guide to Road Design (AGRD)

Part 6: Roadside design, safety & Barriers (2022)

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Contact	standardsmanagementrd@roads.vic.gov.au

Document History

Version	Date	Description of Change
1.0	July 2010	Development of Supplement
1.1	Sept 2010	Minor updates and edits to text
2.0	July 2011	Note 5 added to Figure V4.1. Change review reference within Table V6.3.
3.0	Feb 2019	Major content updates and edits including information on Safe System, use of clear zones and barrier design
4.0	August 2021	Sections 1-4 were re-structured to align with Austroads, with no major content changes. Section 5 received major content updates to support the consolidation of existing barrier design guidelines (including RDN 06-02, RDN 06-08 and RDN 06-15), as well as the restructure of RDN 06-04 (v16) to include general conditions of use, road safety barrier policies and the adoption of the Austroads TCUs.
5.0	March 2023	Sections 1.8, 2.4 and Appendix VD outline DTP's NRRIT values and methodology for applying these to projects. Sections 6 provides additional information on designing barriers in urban environments and at high-risk sites
6.0	Feb 2024	Minor edits including changes to Sections 4.4.3, 6.5.1, 6.8.4, 6.14.3, 6.17.1 and Appendix VD The inclusion of Appendix VG

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Supplement to Austroads Guide to Road Design Part 6: Roadside Design, Safety & Barriers (2023)

This document is administered by Engineering, Department of Transport and Planning on behalf of Head, Transport for Victoria. This Supplement must be read in conjunction with the Austroads Guide to Road Design Part 6. References to Department of Transport in the supplement shall be read as references to Department of Transport and Planning where relevant.

Reference to any Department of Transport and Planning, Department of Transport, VicRoads or other documentation refers to the latest version as publicly available on the Department of Transport and Planning, Department of Transport or VicRoads website or other external source.

Document Purpose

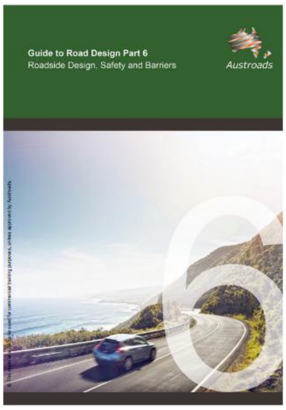
This Supplement is to provide corrections, clarifications, and additional information to the *Austroads Guide to Road Design Part 6: Roadside Design, Safety and Barriers* (2022). This Supplement refers to the content published in Edition 4 (June 2022) of the Austroads guide.

This document is primarily written for people interacting with the declared road network in Victoria, Australia. Advice in the guide relates to the Department of Transport and Planning and MTIA staff and consultants and contractors working for the Transport Portfolio in Victoria. All requirements are processes to be followed for changes to the declared road network.

It is noted that other road agencies, such as local government, may use the guidance in this document. However, they are responsible for managing any processes (such as Design Exceptions) or amendments to the guidance in this document.

If this Part to the Austroads Guide to Road Design is updated, or the information is moved to another Austroads publication, then the content in this supplement should be adopted as supplementary content to the current equivalent Austroads content. Where there is conflicting content in this Supplement with updated content, contact the Department of Transport and Planning for clarification as to which content takes precedence.

This guideline document has been authorised by the Chief Engineer as a delegate of the Head of Transport for Victoria as outlined in the Road Management Act 2004.



How to Use this Supplement

DTPs Commitment to the Safe System

The Department of Transport and Planning (DTP) is committed to the Safe System approach to road safety and to creating a culture that seeks to improve road safety outcomes for the Victorian community. Run-off-road and loss of control crashes are the cause of around one third of fatalities and serious injuries that occur in Victoria. On country roads, the proportion is higher: approximately one half. Designing roads and roadsides to minimise the chances of run-off-road and loss of control crashes and to mitigate the severity of crashes that do occur is critical to progression towards the vision of zero fatalities and serious injuries on Victorian roads.

To provide a Safe System and contribute to a vision of zero fatal and serious injuries, the entire roadside environment must be considered to have an element of risk and designed, as far as is reasonably practicable, with the aim to eliminate or mitigate that risk. Vehicles that leave the roadway can potentially travel significant distances before recovering or decelerating to a speed that will ensure that occupants are not fatally or seriously injured if a hazard is encountered (Austroads 2014, Doecke & Woolley 2011). Historically, the area of interest has been associated with the 85th percentile. However, research has indicated that the distance that vehicles may travel is well in excess of this roadside area.

It is necessary to consider treatment options with the aim of providing a balanced outcome by considering the principles in Section 1.5 of AGRD Part 6. The Safe System Principle (Section 1.5.1) may need to be balanced against the other principles such as the Community Wellbeing Principle (Section 1.5.3) and the Environmental Sustainability Principle (Section 1.5.4) particularly in constrained environments.

Terminology of Information Classification in this Supplement

The information in this supplement has been provided for various purposes in reference to the content in AGRD Part 6. Below is a list of terminologies for how information is classified in this supplement.

Supporting Guidance:	Information that helps users understand the principles, concepts, guidelines and design values contained in the AGRD. This includes methodology and examples of how to apply the content in the guide, and is often aimed at more inexperienced users. This information is aimed at inexperienced or new users of the guide
Clarification:	Information that provides additional details about the application of the content in the AGRD. This includes conditions of use, new guidance and new applications of content in the AGRD based on new information, trials, research or how guidance might be applied to particular contexts. The aim is that this information will be considered to be included in an updated revision of the guide.
Local Guidance:	Information that is specific to the Victorian context and practice. This includes references to Victorian documents such as RDNs, Heavy Vehicle maps and Movement & Place. May also include specific guidance needed to ensure that Department operating and/or maintenance practices are addressed during application of design criteria. This information is aimed at designers working in the Victorian industry.
Departures:	Information where DTP practice differs or departs from the guidance or design values in the AGRD. All departures are highlighted and the associated context and justification is provided. The aim is that this information will be considered to be included in an updated revision of the guide.

Contents

1. Introduction to Roadside Design

1.6 Roadside Safety Design

Supporting Guidance & Local Guidance

In addition to providing the safest possible environment for road users, road authorities have an obligation to provide a safe workplace for personnel involved in works, which includes maintaining roads and roadsides, and repairing any infrastructure that is damaged by a crash (e.g. safety barriers). The duty of care is set out in Clause 11 of the Road Safety Act 2004, Code of Practice, Worksite Safety – Traffic Management (Victorian Government 2010).

Working on a roadside is one of the most dangerous practices due to the exposure of workers to live traffic. Road and roadside design for errant vehicles must consider the risks to any person that may be involved in works and the controls can be implemented to mitigate those risks.

1.6.4 Appropriate barriers and Other Treatments

Local Guidance

Refer to the following guidelines relating to the prevention of head-on crashes:

- Section 4.4.3 of this Supplement for median barriers on divided highways and freeways with a posted speed limit of 100 km/h or higher,
- RDN 03-08 - Central Barrier in Narrow Medians,
- RDN 03-09 - Wide Centre Line Treatment (WCLT),
- RDN 03-10 – Audio Tactile Line Marking (ATLM),

1.8 Overview of the Roadside Risk Assessment Process

Supporting Guidance & Local Guidance

The Department of Transport and Planning (DTP) has developed a position on the use of the Network Roadside Risk Intervention Threshold (NRRIT) methodology as documented in *Austroads Guide to Road Design Part 6 Ed 4.0*.

DTP has adopted the following high-level process for using the NRRIT score set for various contexts. The adoption of the appropriate NRRIT score is applicable when assessing where to install barriers as part of a targeted roadside treatment strategy on a project. Where continuous barrier is required, the use of the NRRIT is not required.

This high-level process should be adopted at the planning phase of a project to identify areas of higher risk along a corridor and feasible mitigation strategies to address these sections of higher risk.

Figure V1.8: Overview of Roadside Risk Assessment Process

Step 1: Analyse a corridor to determine its risk profile and compare this with the Network Safety Plan (NSP or Corridor Plan)

A road corridor should be divided into 1km sections of road and analysed by picking the worst (highest risk) typical cross section in that 1km section to determine the roadside risk score for that section of road. The roadside risk scores can be determined using the methodology in *Austroads Guide to Road Design Part 6*

Section 1.9 ('Short Method) or by using the worksheets in *Austroads Guide to Road Design Part 6 Appendix B* ('Detailed Method').

The risk score analysis against the Network Safety Plan (NSP) or the corridor plan (if either the NSP or corridor plan exists) should highlight which sections of road align well with the planning objectives for the route and also identifies sections of higher risk. If a NSP or corridor plan does not exist, assess these scores for the 1km sections of road against the NRRITs as documented in Table V2.4 of this supplement to reflect the level of infrastructure investment expected.

Note, that the NSP or corridor plan may specify the adoption of a different NRRIT than the NRRIT which is stated in Section 2.4 of this supplement. Where the NRRIT is specified in a NSP or corridor plan, that specified NRRIT is to be adopted instead of the values in Table V2.4.

For more information on how the NRRIT and risk assessment process can be used at the planning and scoping stage of a project see Appendix VD.

Step 2: Adopt Continuous Barrier or Targeted Barrier in accordance with policies, RDNs and supplements

DTP has specific policies and guidelines for treating roadside hazards. These policies and guidelines will determine which roads and context require either continuous barriers or targeted barriers. Refer to safety barrier policies and guidelines on the VicRoads/DTP website to determine how to apply barrier to a particular project.

In addition to this, DTP may specify where certain assets and hazards (such as bridge piers and other high-risk hazards) will require protection, irrespective of the roadside risk score.

Step 3: Implement mitigation strategies to reduce roadside scores to below the NRRIT

Note, where the NSP or Corridor Plan specifies continuous barrier, this step is not necessary.

The Network Roadside Risk Intervention Threshold (NRRIT) ensures a consistent approach to risk across the road network irrespective of the hazard or context (other than urban or rural). The NRRIT also helps to identify where targeted road safety barriers along a route are most effective at reducing risk, particularly where there is limited available funding, or a level of investment expected.

The Department of Transport has set NRRIT scores for various design domains and contexts. Where a section of road has been analysed as being above the NRRIT, then this section of road should be further analysed using the 'Detailed Method' to determine more accurate risk scores. Where there are substantial changes in cross section over a 1km section of road, it may be appropriate to divide the road into smaller sections. However, these sections of road should not be less than 200m.

Once the detailed risk scores have been established, the project team should explore, assess and select suitable mitigation strategies to reduce the roadside risk scores to the NDD NRRIT range as outlined in Section 2.4 of this supplement.

1.9 Calculating a Risk Score

1.9.4 Measuring the Lateral Distance to a Hazard

<u>Clarification</u>

The area of interest shall include all locations that can be feasibly accessed by an errant vehicle. This may be beyond the property boundary. The lateral distance travelled depends upon a range of variables, including speed, angle of departure and the surface type and condition. Table V1.9 suggests values that should be used for the area of interest for roads with different operating speeds.

It is not intended that all hazards within the area of interest should be treated or removed rather that they be assessed. The purpose is to identify all hazards that pose a risk of high severity crashes, regardless of how far they are from the road, so that treatment options that have the greatest potential to reduce FSI crashes are considered.

Table V1.9: Lateral extent of the area of interest for relatively flat roadsides

SPEED LIMIT	LATERAL EXTENT OF THE AREA OF INTEREST
110 km/h	50 - 60 m
100 km/h	40 - 50 m
90 km/h	32 - 40 m
80 km/h	18 - 27 m
70 km/h	14 - 20 m
60 km/h	10 - 15 m

1.9.12 When should the process in AGRD Part 6 Appendix B be used?

Supporting Guidance & Local Guidance

The 'Short Method' as documented in *Austroads Guide to Road Design Part 6 Section 1.9* should be used during planning and the early development of a project to quickly determine the relative risk and areas of higher risk in a corridor (See Section 1.8 of this supplement).

The 'Detailed Method' as documented in *Austroads Guide to Road Design Part 6 Appendix B* should always be used in the assessment of roadside hazards at the project level, particularly during detailed design and project delivery (see Section 3.1 of this supplement).

DTP has developed a "Appendix VF AGRD Part 6 Risk Score Calculator" which automates the detailed method from *Appendix B*. For more information, see Appendix VF.

The "Appendix VF AGRD Part 6 Risk Score Calculator" is available on the website and can be used at all stages of a project (planning, design, delivery and review) to assess the risk of a roadside.

1.9.13 Hazards for Motorcyclists and Other Vulnerable Road Users

Supporting Guidance & Local Guidance

Hazard identification in the context of motorcyclists shall consider the following:

- The concept of a hazard free zone beside a road is based on providing a driver the opportunity to regain control of a vehicle. For motorcyclists, it also provides an area free of obstructions if a rider falls or is thrown from their motorcycle.
- Sealed shoulders in rural areas have been shown to be very cost effective in reducing run-off-road crashes. For motorcyclists, riding vehicles inherently more unstable than motor vehicles when veering off the road, the benefits may be significant. The most cost-effective width for sealed shoulders for motorcyclist safety is not known, any sealed shoulder width is safer than an unsealed shoulder.
- Barrier kerbing (B type) is a severe hazard to motorcyclists in the event of falling off their motorcycle. Contrary to common perception, it provides little protection to pedestrians from traffic. Where possible, semi-mountable kerb profiles should be used in preference to barrier kerb and always used in high-speed contexts.
- Lips or bullnoses on kerbs and raised concrete aprons can snag motorcycle foot pegs and create instability when ridden over.
- Kerb colours which blend into road pavement colours, i.e. asphalt kerb, create inadequate definition of vehicle paths and necessary tyre clearances in poor light conditions and should not be used where alignments are tight or deviations in alignment are created.

DTP publication 'Making roads motorcycle friendly' provides additional information and guidance regarding hazards and treatments to improve safety for motorcyclists. Section 6.17.1 of this Supplement provides guidance relating to barriers and motorcyclist safety.

2.4 The Network Roadside Risk Intervention Threshold (NRRIT)

Local Guidance

DTP has set the recommended risk threshold scores (NRRIT) for two locality contexts – urban and rural. These scores represent the maximum score a project should adopt for untreated hazards. DTP has outlined the Normal Design Domain (NDD), Extended Design Domain (EDD) and Design Exception (DE) for each context.

In general, the NDD NRRIT is expected to be met on all new projects where assessment for the location of targeted barrier installation is required.

In constrained environments, where justification is provided, adoption of the EDD thresholds may be considered and/or approved by DTP (approval for EDD NRRIT range is not required where it has already been agreed for the route or corridor). Approval of risk scores in the Design Exception (DE) range would require significant analysis and justification as to why adopting risk scores above the NRRIT is acceptable. Design Exceptions are required to be approved by DTP.

Table V2.4 documents the NRRIT design domain values and general application for urban and rural contexts.

Table V2.4: NRRIT for Various Contexts

	Urban Context	Rural Context	General Application
Normal Design Domain (NDD)	<0.5	<1.25	New Construction, Carriageway Duplication or Substantial Upgrades (such as alignment or cross section changes)
Extended Design Domain (EDD)	0.5-1.0	1.25-1.5	Minor upgrades which retaining existing geometry (such as shoulder widening or adding turning lanes) or Upgrades in Constrained Environments (such as built-up environments or environmentally constrained corridors) where it has been assessed that the NDD range will not be adopted for either part or the total length of the route or corridor.
Design Exception (DE)	>1.0	>1.5	Undesirable in most contexts, particularly where NDD criteria should be applied

Projects should aim to reduce risks posed by unprotected hazards to a score as low as practical while ensuring that costs are reasonable. The scores in Table V2.4, represent a range with an upper limit. The upper limit should not be regarded as a target.

What happens if the project scores are above the NDD NRRIT?

The NRRIT scores are set to ensure a consistent approach for treating hazards across the network. Where, a project cannot meet the agreed NRRIT scores, a project should document:

- The assessment of the existing risk scores for the project/corridor
- Commentary on the substantive risk (crash history) of the project/corridor
- The assessment of proposed roadside and hazards, the risk scores for those hazards and the justification as to why adoption of the design is acceptable
- Support for the proposed design using a principles-based justification (Refer to *Section 1.5* and *RDN 01-01* and *RDN 01-02*)

Where an NRRIT has been set for a project or corridor as a project requirement and a project proposes to adopt a risk score higher than the set NRRIT, this will require approval by DTP.

Note, where existing trees result in a risk score in the EDD range, no formal approval is required if existing trees are located in accordance with the *VicRoads Tree Planting Policy* (see Section 4.4.1 of this supplement).

V2.4.1 Hazards and Risk Scores for roads less than 60km/h

Local Guidance

The risk score does not need to be calculated for roads with an operating speed of less than 60km/h.

Chart 20 of Figure D.7 of Appendix B demonstrates that risk scores for roadside hazards are less than the NDD NRRIT of 0.5 irrespective of the volume of traffic or the offset of the hazard from the travel lane. Therefore, tree planting for 50km/h speed environments is supported wherever safe and practical in accordance with *VicRoads Tree Planting Policy* (2016) and associated design and sight distance checks in accordance with AGRD.

Roadside hazards located on roads with an operating speed less than 60km/h will not require treatment unless;

- There is a historical crash history associated with the hazard
- The community have raised significant concerns about a particular hazard
- They pose a site-specific safety hazard
- The hazard is classified as a “high risk site”

3. Program and Project Risk Assessment

3.1 Overview of the Risk Evaluation Process

<u>Supporting Guidance & Local Guidance</u>

Section 1.8 of this supplement outlines the high-level approach to evaluating a corridor or route by identifying sections of corridor which are of higher risk and then considering various mitigation strategies available to reduce this risk.

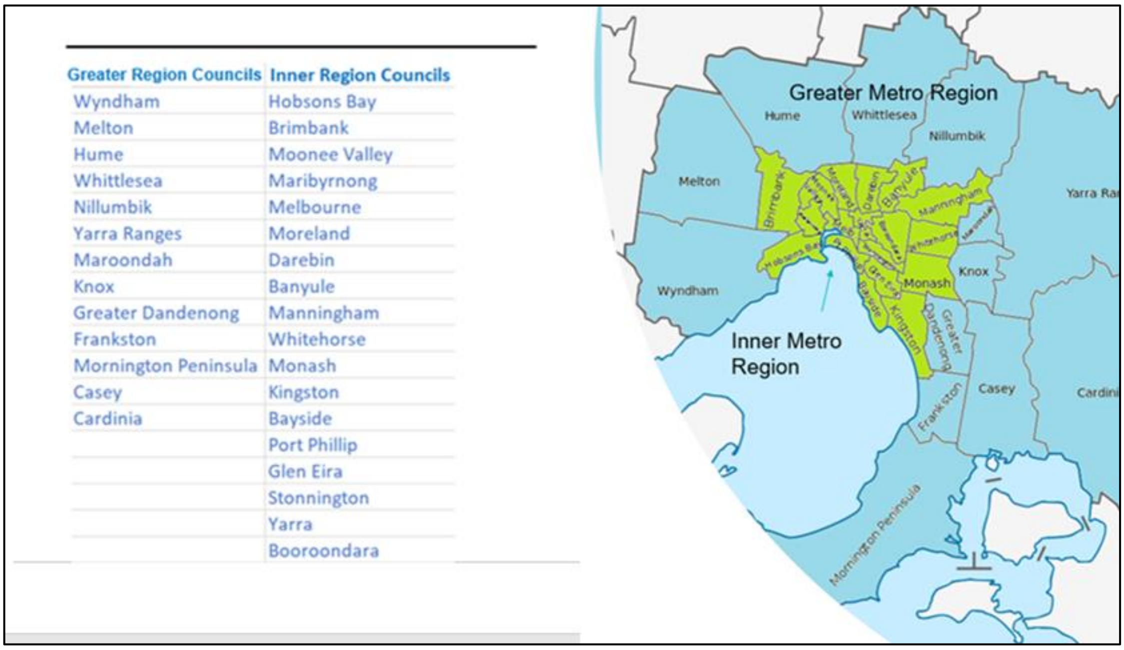
This section provides information for project teams for use of the NRRIT assessment in the development and delivery of a project and outlines typical steps which a project should consider.

Step 1: Identify the context

Selecting the context is important as it identifies which variables, graphs and tables are used from *Austroads Guide to Road Design Part 6 Appendix B*. The context of the project is selected by considering at least a 5km section of the corridor (even if this is longer than project length). If the corridor is less than 5km, then consider the whole length of corridor.

The context is considered "urban" if it falls within the Greater Metropolitan Region of Melbourne (from Figure V3.1 below) or within the existing or proposed built-up limits of regional centres and towns. All other roads are considered to be within a rural context.

Figure V3.1: Melbourne "Urban" classification for NRRIT assessment



Greater Region Councils	Inner Region Councils
Wyndham	Hobsons Bay
Melton	Brimbank
Hume	Moonee Valley
Whittlesea	Maribyrnong
Nillumbik	Melbourne
Yarra Ranges	Moreland
Maroondah	Darebin
Knox	Banyule
Greater Dandenong	Manningham
Frankston	Whitehorse
Mornington Peninsula	Monash
Casey	Kingston
Cardinia	Bayside
	Port Phillip
	Glen Eira
	Stonnington
	Yarra
	Booroondara

The second part of establishing the context is defining whether the road is in a 'flat', 'rolling' or 'mountainous' topography. This is defined by assessing a 5km section of the corridor against the criteria within AGRD Part 6 Section 1.9.6.

Step 2: Identify the relevant NRRIT scores for the project based on the context

The NRRIT score that should be adopted based on the context is taken from the Table V2.4 of this supplement.

Step 3: Identify hazards and hazard attributes

Identify all hazards for the section of the corridor being considered.

Continuous (or background) hazards are multiple hazards of the same type with spacings of less than 20m. Longitudinal hazards such as embankments, cuttings or walls are also considered to be background hazards.

Isolated hazards can be single hazards (such as bridge piers) or multiple hazards of the same type that are spaced apart by 20m or more.

Step 4: Identify typical cross sections using a combination of isolated and background hazards to determine the cross section that produces the highest risk score

Within a section of road, there is likely to be multiple isolated hazards and continuous (background) hazards of different types and offsets. For instance, a single section of road often contains poles, trees, roadside furniture and/or structures (such as bus stops or culverts) as well as various continuous hazards such as fences, embankments, creeks and/or lines of trees.

Each of these isolated and continuous hazards will have different trauma index scores and will produce different risk scores based on the offset to the travel lane and the geometry of the road at that cross section.

As such, it is important to identify typical cross sections, that possess a representative combination of isolated and continuous hazards, and which produce relatively high-risk scores.

These typical cross sections should not focus on isolated or unique point hazards, as these will most likely be treated with targeted barrier. Rather they should represent the highest typical risk score for a section of road.

Determining a typical cross section will often require a degree of engineering judgment. Spacing and offset values that are used for the assessment should be approximated and be justified and documented.

The average offsets of the hazards should be rounded to the nearest metre (m). Hazards that are less than a 0.75 metre offset should use a 0.5m offset for analysis purposes.

The average spacing of isolated hazards should be rounded the nearest value below;

Spacing of isolated hazards	25	40	50	60	75	80	100	125	150	200	250	300	400	500

Note, hazards that are spaced closer than 20m apart should be assessed as a continuous (background) hazard rather than isolated hazards.

Step 5: Identify continuous lengths of similar cross sections of the project

Generally, sections of 1km lengths should be selected.

However, it may be important to divide the project into sections that are less than 1km (such as 500m, 300m and 200m) where the typical cross section, road geometry or topography significantly changes. For the purposes of assessing the risk of a project, it is important to divide the project into lengths of road with a similar risk profile (i.e. highest risk score for the specified typical cross section). Sections of the project that include a tight horizontal curve or steep down grade could be assessed as their own section as these locations may produce significantly higher risk scores and may not reflect the broader corridor risk level.

The minimum length of section that should be assessed is 200m.

Note: where the risk score of a single isolated hazard is assessed, such as a single pole or tree or culvert, then the minimum length of section to be assessed can be 100m (See example of charts for culverts AGRD Part 6 Figure D.11). However, individual utility poles or trees that are spaced at regular intervals along a corridor should not be assessed as single isolated hazards.

Step 6: Assess each section of the project against the NRRIT

Assess each section of the project against the NRRIT to identify sections of higher risk for the project (sections having a score above the NDD NRRIT). The methodology in Austroads Guide to Road Design Part 6, Appendix B should be used for the assessment.

Step 7: Identify, Evaluate and Rank Risk Mitigation Options

AGRD Part 6, Section 4 should be used to identify, evaluate and rank risk mitigation options for section of the project that are above the NRRIT. Mitigation treatments are then selected and applied to the project based on how they align with the network and project objectives.

3.4.2 Examples of the Use of the Procedure

Local Guidance

Refer to *Appendix VD – Applying the NRRIT during planning, development, and delivery of projects* for examples on how to apply the NRRIT to projects.

3.5 Step 3: Identify, Evaluate and Rank Risk Mitigation Options

3.5.1 Identify the Options

Supporting Guidance

Potential treatment options should be identified with the aim to eliminate the risk of fatal and serious injuries, as far as is practically possible, in accordance with best practice and up-to-date knowledge.

For high-speed roads, particularly those with high volumes such as M-Class and A-Class roads, continuous safety barrier provides significant benefit for the level of investment and is the preferred treatment to reduce the risk of fatal and serious injuries from run-off-road and head-on crashes. Continuous barriers should be adopted as default treatments for roads having duplicated carriageways.

3.5.2 Evaluate the Risk Associated with a Roadside Treatment Using a Qualitative Assessment

Supporting Guidance & Local Guidance

The qualitative assessment of treatment options shall consider how well each option aligns with Safe System principles. Reference should be made to Austroads Safe System Assessment Framework (Austroads 2016) for guidance on treatment hierarchy and selection (Section 4.6). Primary or transformational treatments are preferred as they are more likely to eliminate the risk of fatal and serious injuries.

Where appropriate, a Safe System Assessment should be conducted in accordance with DTP's Safe System Assessment Guidelines (2018) to evaluate treatment options.

3.5.4 Rank Treatment Options

Supporting Guidance

The ranking of treatment options shall consider how well each option aligns with Safe System principles and operational/maintenance objectives. Reference should be made to Austroads Safe System Assessment Framework (Austroads 2016) for guidance on treatment hierarchy and selection (Section 4.3). Primary or transformational treatments should be ranked higher than supporting treatments as they are more likely to eliminate the risk of fatal and serious injuries.

4. Treatment Options

4.2 Summary of Treatment Options

Local Guidance

In Victoria, from a road safety perspective, continuous safety barrier should be the first (preferred) option on roads with a posted speed limit of 80km/h and above, and should be considered as an option if it is appropriate on lower speed roads.

While continuous safety barrier can be implemented on any road, it provides the most effective safety outcome for the level of investment required on relatively high volume, high-speed roads with sealed shoulders, minimal access points and few constraints. Therefore, it is considered an optimal investment for routes that connect capital cities, major provincial centres or link major centres of production.

Refer to Section 5.12 and 6.16 of the AGRD Part 6 and Section 6.4 of this Supplement for associated guidance on continuous safety barriers.

Removing hazards from higher risk areas or modifying them to reduce the risk of fatal and serious injuries may also be a cost-effective treatment option for some contexts, where safety benefits can be quantified in the context of available funding.

4.4 Treatments for Different Hazards

4.4.1 Treatments for Trees

Local Guidance

Refer to *VicRoads Tree Policy (VicRoads 2016)* for information and guidance on managing trees within road reserves for which DTP is the Coordinating Road Authority.

Tree planting, wherever safe and practical, is supported in speed environments with operating speeds less than 60km/h.

In urban environments, where existing trees result in roadside risk scores in the Extended Design Domain (EDD) NRRIT range, strong consideration should be made to retain these trees wherever possible. Trees, although considered a hazard from a road safety perspective, provide additional value to the environment and community and their presence promotes active transport.

In lower speed urban environments, tree planting is encouraged (wherever safe and practical) behind road safety barriers if it is in accordance with working width requirements in Section 6.7 of this supplement and appropriate visibility at key decision and/or access points is provided.

4.4.3 Treatments for Medians

Local Guidance

Median barriers shall be used to reduce the incidence of head-on crashes and the severity of run-off-road crashes on new freeways and divided highways with a proposed speed limit of 100km/h or more.

Median barriers should also be considered on divided roads with speed limits of less than 100 km/h to reduce the risk of fatal and serious injuries from run-off-road and cross-median crashes.

Other treatment options to address the risk of head-on and / or run-off-road to the right crashes on undivided roads include centre line barriers and wide centre lines. For detailed guidance on these treatments refer to RDN 03-08 Central Barrier in Narrow Medians (VicRoads 2018) and RDN 03-09 Wide Centre Line Treatment (VicRoads 2018).

On popular motorcycle routes (see Appendix VA), flexible guard fence (FGF) is the preferred barrier type due to product availability and suitability. Refer to RDN 06-04 for the list of approved products.

4.4.4 Treatments for Embankment Slopes

Supporting Guidance

When considering treatments for verges, the risk of roll-over crashes shall be assessed. While it may be possible to remove rigid hazards such as poles, on many roads it is not practical to maintain embankments to the standard that is required to minimise the likelihood that an errant vehicle will overturn. The installation of continuous road safety barriers is often the preferred treatment, particularly on high-volume, high-speed roads.

4.4.5 Treatments for Drains

Local Guidance

Pipes and culverts perpendicular to the road – height 0.6 m maximum

For pipe diameter or box culvert heights up to 0.6 metres, refer to Standard Drawing SD1992 (VicRoads 2019) for details of the traversable endwall.

The channel downstream preferably should not be deeper than the depth of the culvert. Rock beaching will be required to prevent erosion of the batter and the channel. Beaching within the area of interest should be traversable, relatively smooth and no steeper than 4:1. Any rough textured beaching for energy dissipation must be protected or must have an acceptable risk relative to the NRRIT.

Pipes and culverts perpendicular to the road – height 0.6 m to 2.0 m

For pipe diameter or box culvert heights between 0.6 metres and 2.0 metres, safety barrier protection is preferred. Alternatively, where the risk is acceptable, designers may consider extending the pipe or box culvert to the edge of the area of interest or until the roadside risk is below the NRRIT.

Where it is not practical to extend the culvert, or where regular maintenance can be assured, grates may be provided to span between the wingwalls. Each grate must be hydraulically and structurally adequate or its intended purpose.

Safety barrier protection must be provided where the height exceeds 2.0 metres.

Pipes and culverts parallel to the road

Conventional endwalls on culverts under driveways and median openings are hazardous because they can be hit head on. The preferred treatment is to locate them outside the area of interest or where the roadside risk is below the NRRIT. If the endwall cannot be located beyond the clear zone, provide a traversable endwall with transverse bars as shown on Standard Drawing SD1991.

4.4.9 Treatments for Poles

Supporting Guidance & Local Guidance

Utility poles often represent some of the highest risk roadside hazards encountered in urban environments. Designers should apply following list of treatments of utility poles in order of precedence:

1. Underground power to eliminate the roadside risk of utility poles
2. Relocate utility poles and install safety barriers
3. Relocate utility poles to below the NRRIT (See Section 2.4 of this supplement)
4. Reduce the posted speed limit so that poles are below the NRRIT[1]

[1] Note that the reduction of the posted speed limit will need to be in accordance with the guidance and governance in DTP's *Speed Zoning Technical Guidelines (Edition 2, December 2021)*.

Projects should consider the full benefits of undergrounding power before dismissing it as an option due to capital costs alone. These benefits include;

- Reduced crash risk due to the elimination of the poles
- Economic benefits from eliminating routine canopy pruning for powerline clearance

- Additional bushfire risk reduction benefits
- Reallocation of the space for other purposes such as tree planting and wider shared paths/footpaths
- Reduce the requirement[1] of road safety barriers to protect poles which may be difficult to install due to;
    - Available space between the back of kerb and the utility pole
    - Impacts on sight lines at property accesses
    - Achieving the minimum length of barriers due to the frequency of property accesses
    - Impacts to kerbside off peak parking

[1] Note that the installation of road safety barriers may still be required if there are other hazards which require protection such as roadside furniture, large trees and deep drainage channels.

Note that retention of street lighting infrastructure will usually be required on most projects. Where power has been placed underground, street lighting poles should be frangible (such as slip base or impact absorptive).

V4.4.17 Treatments for high-risk sites

Local Guidance

All high-risk sites, such as gantries, bridge piers, retaining walls, must be shielded with an appropriate safety barrier. See Section 6.5.1 and Section 6.9.5 of this supplement for more information.

5. Fundamentals of Safety Barrier Systems

5.5 Barrier System Performance Measures

5.5.2 Working Width, Deflection and System Width

Supporting Guidance

The following figures show typical crash test outcomes and the magnitude of each sub-component. It is important to understand the crash test performance values and behaviour to ensure they are applied appropriately in the field. These figures supplement Figure 5.5 in the AGRD Part 6.

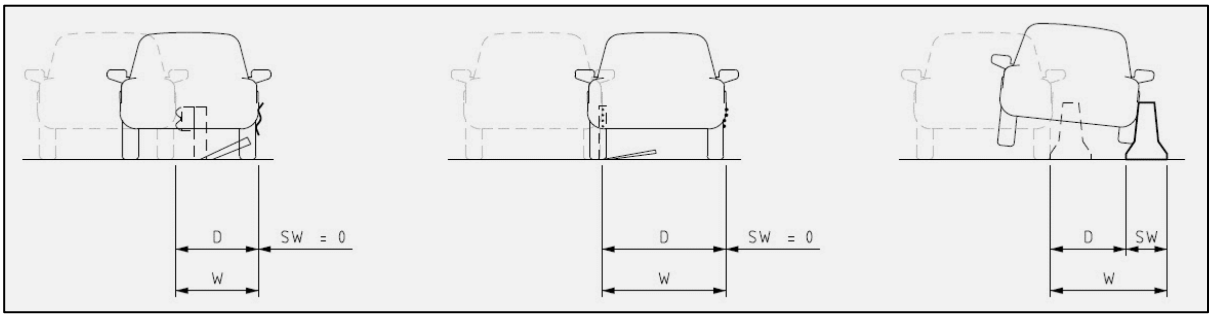


Figure V5.5.2a: Typical Test Level 1, 2 & 3 performance

W = Working width, D = Dynamic deflection, R = Roll allowance, SW = System Width.

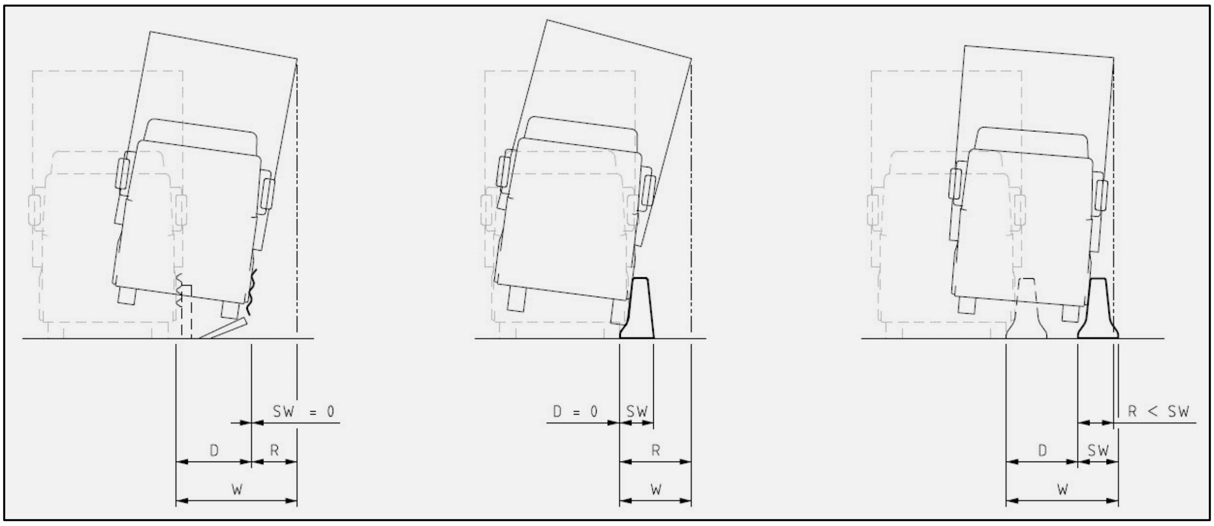


Figure V5.5.2b: Typical Test Level 4, 5 & 6 performance

5.5.3 Working widths for concrete barriers

Local Guidance

For additional information, refer Section V6.7.1.3.

5.5.4 Points of Redirection

Local Guidance

For additional information, refer Section V6.7.1.3.

5.13 Road or Route Containment Level

5.13.1 Choosing an Appropriate Minimum Containment Level

Supporting Guidance

For additional information refer Section 6.5.

5.13.2 Containment Levels at High Risk Sites

Supporting Guidance

For additional information refer Section 6.5.1.

5.14 Choosing an Appropriate Barrier

Supporting Guidance

Barrier selection requires knowledge of the system's characteristics and in-field performance. There are benefits and weaknesses of all systems, therefore the selection process should strive to find an optimal site-specific balance of key risks and benefits. The overall aim of installing an appropriate barrier is to reduce the probability of fatal and serious injury to all road users, acknowledging that a limitation in one factor could reduce the effectiveness of the entire system.

The selection process can be difficult post award of a delivery contract, where the driving factors of barrier selection are often a balance between the minimum containment level, the working width and the cost to install (in that order). As such, barrier selection should occur within the preliminary stages of design, particularly where higher capital cost barrier systems are warranted.

The following guidance is provided to assist designers and project engineers.

Containment

Barrier systems with higher containment capacity (i.e. contain a wider range of impact scenarios and vehicles) are preferred but can be more costly to install. As a minimum, the system must provide the containment level defined by the client or determined in Step 2 of the design process. Generally, the containment level adopted should be consistent along a corridor unless there are significant changes in the roadside risk profile.

Impact Severity

Systems with more flexibility and a lower impact severity (i.e. less likelihood of injury) are generally preferred but often require more area for deflection. As such, they may be more costly to install or may conflict with other assets and environmental requirements.

Designers should recognise that occupant risk is a key criterion of the barrier acceptance process, and all accepted systems must achieve the defined testing thresholds. While it is possible to compare the impact severity of a product using an equivalent crash test, the impact severity experienced on site is largely reliant on the installation conditions and specific impact scenario. Even concrete barriers with almost zero flexibility are designed to contain and protect the occupants of the impacting errant vehicles without serious injuries.

Safety barrier systems are generally divided into broad types - comprising WRSB, flexible w-beam, non-proprietary w-beam (e.g. Type B), Thrie-beam and Concrete barriers – although the associated flexibility and impact severity is a continuum that can often overlap between barrier types based on post spacing or product specific details.

Different barrier systems have different capabilities when it comes to addressing vehicle containment level and vehicle impact severity. Understanding the containment objectives for a corridor at the early stage of the design process is important, as it will affect the product types available.

Table V5.14 provides typical characteristics for longitudinal barrier types.

Table V5.14: Typical characteristics of longitudinal barrier types

Characteristic	Longitudinal Barrier Types					
	WRSB	Flexible W-beam	Non-proprietary W-beam	Thrie-beam	Concrete Barriers	Bridge Barriers
Flexibility (typical)	Very High-Moderate	High-Moderate	Moderate-Low	Moderate-Low	Zero	Zero
Passenger Car Impact Severity (relative)	Low	Low	Moderate	Moderate	High	High
Containment Capacity (typical)	TL-3, TL-4	TL-2, TL-3	TL-2	TL-3, TL-4,	TL-3 to TL-6	TL-3 to TL-6+

Site suitability

Each barrier system relies on characteristics of a site to function, such as support strength, post or footing depth, width, system length and anchorage/terminals.

Crash testing provides a reference point for establishing these performance needs and, unless the site can be modified to match, the performance of the safety barrier may differ from that demonstrated in the test results. Consequently, the barrier performance may deviate from the known set of test values. Depending on the level of deviation from tested performance values, site constraints may preclude selection of certain barrier types.

Technical Conditions of Use (TCUs) are provided for all accepted safety barrier products. These TCUs provide designers with a set of design values and site conditions that have been established from crash testing and are considered ‘suitable’. Where a design value or range cannot be achieved (e.g. shorter length or different pavement/foundation condition), designers should understand the potential impacts on barrier performance and make an informed assessment.

Some design values can be reduced in accordance with this guide for certain contexts, where the risk is mitigated. Some conditions of use are critical to the performance of the system (e.g. post spacing, post type, foundation size, etc), refer to Austroads SBTA-11-001 for an outline of the Technical Conditions of Use documents.

Selecting a longitudinal barrier also requires a suitable terminal or the need to interface or transition into other systems. Like longitudinal barriers, each terminal and transition may have positive and negative outcomes depending on context.

Whole-of-life

Systems that continue to function predictably, under the expected conditions for the intended life of the asset, are preferred.

Designers should consider the operational conditions in which the system is to be installed, maintained and repaired. All systems require an inspection and maintenance regime. However, systems that are likely to fail or degrade, or need frequent or complex maintenance and repair, will need a supporting inspection and maintenance regime to be established and agreed to.

Designers should consider the resources available to maintain and repair the system, including whether the tools and equipment needed to maintain the system are readily available to the relevant maintenance team. The resource demands for an individual barrier may be influenced by the barrier design across an entire route or region. The fewer variations in systems used, the fewer inventory items needed, and the less storage space required. Simpler designs are also more likely to be constructed and repaired promptly and properly by field personnel.

The whole of life costs will vary significantly for each barrier system type and the site characteristics, including location and road function. Inadequate installation, maintenance or repair can compromise barrier reliability and ability to perform appropriately on impact.

Accessibility is another key factor for consideration. Systems which cannot be easily accessed, are likely to be left un-repaired or un-maintained for a longer duration.

The following is a summary of some of the key factors that should be considered when selecting a safety barrier type:

- Workplace safety for maintenance/repair;
- frequency of failure/impact;
- frequency of inspection;
- ease of fault identification;
- ease of fault testability;
- product maintainability; ease of fault repair; and
- accessibility.

5.14.1 Preferred Safety Barrier Systems for a Road Stereotype

Local Guidance

AGRD Part 6 Table 5.7 is supported by DTP.

In Victoria, the F-Shape is the preferred profile for concrete barriers. Constant slope and vertical face concrete barrier profiles may be considered as alternatives to the F-Shape where circumstances are warranted, although the vertical face barrier is only suitable for lower speed environments. For projects considering any shape other than F-Shape, this shall be treated as a design exception requiring approval by DTP. Rigid systems are suitable where there is limited width for barrier deflection, and traffic volumes are high, exposure is high during barrier maintenance activities or a higher containment barrier is needed, as maintenance and repair costs are relatively small.

6. Road Safety Barriers

6.1 Introduction

Local Guidance

Only road safety barriers, barrier variants and end treatments accepted by DTP may be used on the declared road network. For further details on acceptable barrier systems, refer to RDN 06-04 - Accepted Safety Barrier Products.

6.4 Determine the Objectives of the Proposed Safety Barrier (Step 2)

Supporting Guidance

Objectives of targeted safety barrier

Targeted safety barrier refers to the design and installation of barriers in targeted locations along a road, to protect errant vehicles from specific hazards, high-risk sites or in areas with a high risk of departure (e.g. tight curves). This objective reflects a strategic decision to invest in safety barrier infrastructure to address roadside risk greater than an intervention threshold for a corridor or network (refer to Section 1.8 of this supplement).

Objectives of continuous safety barrier

Continuous safety barrier refers to the design and installation of barrier along the entire road length to maximise the protection of errant vehicles from potentially rolling, impacting a hazard, or causing a head-on collision when leaving a lane on a road. Refer Section 5.12 and Section 6.16.

6.5 Determine the Containment Level for the Proposed Barrier (Step 3)

Clarification

Over the length of a corridor/route, while it is desirable to provide a consistent containment level, the adopted level may need to vary at some locations based on the combination of risk factors and site-specific conditions. Firstly, the designer should determine the minimum containment level of the route based on assessment of available strategies or operating speed and the percentage of (heavy) commercial vehicles. The designer should then identify all high-risk sites along the route and determine the minimum containment level and any increases in containment level needed for the site based on a specific risk assessment.

V6.5.1 The minimum containment level of the route

Clarification

In Victoria, the minimum default containment level for any route should be TL-3, to ensure each barrier can redirect a high-speed passenger vehicle. If a TL-4 barrier is just as cost effective, then a TL-4 barrier should be used if it meets all the design requirements, such as deflection.

TL-2 barriers should only be considered where the operating speed is 70 km/h or lower, and where the likelihood of a heavy vehicle run-off-road is low. Designers will need to assess and justify when this is applicable.

If the AADT percentage of commercial vehicles, for the adjacent carriageway, is forecasted to be 20 percent or greater of commercial vehicles, for the design year, then a higher containment level must be considered for the route. This must include a viability review of all TL-4 and TL-5 safety barrier products available for use.

On most urban freeways/motorways, TL-4 and TL-5 concrete barriers are the preferred barrier type given the high traffic flow, the percentage of heavy vehicles and the requirement to be able to safely access the barrier system for maintenance/repair while minimising disruption to traffic flow.

A TL-5 concrete barrier should be the default for narrow medians of urban freeways to separate traffic in opposing directions which typically carry high traffic volumes with high proportions of commercial vehicles. The height of barrier provided in a TL-5 system is important to prevent heavy vehicles from rolling over the barrier into the path of opposing traffic.

Figure V6.5 provides a general overview of the information above.

TL-2	TL-3	TL-4	TL-5
Where the operating speed is < 70km/h AND the % CV is deemed low	**Starting position**	Where the % CV is greater than 20%	Where the % CV is greater than 20% AND the barrier is located within the median of an urban highway/freeway

Figure V6.5: Barrier test level selection guidance

6.5.1 Increasing the Containment Level at Higher Risk Sites

<u>Clarification</u>

In addition, designers should identify all high-risk locations/sites along the corridor and determine the need for a higher containment level. High-risk sites generally include the presence of critical infrastructure or high consequence hazards and land use.

Figure V6.5.1 shows an example sketch of a TL-3 route minimum containment and three high-risk locations identified for higher containment.

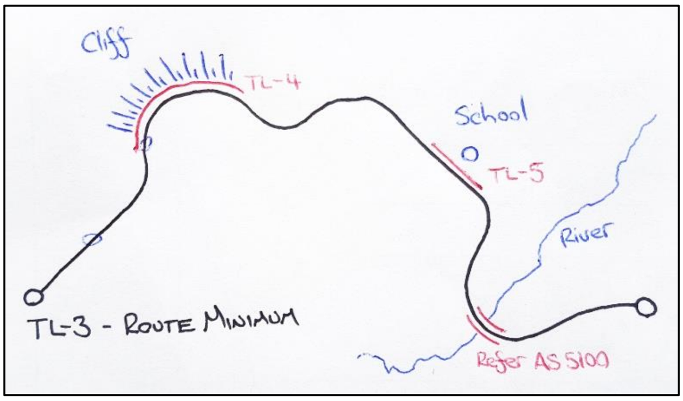


Figure V6.5.1: Containment level route plan (sketch)

The minimum containment level for each high-risk site must be determined, in accordance with relevant procedures. These procedures may rely on engineering judgement and information obtained from a suitable site-specific assessment.

The following risk assessment procedure should be used as necessary:

- where the barrier is shielding a bridge pier or structure, designers must use AS5100 and Bridge Technical Notes to determine the containment level;
- where the barrier is shielding a gantry or cantilever support, designers must determine the containment level in accordance with RDN 06-13 (however, the LoN should be determined by AGRD Part 6 and this supplement);
- where the barrier is shielding a rail corridor, the relevant rail authority process must be used; and
- where the containment level is already specified in the contract documentation.

If a prescriptive procedure is not available, designers should take reasonable steps to ensure an appropriate containment level is selected, using available guidance and/or outcomes from risk assessments/workshops.

Refer Section 6.20 for additional guidance on critical infrastructure.

6.6 Identify Barriers that Meet the Objectives and the Containment Level (Step 4)

V6.6.3 Performance level barriers

Local Guidance

Performance level barriers can be designed for practically any context or constraint, and they can be integrated into the design of structures.

Performance level barriers must be used on structures, in accordance with Bridge Technical Notes, and in other locations when all accepted test level barriers or variants are unsuitable or are unable to achieve the minimum containment level.

6.7 Select a Barrier System and Define its Working Width (Step 5)

Local Guidance

Only road safety barriers and variants accepted by DTP may be used on the declared road network.

V6.7.1 Working widths based on crash testing

V6.7.1.1 General

Local Guidance

Full-scale crash testing provides the most accurate method to determine working width and should be used to define the minimum working width value.

Crash tested working width values are provided in the TCU for each accepted safety barrier product. Refer RDN 06-04 – Accepted Safety Barrier Products.

Where products have been crash tested in multiple configurations (e.g. using various post/pin spacings) or to multiple test levels, the product TCU will list the working width value for each configuration and test level.

Given the variability between WRSB crash testing and in-field performance, working widths for WRSB should be determined in accordance with Section V6.7.1.2.

V6.7.1.2 Working widths for Wire Rope Safety Barriers

Clarification

WRSBs are often tested in a single configuration where factors – such as post spacing, length, curvature and ambient temperature – are set. As such, WRSB working width must be determined in accordance with the following formula:

Wmax	**=**	**Wstd x Fl x Fc,**
Wmax	=	Maximum working width (m)
Wstd	=	Standard working width for the nominated test level and post spacing (Table V6.1 or Product TCUs)
Fl	=	Barrier (rope) length correction factor (AGRD Table 6.11)
Fc	=	Barrier curvature correction factor (AGRD Table 6.12)

A 3.0m WRSB post spacing is desirable given the lower occupant injury values, while a 2.0m post spacing can be used to stiffen the barrier in constrained locations. Refer Section 6.13.1.

Table V6.7.1.2 provides standard working width values for WRSB. Designers should acknowledge aspects of the detailed design for WRSB as early as possible (e.g. length and curve correction factors) to avoid potential conflicts.

Table V6.7.1.2: Standard working width values for WRSB (Wstd)

Test Level	Post Spacing	
	2.0 m	**3.0 m**
TL-4 Working Width:	-	3.05m[1], or refer product TCU
TL-3 Working Width:	2.4m or refer product TCU	3.05m[1], or refer product TCU

Notes:

1. Working width value sourced from AGRD Part 6, Table 6.3.
2. Working width value sourced from the MASH Brifen product TCU, which had the smallest post spacing and largest working width at the time of release.

V6.7.1.3 Working widths for concrete barriers

Local Guidance

As DTP uses standard barrier heights of 920, 1100 and 1300 mm, the corresponding working widths for these barriers are those listed in Table 6.4 for 915, 1070 and 1370 mm respectively.

DTP allows for the use of 820 mm concrete barriers (with a working width of 650 mm for a TL-3 test) as a design exception. DTP also allow for a working width associated with the cabin only to be used in a design exception. These cabin working widths are 60% of the recommended working widths based on the relative heights of the cabin and truck body. While the cabin working width will provide for the cabin to not impact a hazard, the truck body will impact the hazard. The designer must consider the implications of this event and the impact loads on the hazard.

For concrete barriers taller than 1300 mm, working width values should be determined using the ‘point of contact’ method. This method adopts a projected vehicle roll line that contacts the face of the barrier (kerb reveal to top corner) and extends to a height of 4.6 m above the pavement surface. This method can also be used for estimating the working widths of barriers with sway protection. Refer to Section 6.13.1.

For additional information Refer RDN 06-16 – Barrier design commentary for additional information.

V6.7.2 Working widths in lower speed environments

Local Guidance

DTP recognises that the road network is constrained in many locations, particularly in urban environments, and it may be impractical or unfeasible to remove, relocate or modify roadside elements. While larger barrier-to-hazard distances are preferred, the following methods may be used to determine a ‘speed-specific working width’ value when space is limited. Refer to Section 6.8.2 for guidance on when these methods can be applied within the Normal Design Domain and the Extended Design Domain.

When considering a speed-specific working width value, it is the designer’s responsibility to confirm whether the value has been based on one of these methods. All speed-specific working width values should be determined for an equivalent 2.27T vehicle and an equivalent impact angle of 25 degrees. At present, there is insufficient evidence to estimate likely impact angles based on specific road types, hence impact angles less than 25 degrees are not permitted, despite any reference in product manuals.

V6.7.2.1 Speed-specific working widths from physical crash testing

Local Guidance

Speed-specific working width values may be determined from physical crash testing using lower impact speeds.

In some cases, product suppliers may have undertaken physical crash testing to determine a working width for lower impact speeds. These values are more accurate than simulation, interpolation and extrapolation.

Where physical test values exist, it is critical that the Product Supplier confirms how the working width value has been determined; testing must be based on the MASH protocol and modified for lower speeds.

V6.7.2.2 Speed-specific working widths from computer simulation

Local Guidance

Speed-specific working width values may be determined using computer simulation that has been validated in accordance with ASBAP Technical Advice SBTA 20-004.

Computer simulation (using a validated model) is considered a reasonable prediction of working width, therefore speed-specific working width values may be based on the impact speed of the simulation.

V6.7.2.3 Speed-specific working widths from extrapolation

Local Guidance

Speed-specific working width values may be determined using an impact energy modification factor.

These values are calculated by extrapolating from an existing crash tested value, such as a MASH TL-3 working width value, using a suitable relationship for lower impact speeds. While this technique is a reasonable estimation of working width, it has the lowest accuracy of all methods, and designers should be conservative in their approach.

Due to the greater effect of vehicle roll during a MASH TL-4 crash test, and higher, these modification factors do not apply particularly for taller vehicles that may exhibit roll. Speed-specific modification factors for MASH TL-4 and higher are considered design exception.

For wire rope, w-beam and thrie-beam safety barriers, the longitudinal steel rail and cables act in tension during an impact, therefore the deflection of the barrier is considered a function of the impact energy and the stiffness (K) of the barrier (equation 1). Where the barrier stiffness, the vehicle mass and the impact angle remain the same, we can estimate the deflection and working width of the barrier at lower impact speeds (equation 2). This relationship is used within EN1317.2:2010 to calculate normalised dynamic deflection and working width.

$$\text{equation 1:} \quad \frac{m_1(V_1 \sin\alpha_1)^2}{{D_1}^2} = \frac{m_2(V_2 \sin\alpha_2)^2}{{D_2}^2} \qquad \Big| \ \text{equation 2:} \quad \square \ \frac{D_2}{D_1} = \frac{V_2}{V_1}$$

m = vehicle mass, V = velocity/speed, α = impact angle, D = dynamic deflection

Based on this relationship, Table V6.7.2 below provides modification factors for a MASH TL-3 impact scenarios. For example, the speed-specific working width for a barrier in a 70km/h posted speed environment, would be calculated as x0.7 of the crash tested MASH TL-3 working width value. Refer Section 6.8.2 for details on when speed-specific working width values are considered suitable.

Table V6.7.2 - Modifications factors for speed-specific working width

	Posted Speed (km/h)						
	100	**90**	**80**	**70**	**60**	**50**	**40**
Modification factor compared to MASH TL-3	-	-	0.8	0.7	0.6	0.5	0.4

1. Modification factors based on an equivalent 2.27T vehicle, an equivalent impact angle of 25 degrees and an impact speed equal to the posted speed.
2. Refer Section 6.8.2 for details on when speed-specific working width values are considered suitable.

Extrapolated working width values published in the product manual have not been confirmed by Austroads or DTP, therefore designers must confirm that the underlying calculation aligns with the guidance above.

For temporary freestanding barrier systems, the impacted length of barrier relies on a constant friction and resistance from the pavement surface. Therefore, the deflection of a freestanding barrier is considered a function of the impact energy and a constant restraining force. This relationship results in less-conservative values and was previously used within EN1317.2:2007 to calculate normalised dynamic deflection and working width.

6.8 Define the Constraints on the Lateral Position of the Barrier (Step 6)

Supporting Guidance & Local Guidance

Selecting the ideal lateral position of a barrier is iterative and will require a designer to balance various performance objectives within the site constraints. Table V6.8 below provides an overview of the key objectives and how they each benefit from different design values.

Table V6.8: Performance objectives and design principles of barrier positioning

Key Performance Objectives		**Design principles**
Impact performance	Maximise the likelihood that vehicles will impact the barrier in a desirable manner	Minimise the lateral distance from the road to reduce the likely impact angle into the barrier (Section 6.8.1). Minimise the slope between the traffic lane and safety barrier (Section 6.8.3). Locate barriers a certain distance from kerbs and batter hinge points to reduce the likelihood of vaulting or under-riding the barrier (Section 6.8.4).
	Maximise the percentile of impacts that are redirected from the hazard	Maximise the lateral distance of the barrier from the hazard, to cater for more impact energy (Section 6.8.2).
Operational performance	Maximise the opportunity for vehicles to pull over in an emergency	Maximise the lateral distance of a barrier from the road, or provide regular pull over opportunities (Section 6.16.3).
	Maximise the sight distances necessary for drivers to make decisions	Maximise the lateral distance of a barrier from the road, to avoid sight distances being blocked (Section 6.13.4).
Maintainability	Minimise the frequency of impacts, particularly nuisance impacts	Maximise the lateral distance of a barrier from the road, to give drivers an opportunity to recover (Section 6.8.1). Avoid locating barriers within or near vehicle swept paths, to cater for driver error.
	Minimise the risk and effort associated to maintain the roadside	Locate barriers so that typical maintenance practices can be carried out, considered in accordance with Section 28 of the OH&S Act 2004

These performance objectives and principles are embedded throughout Section 6.8 of the AGRD Part 6, although are not prescriptive.

As such, this supplement attempts to integrate the lateral positioning guidance by consistently referencing Table V6.8 and encouraging designers to select a lateral position that balances all principles. Lateral positioning is a single balanced decision that depends on the context of the road, the barrier type, the combination of risks and a balance of the relevant performance objectives.

6.8.1 Offset from the Traffic Lane

<u>Supporting Guidance & Local Guidance</u>

In general, road safety barriers should be located (i.e. offset / positioned) as far as possible from the edge of the traffic lane as site conditions permit.

As per Table V6.8, a larger barrier offset:

- maximises the opportunity for drivers to regain control of the vehicle,
- provides opportunity for drivers to pull over,
- minimises any impact on sight distances, and
- minimises the frequency of barrier impacts, particularly nuisance impacts.

However, it is to be noted that a greater offset from the edge of the traffic lane can also have the following impacts on performance;

- it increases the likelihood of higher angle impacts and thus impact severity, and
- it increases the likelihood of vehicle instability before engaging with the barrier.

The desirable range of safety barrier offsets from the nearest traffic lane are detailed in Table V6.8.1a. This table supplements AGRD Part 6, Table 6.5. It is ideal that the slope between the traffic lane and safety barrier is essentially flat. Refer Section 6.8.3.

An offset of 4.0 m allows broken down vehicles to pull over clear of traffic lanes and provides space for maintenance vehicles and workers. It also maximises the opportunity for the driver of an errant vehicle to recover control before striking the barrier.

Barrier offsets greater than 6.0 m should be avoided, as they increase the likelihood of higher angle impacts, but may be adopted in locations limited to a specific need such as an emergency stopping bay or maintenance access.

Table V6.8.1a: Offset from the traffic lanes (m)

Design Domain		Rural high-speed [1]	Rural low-speed	Urban freeways	Urban roads
NDD	**Desirable**	4.0 – 6.0 m	3.0 – 6.0 m	4.0 – 6.0 m	2.5 – 6.0 m
	Minimum	3.0 – 4.0 m	2.5 m	3.0 m	1.0 – 3.0 m
EDD		1.0 – 3.0 m	-	-	0.0 – 1.0 m [3]
DE		0.6 – 1.0 m	0.6 – 2.5 m	0.6 – 3.0 m	-

Notes:

1. Operating speed greater than or equal to 80km/h
2. Barrier offsets are measured to the closest part of the barrier. E.g. the face of W-beam or Thrie-beam, or the face of WRSB post.
3. On urban roads, a barrier offset assessment must be undertaken in accordance with Table V6.8.1b for all offsets less than 1.0m. If the assessment results in a ‘Yes’ for all questions, offsets between 0 – 1m are considered NDD. If the assessment results in a ‘No’ for any question, offsets between 0 – 1m are considered EDD, and the assessment must be provided to DTP.
4. NDD = Normal Design Domain, EDD = Extended Design Domain and DE = Design Exception. Further information can be found in Commentary V2 of this Supplement.

Where the minimum offsets cannot be achieved, designers need to understand the risks generated and mitigate them to an acceptable level. The relevant performance objectives and issues from Table V6.8 must be addressed, including provision for stopping, frequency of nuisance impacts, effect on sight distance, and maintainability.

An assessment must be undertaken to ensure the combination of risks are acceptable for the context and have been managed. Table V6.8.1b has been provided to assist with this assessment.

While Table V6.8.1b does not calculate the level of risk, it helps a designer identify key factors and determine if mitigation or other intervention is required. Where the assessment results in a 'Yes' for all questions, the risk is relatively low. If the assessment results in a 'No' for any question, mitigation must be implemented and the assessment must be provided to DTP.

Refer to Commentary V2 for additional guidance.

Table V6.8.1b – Barrier offset assessment

No.	Topic	Yes/No	Comment or mitigation
1	**General**		
1.1	Have the site constraints (e.g. trees, poles, batters, etc.) been removed, relocated or modified so far as is reasonably practicable to increase barrier offset?		
1.2	**If Rural**: Has a stiffer barrier system been considered to increase barrier offset?		
1.3	**If Urban**: Where speed limits are 80km/h and less, has a speed-specific working width been considered? Refer Section 6.8.2.		
1.4	**If Urban**: Is kerb required?		
2	**Provision for stopping**		
2.1	Is there sufficient opportunity for a vehicle to always pull over within 500m (rural) or 200m (urban)? E.g. have emergency stopping bays or breaks in the barrier been provided where needed?		
2.2	Is a motorist able to logically identify safe locations to stop both at day and night times (e.g. signs, other advisory information or self-explaining roadside)?		
2.3	Is the risk of rear-end collisions involving a broken-down vehicle considered low (e.g. significant sight distances or ability to pass)?		
3	**Sight distances**		
3.1	**IMPORTANT**: Is there sufficient sight distance to/from access roads and intersections?		
3.2	Is there sufficient sight distance to a potentially parked (broken-down) vehicle protruding onto the traffic lane?		
3.3	Is there sufficient sight distance to potential roadside hazards?		
4	**Nuisance impacts**		
4.1	Have 3.5m traffic lane widths been provided?		
4.2	**If Urban**: Does the context and road geometry have a low risk of nuisance impacts? i.e. driver errors are unlikely.		
4.3	**If Rural**: Has shoulder sealing between provided for errant vehicles to re-gain control? **If Rural**: Has audio tactile edge line marking been provided to mitigate fatigue issues along the route?		
4.4	Has an appropriate type of barrier been used? - Barriers that remain operational after an impact should be used where there is a high risk of repeat impacts before repairs can be made.		
4.5	Have the barrier offsets been checked for OSOM and HV operational and access requirements?		
5	**Maintenance**		
5.1	Can barrier maintenance activities (e.g. inspection, repairs to barrier, grass mowing and weed spraying) be carried out safely?		
5.2	Can nearby assets be safely accessed (e.g. structures, signs, lighting or vegetation)?		
	Was the answer 'yes' to all questions:		**Yes = Low Risk, No = Mitigation needed**

6.8.2 Minimum Lateral Distance of a Barrier from a Hazard

Local Guidance

V6.8.2.1 General

The designer should make reasonable attempts to align the barrier-to-hazard distance, with the crash tested working width value defined in Section V6.7.1. Therefore, no hazard, including rigid or frangible objects, paths, or non-traversable slopes, should be placed within the 'working width' of the barrier, measured from the traffic face of barrier.

While larger barrier-to-hazard distances may further increase the percentile of impact scenarios (speed, angle and mass) that can be redirected from the hazard, larger distances will often limit the space available to achieve other roadside objectives. As such, the minimum lateral distance is recommended.

Exceptions to this requirement are detailed in Section V6.8.2.2 to Section V6.8.2.4.

In urban medians, where trees and vegetation are proposed (or exist), designers should also consider maintenance access needs such as mowing and pruning. In general, a clearance of 2m is required from the back of barrier to the tree for mowing equipment. This often exceeds the crash tested working width value.

Where the barrier-to-hazard distance cannot be achieved, refer to Section 6.8.9 of this supplement.

V6.8.2.2 Short hazards

Local Guidance

If the hazard is lower than the barrier height, such that it does not interfere with the vehicle roll sub-component of working width (e.g. a wingwall or fire hydrant), then the minimum barrier-to-hazard distance may be equal to the dynamic deflection (and system width), as defined on the product TCU. Refer Section 5.5.2.

V6.8.2.3 Hazards on urban roads

Supporting Guidance

On urban roads, several characteristics are common:

1. Roadside space is often limited and must be allocated considering often competing objectives.
2. The operating speed is usually less than most barrier crash tests, particularly where vehicles may be stopping frequently.
3. Fatigue related run-off-road events are rare, therefore it is common for drivers to brake or attempt to recover before impacting a safety barrier.
4. In peak hours, when the exposure for run-off-road and head-on crashed is highest, the operating speed is lower and thus the impact likelihood and severity into safety barriers is lower. In these conditions, barrier impacts are often a secondary outcome from an initial vehicle to vehicle impact.

As such, the lateral barrier-to-hazard distance may align with a speed-specific working width value, in accordance with Section 6.7.2, without approval, when the following conditions are met:

- The road is located within an urban environment.
- The road has a posted speed of 80km/h or less.
- The road does not have a history of run-off-road crashes.
- The hazard being protected is not considered high-risk or critical infrastructure.

V6.8.2.4 Cyclist and pedestrian paths

Supporting Guidance & Local Guidance

The Safe System philosophy recommends that designers mitigate the potential of vehicle-to-pedestrian impacts when speeds are greater than 30km/h. Therefore, the placement of safety barriers between the traffic lane and path can provide significant safety benefits.

Where paths are impractical or unfeasible to relocate beyond the crash tested working width, the designer may adopt a smaller barrier-to-path offset, when the following three risks in Table V6.8.2.4 can be mitigated.

Table V6.8.2.4 –Barrier between path and road; risks and mitigation strategies

Risk	Context	Mitigation
1. A vehicle hitting a path user during an impact with the barrier. *Note that unlike a permanent roadside hazard, pedestrians and cyclists are not permanently present, therefore, this risk is influenced by path volume.*	On M&P C1 routes with an operating speed greater than 60km/h	The minimum distance from barrier to the edge of path must be the crash tested working width
	On M&P C1 routes with an operating speed less than 60km/h; or On M&P C2 routes	The minimum distance from the barrier to the edge of path must be the speed-specific working width (in accordance with Section V6.7.2).
	On M&P C3-C4 routes	The minimum distance from barrier to edge of path in accordance with the cyclist's snagging requirements (see 2).
2. Cyclist (or pedestrian) snagging on the back of road safety barrier.	Where the back of barrier has exposed metal posts on paths with cyclist operating speeds ≥20km/h and is offset by less than 0.5m	Consider an alternative road safety barrier system with a smooth back. Consider an accepted smooth plastic cover to be attached to the back of barrier (refer RDN 06-04 for availability), Consider installing a pedestrian fence between the path and barrier, ensuring that there is at least 0.3m from the edge of path to the fence. At constrained locations, consider a localised path narrowing using linemarking to increase offset to the path to at least 0.5m.
	Where the back of barrier has exposed metal posts on paths with operating speeds <20km/h	Undertake a risk assessment and determine feasible and practical mitigation measures.
3. Cyclist vaulting over road safety barrier (≤900mm high) into traffic lane	Where the posted speed of the road is ≥70km/h Where cyclist speeds are likely to be ≥30km/h (such as on long sections of downgrade above 5%)	Consider selecting a barrier height ≥1200mm. Consider increasing the offset from the barrier to the path to ≥1.0m. Consider installing a pedestrian fence between the path and barrier. Consider providing at least a 3m offset between the edge of lane and the barrier as a vaulting buffer.
Notes [1] Where a path is walking only, designers should use the equivalent walking classifications (i.e. C1 = W1)		

V6.8.2.5 Slip-base poles

Supporting Guidance

When considering the placement of slip-base poles in general, designers should refer to relevant DTP requirements and guidance. Where slip-base poles are necessary behind a safety barrier the following guidance is provided for the minimum barrier-to-hazard distance.

Pajouh et al (2017) indicated that slip-base poles or shear type posts are still likely to be activated (i.e. will shear) when located within the working width of a safety barrier. The impacting vehicle still has enough energy (at speeds of 30 to 50 km/h) during the redirection process, to activate or shear the post.

While this research did not specifically consider flexible guard fence systems or wire rope safety barrier systems, these barrier types also record vehicle exit speeds of >50km/h during physical crash testing, therefore the principles are considered the same.

As such, if a slip-base or other frangible pole type is considered appropriate for the location (i.e. speed and proximity to pedestrians), designers may locate slip-base poles within the working width of a barrier. The distance between the barrier and slip-base pole should be maximised as much as possible, and designers will need to consider factors such as accessibility, maintenance, or other asset-owner requirements.

V6.8.2.6 Bridge piers

Local Guidance

The designer must align the barrier-to-hazard distance with the crash tested working width value defined in Section 6.7. The barrier type, barrier height and barrier position must be adjusted until this is achieved. DTP is unlikely to approve variations to this requirement.

6.8.3 Minimum Lateral Distance of a Barrier from an Embankment Hinge Point

Local Guidance

The slope between the traffic lane and safety barrier should be essentially flat. However, where the barrier is located beyond the verge, installation of safety barrier on steeper slopes is acceptable in accordance with Table V6.8.3.

Table V6.8.3: Maximum slope in front of the barrier

Project type	Maximum slope
New construction	10:1 or flatter
Retrofitting barriers to existing road	6:1 or flatter (see note)

When safety barriers are placed on slopes between 10:1 and 6:1, studies have shown that for certain encroachment angles and speeds, the barrier may not perform as intended. As such, Commentary 6 from AGRD Part 6 must be considered and a 3.8m barrier free area beyond the hinge point should be adopted when operating speeds are 80km/h and greater. Slope hinge point rounding is recommended.

Where batters are steeper than 6:1, the barrier must be placed prior to the embankment hinge point, adjacent to the traffic lane.

The desirable lateral distance of a barrier from an embankment hinge point is the crash tested working width as defined in Section 6.7.

The minimum lateral distance of a barrier from an embankment hinge point is the dynamic deflection (and system width), or 1.0m, whichever is greater. Refer Section 6.7.

There are no WRSB products accepted for use in Victoria that have been designed and tested on batter slopes steeper than 6:1.

6.8.4 Barrier Setback from Kerbs

Clarification & Local Guidance

When barrier is positioned behind a kerb, the vehicle's trajectory is first affected by the kerb, which can result in the vehicle not engaging with the barrier effectively.

While this objective must be balanced with other competing objectives, such as minimising nuisance impacts and providing sight distances, designers should first consider the feasibility and risks of locating the barrier at 'back-of-kerb', before considering other distances, including EDD distances.

In rural situations, if possible, drainage should be designed so that it is not necessary to place a kerb under or in front of a barrier.

In urban situations, where the road design cannot eliminate the 'kerb-barrier' interaction, the barrier setback distance is to be in accordance with Table V6.8.4 whereby the preferred barrier setback distance is the maximum NDD distance possible. Where a setback less than 1m is being considered, a barrier offset assessment should also be undertaken.

DTP notes that Austroads recommend barrier be installed as close as possible to face of kerb, which locates the face of barrier above the kerb. While this practice is acceptable (i.e. setback values of 0.1m and 0.2m), this may increase nuisance impacts in many cases; hence the preferred barrier setback distance is the maximum NDD distance possible.

Table V6.8.4: Offsets from line of kerb to barrier face

		Operating Speed (km/h)		
		< 70	**70 – 80**	**> 80**
Barrier Kerb (>100mm height)	**Wire Rope Safety Barrier (WRSB)**	NDD: ≥2.5m EDD: - DE: <2.5m	NDD: ≥4.5m EDD: - DE: <4.5m	Not Permitted – all values are Design Exception
	Flexible Guard Fence (FGF)	NDD: 0.1-0.2m & ≥6.0m EDD: - DE: 0.2-6.0m	NDD: 0.1-0.2m & ≥7.0m EDD: - DE: 0.2-7.0m	Not Permitted – all values are Design Exception
	Guard Fence (GF)	NDD: 0.1-0.2m & ≥2.5m EDD: - DE: 0.2-2.5m	NDD: 0.1-0.2m & ≥4.5m EDD: - DE: 0.2-4.5m	Not Permitted – all values are Design Exception
	Concrete Barrier	NDD: >2.5m EDD: - DE: <2.5m	NDD: >4.5m EDD: - DE: <4.5m	Not Permitted – all values are Design Exception
Semi-mountable Kerb (50-125mm height)	**Wire Rope Safety Barrier (WRSB)**	NDD: ≥2.5m EDD: - DE: <2.5m	NDD: ≥4.0m EDD: - DE: <4.0m	NDD: ≥4.5m EDD: - DE: <4.5m
	Flexible Guard Fence (FGF)	NDD: 0.2-0.4m & ≥2.5m EDD: 0.4-1.0m DE: 1.0-2.5m	NDD: 0.2-0.4m & ≥4.0m EDD: 0.4-0.6m DE: 0.6-4.0m	NDD: 0.2-0.4m & ≥4.5m EDD: - DE: 0.4-2.5m
	Guard Fence (GF)	NDD: 0.2-0.4m & ≥4.0m EDD: 0.4-1.0m DE: 1.0-4.0m	NDD: 0.2-0.4m & ≥5.0m EDD: 0.4-0.6m DE: 0.6-5.0m	NDD: 0.2-0.4m & ≥6.0m EDD: - DE: 0.4-6.0m
	Concrete Barrier	NDD: 0.2-0.4m & ≥4.0m EDD: 0.4-1.0m DE: 1.0-4.0m	NDD: 0.2-0.4m & ≥5.0m EDD: 0.4-0.6m DE: 0.6-5.0m	NDD: ≥4.5m EDD: - DE: <4.5m

1. There are no additional considerations when considering the risk of vaulting for offsets behind fully mountable kerbs.
2. There are no restrictions on setbacks in low-speed areas such as car parks.
3. Setback distances are measured from the line of kerb for simplicity, to the traffic side face of barrier.
   Note: While most literature references the 'face of kerb', the values in this table have been modified for Victorian kerbs. As such, the values differ slightly to Austroads. For SM Kerbs: the line of kerb is taken as 200mm in-front of face of kerb (rounded up from 190mm). For B Kerbs: The line of kerb is taken as 100mm in-front of face of kerb (rounded up from 40mm).For setbacks distances larger than 2m, these differences are ignored, and values are aligned directly with Austroads for simplicity and are measured from line of kerb.
4. Thrie-beam can be considered anywhere Flexible Guard Fence is mentioned.
5. Where concrete barrier is proposed in the EDD and DE range, barrier heights must be a minimum of 1100mm high and supported by compacted fill in accordance with SD3901 to reduce the risk of a barrier being toppled over when impacted.
6. To improve barrier performance, the preferred EDD setback distance is closer to the 'back of kerb' unless there is a justified risk (e.g. underground services or insufficient sight distances). Designers should not adopt the maximum EDD setback distance simply to achieve the desirable barrier offset value to traffic lane.
7. Barriers located >6m from the edge of traffic lane may have an increased likelihood of higher angle impacts. Designers will need to balance performance objectives based on the context. Refer Table V6.6
8. The information in this table is also presented in Figure V6.8.4 below in a diagrammatic format.

The EDD range may be used without DTP approval, when the following constraints are present;

- existing utility services (e.g. power, telecom, gas),
- existing subsurface drains,
- existing surface drain pipes and pits, or
- new surface drain pipes and pits that cannot located elsewhere.

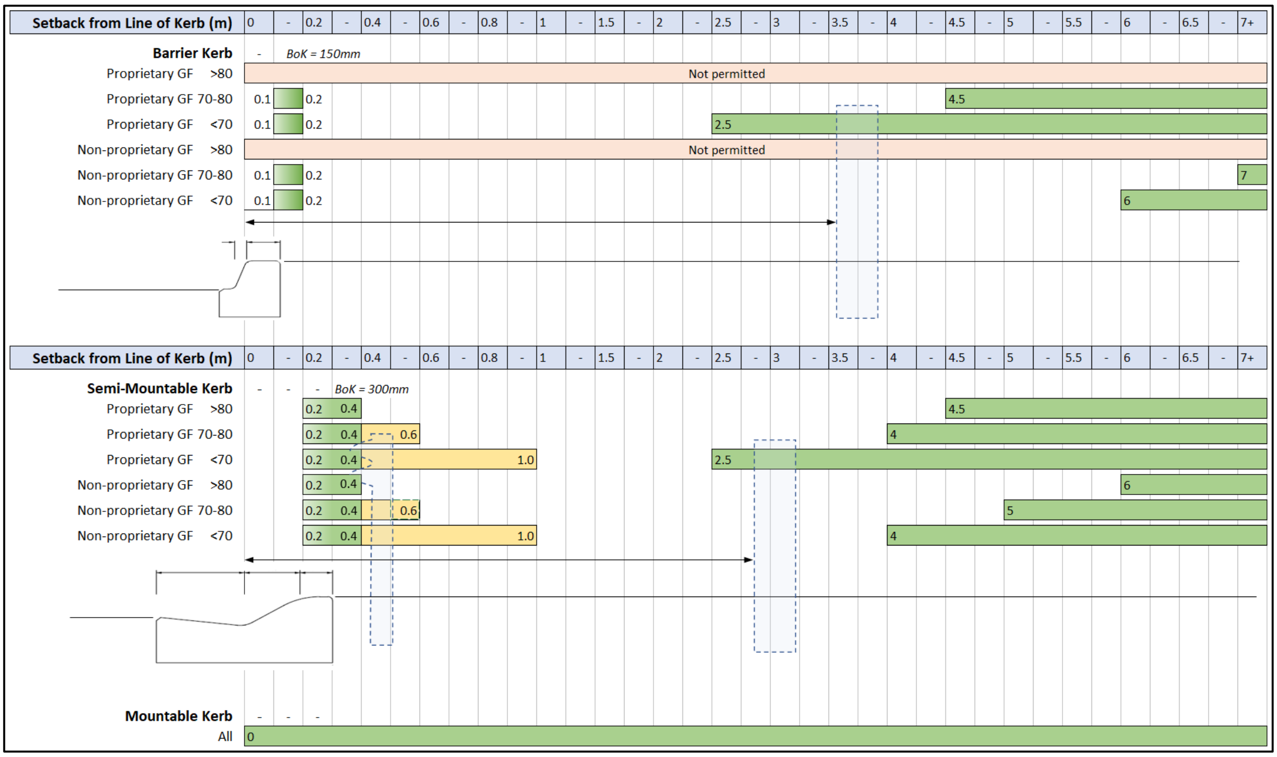
Designers should adopt smaller EDD setback distances as far as practicable to minimise vaulting, and a barrier offset assessment should be undertaken (refer Table V6.8.1b) before adopting the EDD range. Where the barrier options are WRSB or flexible Guard Fence, flexible Guard Fence shall be adopted when EDD or Zone 1 (refer Table V6.8.4) setback distances are adopted.

Designers may also consider the EDD setback range in other locations where there is a justified reason, and where the risks cannot be mitigated through design. This will require DTP approval.

While designers should consider alternate barrier products and variants to achieve the NDD setback range, some product variants (such as base plate posts) are only accepted for use in constrained locations (e.g. to span a culvert, pipe or utility) and should not be adopted for a typical cross section. As such, designers should consider the EDD setback range in lieu of adopting such variants for long lengths.

For additional information on barrier setback distances from kerb, and a comparison of these values against the historical values, refer RDN 06-16 – Barrier Design Commentary.

Figure V6.8.4: Barrier setback distances from kerb (source: Table V6.8.4)



Note: Green represents the NDD range and yellow represents the EDD range. This figure is based on the values provided in Table V6.8.4. Refer all notes within Table V6.6. Darker shades are preferred.

Brownfield locations

When installing safety barriers on existing roadsides, the presence of underground services and drainage systems are more likely. As such, there can be more constraints on lateral positioning of barrier.

In brownfield locations where the project is making no significant modifications to the roadside, the designer may adopt the following principles:

- Barriers should be located as close to back of kerb as practical to maximise impact performance.

- The barrier may be located within the EDD setback range without approval.
- A barrier offset assessment (Table V6.8.1b) should be undertaken to evaluate the key risks.

Guard Fence Terminals

Table V6.8.4 does not apply to flared guard fence terminals.

The likelihood of impacting a flared terminal is relatively low (compared to the entire length) and the risk of vehicle vaulting is mostly increased within the gating non-redirective section of the terminal, which is inherently designed to allow a vehicle to penetrate the system.

6.8.5 Lateral Location of Barriers in Medians

<u>Local Guidance</u>

Median barrier offsets must be designed in the same manner as outer or left-hand side barriers in accordance with Table V6.8.4.

Where a divided carriageway has three or more traffic lanes in one direction, it is preferable to have desirable offsets on both sides of the carriageway, noting that this may not be possible for urban Managed Motorway contexts where the median shoulder width is often reduced. Where desirable offsets are provided on both sides, this limits the number of lanes a vehicle may have to cross in the event of a breakdown to stop clear of the traffic.

Where a divided carriageway has two or less traffic lanes in one direction, median barrier offsets may be less than minimum when a barrier offset of 3.0 m or greater is provided on the outer or left-hand side of the carriageway(s).

6.8.7 Location of Barriers in Narrow Medians

<u>Local Guidance</u>

Further guidance on barriers in narrow medians is given in *RDN 03-08 - Central Barrier in Medians* and the Supplement to AGRD Part 3.

6.8.8 Flaring of Barriers and Terminals

<u>Supporting Guidance</u>

When locating barrier terminals behind kerb, the designer often faces competing objectives to;

- Flare the terminal slightly and decrease the potential for nuisance impacts, or
- Locate the terminal close to back of kerb, in order to optimise impact performance.

While both objectives have benefits, the following guidance is provided;

- In locations where the kerb and terminal are located 3.0m or greater from the edge of traffic lane, the preferred method is to provide a parallel terminal alignment as close to the back of kerb. In this case, the nuisance impact risk is already mitigated.
- In locations where the kerb and terminal are located less than 3.0m from the traffic lane, the preferred solution is to provide a flared terminal alignment even if the terminal may be located outside the recommended barrier-kerb setback ranges. In this case, the risk of vaulting is low and DTP approval is not required.

6.8.9 Barriers in Constrained Locations

<u>Local Guidance</u>

V6.8.9.1 General

Lateral positioning should not be determined from one objective or design principle alone. It should depend on the context of the road, which risks are greatest, the barrier type and a balance of the relevant performance and access objectives.

In constrained locations, the designer will need to decide which lateral offset criteria and constraints are most critical when determining the position of the barrier. Table V6.8.9.1 provides a simple table to represent the key information often requiring consideration for determining barrier positioning. While use of this table is not mandatory, it may assist designers assess risk and represent and justify a barrier position using below minimum design values.

Table V6.8.9.1 - Proposed barrier position in constrained locations

1	**Barrier No:**	XX				
2	**Design Element:**	Traffic-to-barrier offset	Traffic-to-barrier slope	Kerb-to-Barrier setback	Barrier-to-hazard / embankment distance	Sight distance
	Value:	X.X m	X:1	X.X m	X.X m	X.X m
	Domain:	NDD / EDD / DE	NDD / DE	NDD / EDD / DE	NDD / EDD / DE	NDD / EDD / DE
3	**Commentary / Justification:**					
	Barrier offset assessment completed:		Yes / No	Results:	High risk / Low risk	
	Speed-specific working width adopted:		Yes / No	Justification:		
	Constraints located behind kerb (e.g. services):		Yes / No	Justification:		

V6.8.9.1 Below minimum distances from barrier to hazard (EDD)

Local Guidance

If the designer has systematically considered all barrier configurations/designs (e.g. barrier offset, type, variant, etc) and cannot practically provide the minimum barrier-to-hazard clearance (e.g. working width), consideration may be given to the use of a below minimum distance to balance safety outcomes and practicality of installing other infrastructure.

In urban environments, a speed specific working width may be considered in accordance with Section V6.7.2 without approval. Where this is not applicable, a risk assessment should be undertaken to evaluate the net risk/benefit of installing a barrier. A barrier offset assessment should be undertaken (refer Table V6.8.1b) and justification should be documented.

While providing a less than minimum distance to the hazard will reduce the percentage of impact combinations (speed, angle, mass) that are redirected within the space provided, designers should acknowledge that barriers will still redirect a certain percentage of vehicle impact scenarios. This is an important concept to acknowledge when considering the net risk/benefit of installing a barrier.

Often, the installation of safety barrier will still provide an overall safety benefit, especially if the probable barrier impact conditions are less than the tested impact conditions, or if the risk exposure is limited to a short section. As such, designers may consider below minimum clearances within the Extended Design Domain (EDD) for application in suitable contexts.

Designers are encouraged to consider any installation refinements detailed in Section 6.13.

V6.8.9.2 Below minimum distances from barrier to embankment hinge point

Local Guidance

When the minimum distance from barrier to embankment hinge point cannot be provided, in accordance with Section 6.8.3, the following risks must be addressed:

1. Barrier impact performance,
2. Barrier support and maintenance

Barrier support widths and maintenance widths must be considered from an infrastructure lifecycle perspective, as softening of the verge may occur over time. While some suppliers of barrier systems claim an extremely small support width, Table V6.8.9.2 provides the absolute minimum support widths to be used, measured from back of barrier.

Absolute minimum support widths can only be used when the selected barrier system has been successfully crash tested while located on or near the batter and when the design meets or exceeds the crash tested configuration/design, including minimum batter slope, minimum barrier offset, suitable post type and support (as confirmed by side load testing) and minimum barrier height.

Table V6.8.9.2: Absolute minimum support widths

System type	Minimum Support Widths (measured from back of barrier)
WRSB	1.0 m
Flexible Guard Fence, Public domain Guard Fence & Thrie-beam	0.5 m
Permanent concrete barrier	Varies - e.g. could be 0m where barrier is integrated with a structure and designed in accordance with AS5100 and BTNs.

Narrower support widths should only be implemented in constrained locations following a risk assessment and approval to a design exception. Documented evidence should be sought from the supplier to support any decisions and/or assessment of risk. This may include product specific requirements, testing and long-term performance as justification. Additional post embedment depth may be an appropriate option investigated to provide sufficient lateral barrier system support.

V6.8.10 Typical positioning of barriers in urban medians

<u>Local Guidance</u>

To assist the designer, several typical scenarios have been provided for barriers in urban medians. It is the responsibility of the designer to ensure that any scenario adopted is appropriate for the context being considered. Table V6.8.10 provides nine median scenarios, each with a different combination of characteristics and constraints. The scenarios are sorted based on the overall width required. Designers can identify the characteristics and constraints of their site and align this with the relevant cross section in Table V6.14 as a starting position.

For example,

- Scenario 2 provides a cross section in which there are no constraints located behind kerb, the speed environment is high, maintenance access is required within the median and tree planting is being provided. The typical overall width is 5.7m.
- Scenario 7 provides a cross section in which there are no constraints located behind kerb, the speed environment is low, maintenance access is not required, and planting is not proposed.

The principles used to develop these typical scenarios were as follows:

- The desirable setback from kerb was adopted, unless specific constraints are present such as underground services, impacts on sight lines, or swept paths.
- Given the typical balance of performance objectives on urban roads, all scenarios assume that a reduced traffic-to-barrier offset would be low risk. This must be confirmed via a barrier offset assessment.
- Given the lower speed in urban environments, several scenarios assume the conditions in Section 6.8.2 are met, and a speed-specific working width is suitable.
- Required mowing, pruning and litter collection activities carried out in a safe manner are often key considerations within urban planted medians, therefore a 2.0m wide area between back of barrier and hazard is provided in most scenarios. Widths less than this would require detailed maintenance planning.
- Landscaping is often desirable in urban environments, therefore a 1.5m clearance has been provided in some scenarios to facilitate desirable growth.

Table V6.8.10 - Typical positioning of barriers in urban environments

Typical Scenarios	Characteristics & Constraints: Constraints behind kerb	Low speed environment	Maintenance access req.	Tree Planting	Barrier Type	Setback from kerb	Offset	Barrier to hazard clearance	Maintenance width	Landscaping	Overall Width (80km/h)	Overall Width (60km/h)
Scenario 1 (EDD)	✓		✓	✓	FGF	0.6m offset (EDD) provided to avoid services.	Barrier offset assessment required.	Crash tested working width provided.	Desirable clearance for mowing provided (2m)	Clearance for sustainable growth provided (1.5m)	6.1m	6.1m
Scenario 2			✓	✓	FGF	0.4m offset (NDD) provided	Barrier offset assessment required.	Crash tested working width provided.	Desirable clearance for mowing provided (2m)	Clearance for sustainable growth provided (1.5m)	5.7m	5.7m
Scenario 3		✓	✓	✓	FGF	0.4m offset (NDD) provided	Barrier offset assessment required.	Speed-specific working width provided.	Desirable clearance for mowing provided (2m)	Clearance for sustainable growth provided (1.5m)	5.7m	5.7m
Scenario 4 (EDD)	✓	✓		✓	FGF	0.6m offset (EDD) provided to avoid services.	Barrier offset assessment required.	Speed-specific working width provided.	Clearance for mowing not required	Clearance for sustainable growth provided (1.5m)	5.5m	4.4m
Scenario 5a		✓		✓	FGF	0.4m offset (NDD) provided	Barrier offset assessment required.	Speed-specific working width provided.	Clearance for mowing not required	Clearance for sustainable growth provided (1.5m)	5.1m	4.3m
Scenario 5b		✓		✓	Thriebeam						4.5m	3.7m
Scenario 6					FGF	0.4m offset (NDD) provided	Barrier offset assessment required.	Crash tested working width provided.	Clearance for mowing not required	N/A	4.7m	4.7m
Scenario 7		✓			FGF	0.4m offset (NDD) provided	Barrier offset assessment required.	Speed-specific working width provided.	Clearance for mowing not required	N/A	4.1m	3.3m
Scenario 8					Back-to-Back FGF	0.4m offset provided on one side and mountable kerb provided on opposite side.	Barrier offset assessment required.	Central slip base pole located within working width	Clearance for pole access provided	N/A	2.5m	2.5m

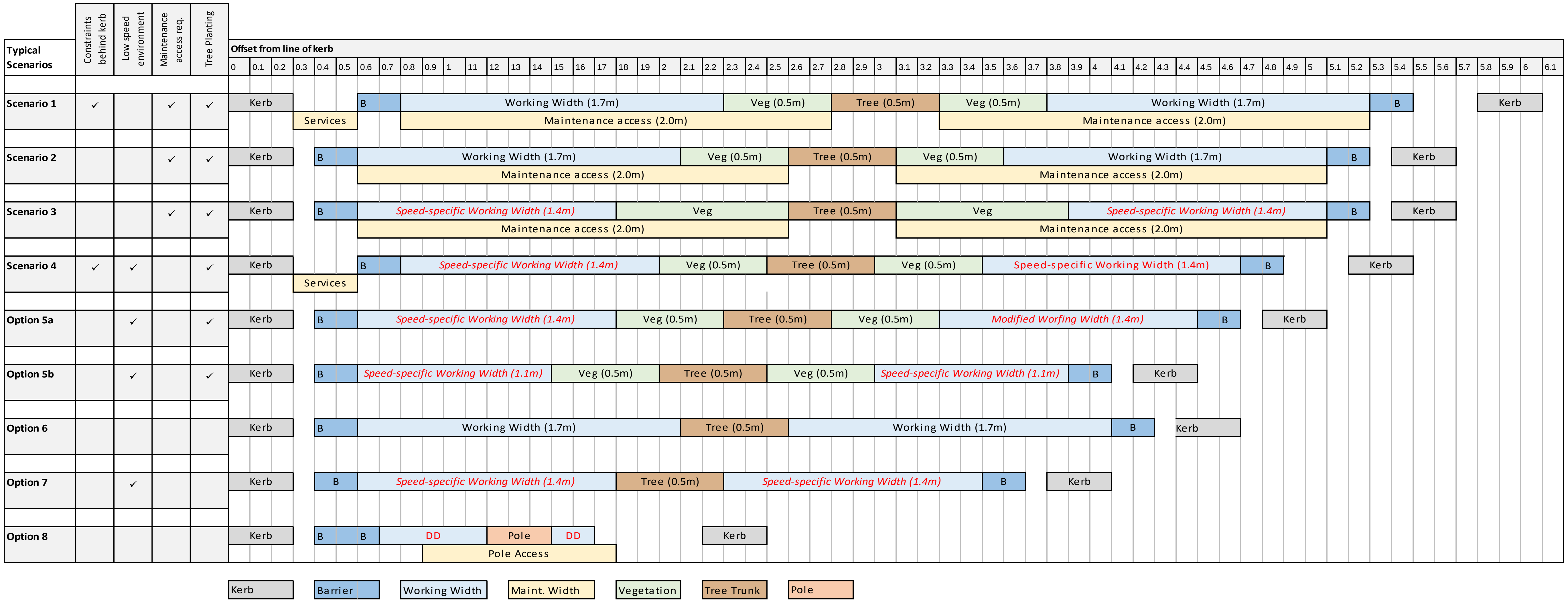


Figure V6.4 - Typical positioning of barriers in 80km/h urban environments

6.9 Determine the Longitudinal Location of a Barrier (Step 7)

6.9.1 Determine the Length of Need

Supporting Guidance

Departure point of redirection

In 2022, AGRD Part 6 introduced a new and important concept regarding the departure point of redirection for WRSB, FGF and GF barrier types. Refer AGRD Part 6 Section 5.5.4. When a vehicle impacts the barrier toward the end of these systems, it is likely to gate, and allow a vehicle to pass through. As such, hazards should not be placed near the terminal as shown in Figure V6.9.1 below.

This is an important design element to consider and achieve, especially in high-speed areas and when protecting critical assets. Figure V6.9.1 shows the unprotected area, assuming a 20m departure point of redirection. Refer AGRD 06 Section 5.5.4 for specific values.

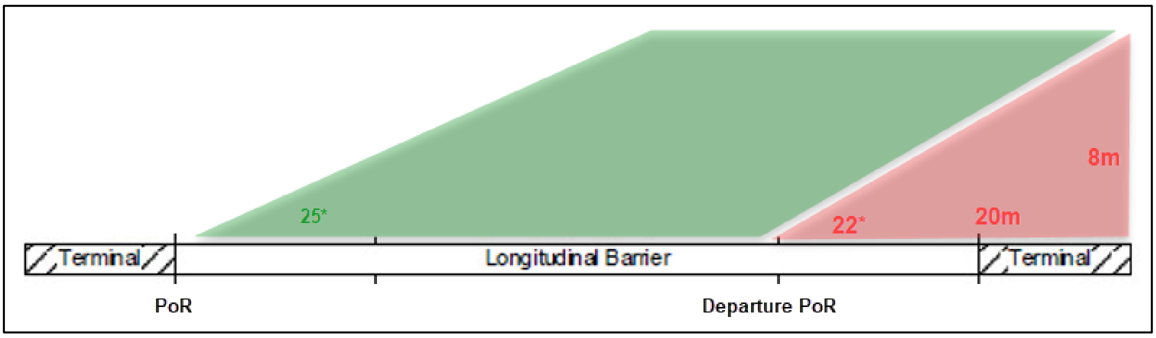


Figure V6.9.1 - Typical unprotected area for a 20m departure PoR

In urban areas, when placing barriers between property entrances, this requirement is a consideration only, and designers should extend the barrier as far as is practicable.

6.9.4 Continuous Barriers and the Length of Need Concept

Local Guidance

Refer Section V6.13.2.1 for addition guidance on barrier lengths between urban property entrances.

6.9.5 Length of Need for TL-5 and TL-6 Concrete Barriers at High Risk Sites

Supporting Guidance & Local Guidance

At high-risk sites, designers will need to determine the length of higher containment level barrier required on the approach and adjacent to the site, in accordance with Bridge Technical Notes.

This localised length of higher containment level barrier mitigates the increased risk near the site. While the minimum containment level (refer Section 6.5.1) could extend for the full 'length of need', as per the sections above, this solution can be quite costly and the benefit-cost would be diminished further from the site, where the likelihood of collision is lower.

As such, the length of need at high-risk sites can be determined as follows and the containment level of the barrier can be increased gradually (stepped-up) on the approach to the high-risk site. This approach is intended to optimise the benefit-cost ratio.

It should also be noted that the barrier type is likely to change along the approach length of the barrier, depending on site constraints, product suitability and the containment level needed. For example, the barrier type may need to change when a smaller working width is required, the barrier is attached to a structure, or the barrier needs to achieve higher containment levels. Consideration should be made to optimising the number of changes in barrier types (i.e. fewer changes) if that is an economically viable solution.

Step 1 – Determine the perimeter of the high-risk site

As detailed in Section 6.9.1, the designer must determine the perimeter of the high-risk site (i.e. the width and lateral extent of the hazard) in order to determine the first point of contact.

Where the high-risk site is an area, rather than a physical object, the designer should use engineering judgement when selecting the perimeter.

For high-risk sites that extend long distances perpendicular to the road, the maximum lateral extent (LA) of the perimeter should be determined in accordance with Table VB1 (also refer BTN 001).

Table VB1 provides lateral distances in which the majority of errant vehicles are likely to recover. Correction factors are provided for curves.

For railway corridors, the perimeter must include the full width of the rail corridor, up to the maximum lateral extent defined in Table VB1

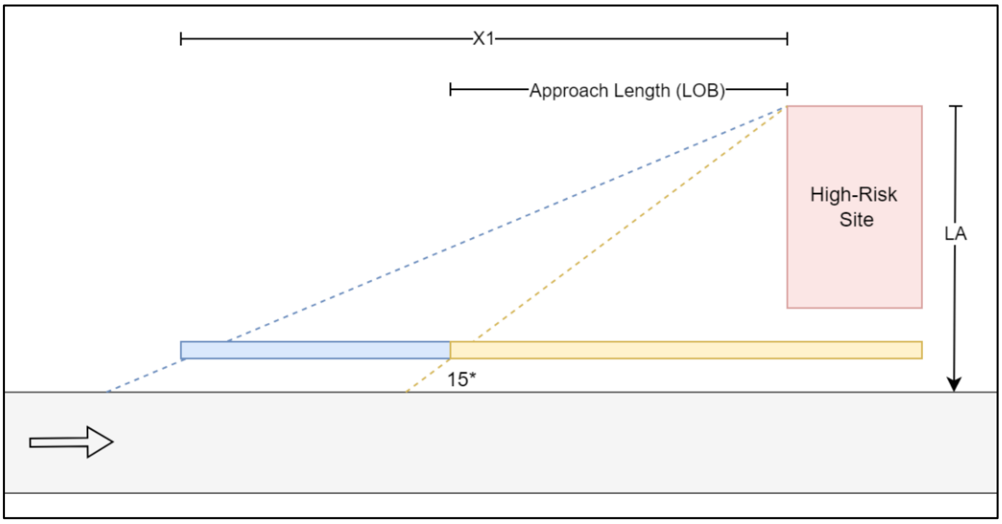
At an orthogonal bridge-crossing, the maximum lateral extent (LA) is projected at right angles from the end of the bridge which is either the end of the deck or, in an integral bridge, is defined as the exposed face of the face of abutment crosshead

Step 2 – Determine the minimum length of approach barrier (LOB) needed for the high-risk site

To determine the length of higher containment level barrier needed (aka the 'approach barrier' or 'LOB'), the designer should draw a departure angle of 15° from the edge of the traffic lane to the outside edge of the high-risk site perimeter, and ensure the barrier intersects with this line. Refer Figure V6.9.5.

Note that the barrier may need to extend beyond the LOB, in accordance with Section 6.9.1 and 6.9.2, at the containment level of the route.

Figure V6.9.5 – Approach Barrier Length (LOB)



Step 3 - Determine the minimum partition length for each containment level

Based on the approach length of the barrier (LOB), the designer should determine the minimum length of each consecutive containment level, in accordance with Table V6.9.5b. This table is based on information in current Bridge Technical Notes.

These partition lengths are intended to optimise the benefit-cost ratio and are based on the level difference between the route and the high risk-site. For example, where the high-risk site only warrants one level above the route minimum, the entire LOB should be at the higher containment level.

Table V6.9.5b - Minimum partition length for each containment level

Minimum Containment level:		Length of TL-3	Length of TL-4 or RPL	Length of TL-5 or MPL	Length of HPL
Route	**High risk site**				
TL-4 (or RPL)	SPL	-	*As needed*	LOB / 2	LOB / 2
TL-3	SPL	*As needed*	LOB / 3	LOB / 3	LOB / 3
TL-4 (or RPL)	TL-5 (or MPL)	-	*As needed*	LOB	-
TL-3	TL-5 (or MPL)	*As needed*	LOB / 2	LOB / 2	-
TL-3	TL-4 (or RPL)	*As needed*	LOB	-	-

Notes:

1. The length of each containment level must not be less than 12m.
2. This table has been developed in conjunction with BTN 001, Table A3. Refer BTN 001 for additional requirements.
3. RPL: Regular Performance Level. MPL: Medium Performance Level. SPL: Special Performance Level. LOB: Approach Length of Barrier.

V6.9.6 Length of barriers in urban medians where direct access is provided

Supporting Guidance

When selecting the extent (length) of barriers in urban medians and the location of terminals near an intersection, or access break, these objectives should be considered and balanced, in order of priority:

1. The safety barrier alignment should ensure **necessary sight distances are achieved**, particularly at unsignalized intersections (where decision making is necessary).
2. The safety barrier alignment should **protect rigid hazards** located within the median.
3. The safety barrier alignment should **not be located within the swept path** of a design or check vehicle. In addition, terminals should not be in areas with a high risk of nuisance impact.
4. The safety barrier alignment should **enable typical maintenance practices**, including access to slip-base lighting poles and ITS equipment.
5. The safety barrier alignment should **mitigate the potential for head-on crashes**.
6. The safety barrier alignment should **be located within the NDD barrier-kerb setback distances**.

Refer to Commentary V1 for justification of these objectives and order of priority. Refer to Appendix VE for several examples of barrier layouts within medians.

V6.9.7 Length of need in constrained locations

Supporting Guidance

Where the length of need cannot be achieved, there is an increased probability that someone will collide with the hazard. As such, designers should assess the probable vehicle departure path for vehicles that leave the road prior to the barrier and extended the barrier as far as possible and terminate with an appropriate terminal.

In lower speed environments, ≤ 60km/h, the barrier should be curved in plan and extended away from the road until it intersects with the associated vehicle departure path. The barrier radii should be designed such that it mitigates the risk of snagging and provides for spreading the impact load across the vehicle during impact.

At freeway interchanges, appropriate barrier systems must be extended down freeway or major highway entrance and exit ramps for a suitable distance to protect against errant vehicles penetrating the freeway or highway. Provision of appropriate sight distances at freeway merges and diverges is essential and can impact on where barriers can be located.

In situations where it is physically impossible for an errant vehicle to reach the hazard or site, due to the presence of existing obstacles or other high-risk sites, the designer may adopt the maximum length of barrier that is possible. This is only applicable when an existing roadside object/obstacle can be demonstrated, without a doubt, to prevent an errant vehicle from reaching the high-risk site and it is impractical to remove existing hazard. In addition, designers must not install hazardous objects/obstacles with the primary purpose of reducing the approach barrier length.

6.12 Structural Design of the Proposed Barrier (Step 10)

Local Guidance

Test level safety barrier systems should not be modified without DTP approval. Accepted safety barrier systems and variants must be used as they were designed and within their accepted conditions of use and/or associated Standard Drawings.

The following test level barriers require some degree of structural design:

- Where the accepted ground beam design is not suitable, the designer may design an alternative in accordance with AS3600 and the product manual. Site-specific designs must be subjected to proof-engineering.
- Where test level concrete barriers are used, refer DTP Standard Drawings.

6.13 Detailed Installation Refinements (Step 11)

6.13.1 Modification of the Working Width

Supporting Guidance

Local stiffening

In constrained locations, where the minimum barrier-to-hazard clearance cannot be accommodated, it may be possible to locally stiffen some barrier products with additional posts or anchors. Products with this variant are listed in the product TCU.

In many cases, local stiffening (e.g. reduced post spacing) has not undergone full-scale crash testing and therefore the variant is only accepted for use in constrained locations. Local stiffening will reduce the working width of the product, although the precise working width value may not be known. As such, this modification should be used sparingly and preferably not in high-speed environments.

Where local stiffening is adopted, the reduced post spacing must extend for the full length of the hazard plus a minimum of 10m either side of the hazard, and not be less than 30m in total.

For WRSB products, a 2.0m post spacing has been used successfully across Victoria for several decades and therefore a 2.0m post spacing may be adopted for all accepted WRSB products.

Sway protection on concrete barrier

Sway protection on concrete barriers can be used to reduce the amount of vehicle roll above and beyond the barrier that would otherwise impact the hazard. Sway protection is a modification to the barrier profile and should be used only when necessary. The modification must begin 920mm or more above the surface level and have a 30mm maximum protrusion to ensure any adverse effects to smaller vehicles are mitigated by minimising snagging and impact severity. Refer Section V6.7.1 for modified working width values.

6.13.2 Minimum Length of Barrier System

Supporting Guidance

As per AGRD Part 6 and Austroads SBTA 21-002,

- "When crash testing a barrier, the Manual for Assessing Safety Hardware (MASH) (AASHTO, 2016) requires the minimum article length to be at least three times the length in which deformation is predicted, but not less than 30 m for steel beam systems and 180 m for wire rope safety barriers (WRSBs). The primary basis for testing barriers at these lengths is to accurately predict the working width and dynamic deflection for the barrier system at a location where end (terminal) effects are eliminated.“, and

- “For shorter systems, a larger portion of a barrier’s redirective force must be carried by the end anchors. Higher anchor loads produce larger longitudinal anchor movements. In general, terminal testing has shown that increases in the longitudinal movement of the anchor can lead to increases in lateral barrier deflection. It is important to understand how shortening a system affects anchor movement, barrier deflection and the ability of the system to redirect vehicles without gating. These qualities will assist in determining appropriate minimum lengths for a barrier system to operate satisfactorily.”

Within each product technical conditions of use (TCU), Austroads provides a tested length. This is the length associated with the systems performance characteristics and is the length in which performance has been confirmed/demonstrated by the System Supplier.

As per SBTA 21-002, barrier lengths shorter than the TCU are possible and there is general evidence to suggest shorter lengths are worthwhile compared to omitting the barrier. While these lengths are shorter than recommended by the TCU, designers may adopt the practical minimum length without approval where a safety benefit can be demonstrated.

Practical minimum length of barrier system

As per AGRD Part 6 and Austroads SBTA 21-002, the practical minimum lengths have been established based on several factors, including the typical contact length during an impact, plus several w-beam rails where appropriate.

In general, short lengths of barrier should be avoided, as this eliminates a leading terminal which is more hazardous than the longitudinal barrier. However, in lower speed environments, the practical minimum lengths are often worthwhile for isolated treatments when there is a significant hazard (e.g. pole or tree) present.

To assist designers to understand the Austroads practical minimum lengths, Table V6.13.2 has been developed based on available products at the time of publishing (12/2022).

In general, adoption of an alternate barrier type should be considered rather than a barrier length less than the practical minimum. Shorter lengths are considered a design exception, even if they are suggested or recommended by the System Supplier.

Table V6.13.2 - Examples of practical minimum lengths

Overall Length	Barrier components					
	Gating < -	- > Redirective		(Various)		
~24m (~18m redirective)	TL2 GREAT (3m)	TL2 GREAT (5m)	W-beam (12m)	Trailing terminal (4m)	-	-
~28m (~22m redirective)	TL2 GREAT (3m)	TL2 GREAT (5m)	W-beam (12m)	TL2 GREAT (5m)	TL2 GREAT (3m)	-
~28m (~20m redirective)	TL3 GREAT (5m)	TL2 GREAT (11m)	W-beam (8m)	Trailing terminal (4m)	-	
~36m (~26m redirective)	TL3 GREAT (5m)	TL3 GREAT (11m)	W-beam (4m)	TL3 GREAT (11m)	TL3 GREAT (5m)	-
~30m +Xm (~22m +Xm redir.)	TL3 GREAT (5m)	TL3 GREAT (11m)	Transition (5m)	Thrie-beam (Xm)	Transition (5m)	Trailing terminal (4m)
~84m (~60m redirective)	WRSB Terminal (12m)	WRSB (60m)				WRSB Terminal (12m)

Note: This table is based on typical barrier lengths available at the time of publishing. Overall length is measured from barrier end to end. Redirective length is measured between barrier points of redirection. Yellow cells are considered gating non-redirective sections of the barrier. The length in brackets note the length of the particular section of the system.

Designers should note that an end-to-end TL-3 GREAT configuration has not been included in the table above. While this configuration (32m) would exceed the Austroads minimum practical length, and would perform similarly to a configuration that includes 1-2 rail lengths between terminals, the benefit provided is limited. As such, this configuration may only be considered as part of the Extended Design Domain where there is a significant hazard present and other treatments are not possible.

V6.13.2.1 Minimum length of barrier between urban property entrances

<u>Local Guidance</u>

In urban environments, it is common to have frequent property entrances along the roadside which can hinder the installation of continuous safety barrier. As such, the designer will need to determine whether a barrier should be provided or omitted based;

1. Whether sufficient sight distance can be provided based on the type of access, volume of movements, type of vehicles using the access
2. on the length available between property accesses

Considering the concepts described in AGRD Part 6, SBTA 21-002 and the Sections above, short barrier lengths are possible, but should be avoided unless they provide a net reduction in risk.

As such, Table V6.13.2.1 provides guidance on whether continuous safety barrier should be installed between adjacent property entrances, based on the length available and the roadside risk.

Where safety barrier is regularly omitted between property entrances, the designer should engage with the client to reconfirm the objective of the safety barrier. Continuous safety barrier is not considered an appropriate solution, if it is not able to be continuous and protect a reasonable percentage of the roadside.

Table V6.13.2.1 - Installation of continuous safety barrier between urban property entrances

<table>
<tr><th colspan="2">Site Conditions:</th><th rowspan="2">Recommended solution:</th></tr>
<tr><th>Length Available:</th><th>Roadside Risk</th></tr>
<tr><td>Tested barrier length can be achieved, as per the relevant product TCU</td><td>N/A</td><td>Install safety barrier</td></tr>
<tr><td rowspan="2">Practical minimum length of barrier can be achieved.</td><td>Significant hazards (refer AGRD 06) are:
• located within 4.5m of the traffic lane in ≤70km/h speed environments, or
• located within 9m of the traffic lane in ≥80km/h speed environments;</td><td>Install safety barrier</td></tr>
<tr><td>Risk is lower than above</td><td>Omit safety barrier</td></tr>
<tr><td>Practical minimum length of barrier cannot be achieved</td><td>N/A</td><td>Omit safety barrier, and
Remove or relocate isolated hazard;</td></tr>
<tr><td colspan="3">Notes
1. The hazard offset values have been determined using a roadside risk score of 0.5 (threshold for NDD range) and the following conditions - Flat, Urban, 80km/h/70km.h, Undivided, 1 lane in each direction, 3.5m lane, >20,000 AADT, Straight, Background hazard is Generic Fixed Object (Trauma Index Score = 6).</td></tr>
</table>

6.13.4 Sight Distance Requirements

<u>Supporting Guidance</u>

The effect of barriers on sight distances, particularly on horizontal curves and in the vicinity of intersections and driveways, must be considered when selecting the barrier location and extent. Providing adequate sight distance is essential for drivers and pedestrians to make good decisions and avoid crashes, particularly at uncontrolled intersections or crossings where gap selection is required.

For the purposes of assessing sight distance, all barriers must be considered non-permeable to the highest point on the barrier (e.g. top of post or w-beam rail). In addition, it is desirable that all sight distance requirements are achieved in accordance with AGRD Parts 3, 4a and 4b.

Where site constraints limit the necessary sight distance requirements, designers must decide whether to adopt a reduced sight distance or modify the offset and/or extent of the barrier. As such, the following guidance may be considered when space is limited and the barrier is considered essential (e.g. to protect a rigid or high-risk hazard). Where the barrier is not considered essential or the critical sight distances cannot be achieved, the barrier offset and extent must be modified to suit.

Pedestrian crossings on urban roads

AGRD Part 4A states that Approach Sight Distance (ASD) and Crossing Sight Distance (CSD) is necessary at all pedestrian crossings. The importance of these distances will depend on the type of crossing and the necessary decisions to be made.

At signalised crossings where drivers and pedestrians are both yielding to pedestrian activated signals, both ASD and CSD may be reduced. To offset this reduction, the designer must ensure the environment is self-explaining (i.e. promotes the presence of a pedestrian crossing) and that sufficient sight lines are provided to the signal lanterns.

At unsignalized crossings where vehicles yield to pedestrians (e.g. a zebra crossing), both ASD and CSD are required. Drivers must have sufficient time to identify the crossing type, identify the presence of pedestrians and then yield. Where barrier is necessary to protect rigid hazards, an alternate pedestrian crossing type should be considered.

At unsignalized crossings where pedestrians yield to oncoming vehicles, CSD is required and ASD may be reduced providing there is clear indication of the crossing location for the approaching driver. The pedestrian eye height should be taken as 1.07 m which represents the lower bound of the range applicable to a person in an A80 wheelchair.

Urban signalised intersections

At urban signalised intersections, the following guidance is provided on ASD and SISD. For unsignalized slip lanes refer the next section. Refer AGRD Part 3 and Part 4A for guidance on the fundamentals of sight distance.

- At urban signalised intersections where drivers are yielding to traffic signals, ASD may be reduced when the environment is considered self-explaining by the designer (i.e. promotes the presence of a pedestrian crossing) and that sufficient sight lines are provided to the signal lanterns.
- At urban signalised intersections, SISD may be reduced as follows. Designers must consider how the intersection will operate when the signals are non-functional, by determining a likely operating speed during this time-period and designing SISD for this speed. In the absence of site specific data, 40km/h can be used by default unless justified otherwise. The omission of SISD all together is unacceptable.

Urban unsignalized slip lanes and service lane exits

At urban unsignalized slip lanes and service lanes, appropriate decision making by road users is important.

- On divided multi-lane carriageways, where oncoming vehicles are able to avoid an error made by the vehicle entering, MGSD and SISD are required. If an existing condition, SISD capability may be able to be reviewed using (say) EDD criteria and the risk assessed.
- Where vehicles can turn right from a service lane, SISD and MGSD are both required.

6.14 Select End Treatments to Longitudinal Barriers (Step 12)

<u>Local Guidance</u>

Only accepted end treatments and variants contained in RDN 06-04 - Accepted Safety Barrier Products, should be used on the declared road network.

Where rigid barriers need to be terminated (e.g. at bridge end posts) and the appropriate transition cannot be accommodated, the barrier shall be protected by a crash cushion.

Designers should note that attaching a crash cushion on the end of a tall concrete barrier is not recommended. The nominal height of a crash cushion is 820mm so any concrete barrier in excess of this height presents a snag risk for all vehicle types. To eliminate the potential for snagging, tall concrete roadside or median barriers must gradually transition in height and shape to a 820mm high concrete barrier or end block to match the crash cushion height.

6.14.3 Run Out Areas

Local Guidance

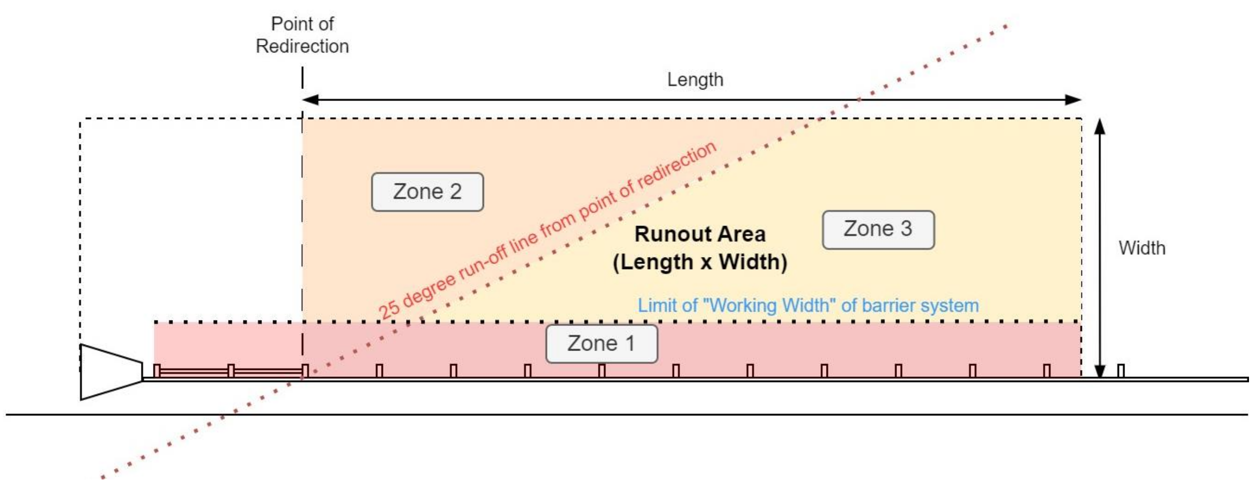
As stated in AGRD Part 6 Section 6.14.3 *"the run out area should contain no fixed hazards (e.g. poles and trees) and be traversable, with a lateral slope of 6:1 or flatter'*.

The placement or retention of hazards/objects in the runout area should be considered after options to remove them or extend the barrier to fully protect them have been assessed as unsuitable. Where trees, fixed based lighting columns, utility poles or traffic signal poles (hazards with a trauma index of 6 or higher) are proposed or are being retained within the run out area, the designer must assess the residual risk. Figure V6.14.3 is provided to assist in this assessment.

- Objects / hazards within Zone 1 are located within the working width of the terminal and the safety barrier system. These objects are likely to interact and/or interfere with the barrier during impact and therefore are considered 'Design Exception'.
- Objects / hazards within Zone 2 are beyond the working width and are located prior to the 25º run-out line measured from the terminal point of redirection. These objects are considered unprotected and are exposed to vehicles that impact the terminal and yaw. As such, objects should be treated as if they were located prior to the terminal point of redirection – they should be considered unprotected, and the designer must document and seek approval similar to other unprotected hazards. As such, this area is considered 'Extended Design Domain'.
- Objects / hazards within Zone 3 are beyond the working width and the run-out line measured from the terminal point of redirection. While these objects are considered 'partially-protected' the likelihood of a vehicle impacting the terminal and subsequently the object, is very low. The decision to accept a hazard or object in this zone will be dependent on the type of hazard (trauma index of the hazard) and the safety (road-users) and operational outcomes if impacted.

In all locations, the designer must document their evidence that demonstrates why the hazard cannot be relocated or be protected by extending the barrier. Note, that while an assessment of the risk profile using the NRRIT risk assessment process may provide some comparative risk justification, it should not be the basis for deciding whether hazards should be proposed or retained within the run out area of an end terminal.

Figure V6.14.3 – Zones of risk for hazards within barrier terminal run-out areas



6.14.4 Transitions and Overlaps

Local Guidance

Accepted transitions are detailed in the Product TCUs or Standard Drawings. Transitions that are not approved are treated as design exceptions requiring site-specific DTP approval.

Transitions between bridge barriers and road barriers should be designed in accordance with SD 3951 – SD 3957.

Overlaps from wire rope safety barrier to concrete barriers are not permitted, unless the end of the concrete barrier is treated with a crash cushion or is transitioned to guard fence.

6.14.6 Overlaps

Local Guidance

Overlaps from wire rope safety barrier to concrete barriers are not permitted, irrespective of offset, unless the end of the concrete barrier is treated with a crash cushion or is transitioned to guard fence.

6.15 Access Through Barriers

6.15.1 Access Through Barriers in the Verge

Supporting Guidance & Local Guidance

Access Locations

Access to the roadside can be critical to assist operational activities and response of emergency services. As such, installations of continuous safety barrier must consider the requirements of local emergency services and provide adequate access where possible. Frequency of access points and locations must be determined in the context of a specific road section (e.g. access to water supply fire hydrants and high-risk locations, safe parking of vehicles used for roadside management etc.).

The Occupational Health & Safety implications of the provision and maintenance of these access points need to be considered in accordance with Section 28 of the OH&S Act 2004.

As a minimum, the following safety barrier design requirements should be provided as per DTP guidelines and the CFA Position Paper:

- total barrier lengths should not exceed 1000 m;
- where multiple WRSBs are required along a stretch longer than 1000 m, a separation between barriers of at least 4 m should be provided to allow emergency services vehicle access;
- 500 m lengths between access locations are desirable to prevent delays from barrier dismantling, restricted escape routes and delays from travelling around barriers.

Access locations should be selected based on the principles included in AGRD Part 6.

Access configurations

Depending on the site constraints, verge access overlaps should be designed as follows (in order of preference):

- 90-degree PON overlap (Desirable – but may not be practical)
- 25-degree PON overlap (Desirable)
- 10-degree PON overlap (DE – to be used in constrained locations)
- No overlap. (DE – to be used in extremely constrained locations)

While 90-degree PON overlaps are preferred and should be provided for a typical no-access barrier overlap, the overlap width can be quite large where access is required. As such, 25-degree PON overlaps are more common for maintenance and service authority access locations. 25-degree PON overlaps are also preferred within medians, to protect the opposing barrier.

Consultation with the relevant DTP Operations area should be undertaken to determine an appropriate access width for maintenance purposes. In general, 3 - 5 m should be provided between overlapping barriers. Refer AGRD Part 6 Commentary 14 for an example diagram of a barrier access arrangement.

The locations and orientation of access gaps should consider the desirable safe entry and exit of maintenance vehicles. This includes providing entry and exit locations between obstacles, such as creeks, culverts, trees, etc. Typically, tractors used for maintenance are 2.5 - 3.5 m wide and 3.5 m high.

Any unprotected hazards located in close proximity to the break in barriers (i.e. outside of the length of redirection) must be reviewed for removal, relocation or alternative protection.

6.15.2 Median Barrier Openings

Supporting Guidance & Local Guidance

When installing two runs of barrier within a median, the back of barrier should not pose a hazard for the opposing carriageway. To mitigate this risk, the closest barrier should protect the opposing barrier by using a 25-degree angle of departure. Refer Figure V6.15.2.

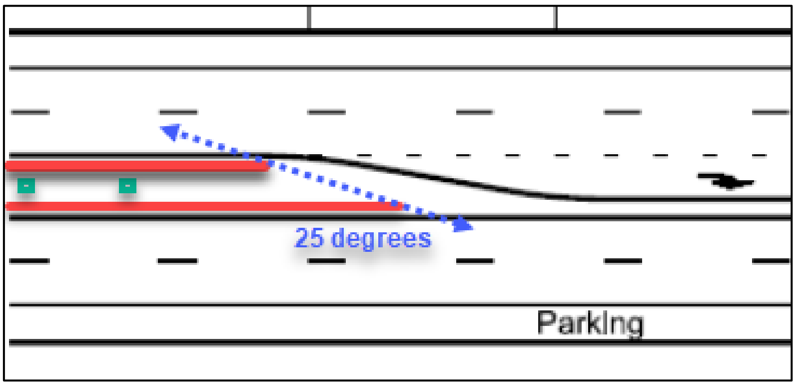


Figure V6.15.2: Median barrier opening layout

While the angle of departure should be measured from the PON of the adjacent barrier to the extremity of the opposing barrier. For simplicity, it is also acceptable to measure the angle of departure from the extremities of both barriers.

Where the back of barrier is located beyond the 25 degree angle of departure (protected area), a back-to back system should be considered. All back to back systems must be treated with a trailing terminal to anchor the opposite side rail. Refer to the product installation manuals.

Refer Section V6.9.6 for additional guidance on lengths of median barriers in urban environments.

6.15.3 Barriers at Intersections and Property Accesses

Local Guidance

Refer Section V6.9.6 for guidance on lengths of median barriers in urban environments.

6.16 Continuous Barriers on the Verge

Supporting Guidance

Rather than designing a barrier to shield a specific hazard(s), continuous safety barrier should be designed as a longitudinal element of the road, with an objective to maximise road user safety while delivering required operational and access objectives.

When designing continuous safety barrier, the key objectives of design should be to:

- maximise the protected length/area,
- provide a suitable and functional safety barrier that performs optimally during impact,

- support the safe and sustainable operation, access and maintenance of the road and roadside, and
- minimise the impact on significant flora and to fauna connectivity.

Continuous safety barrier aims to protect the entire roadside, yet some areas cannot be protected due to constraints that prohibit the installation of barrier (e.g. driveways, intersections, important existing vegetation). The residual risk of these areas must be assessed and mitigated where possible, noting that in some situations (often urban), the frequency of constraints such as access points may be too high, and the effectiveness of continuous safety barrier will not be achieved.

In addition to barrier treatments, speed management intervention (e.g. reduced speed limits and speed calming treatments) may be needed where:

- continuous safety barrier cannot be achieved due to the frequency of side roads, access points/driveways and median openings, as well as pedestrian activity and the amenity requirements of councils;
- the subject road length has a high frequency of at-grade intersections or pedestrian crossings and the risk of vehicle-vehicle and vehicle-pedestrian crashes can be mitigated through speed management (e.g. reduced speed limits);
- the existing road geometry is less than suitable for the current operating speed and this may be supported by crash history (even where there is no crash history, an analysis of the geometry may identify geometric elements that have a higher crash risk). An assessment of the road geometry including horizontal curvature, cross fall, existing sight lines and other factors should be undertaken to inform decisions regarding speed management interventions;
- the retention of existing tree vegetation with biodiversity, historic and social benefits.

6.16.1 Barrier Offsets

<u>Local Guidance</u>

Audio tactile line marking (ATLM) should be installed along the entire barrier length to reduce the likelihood of barrier nuisance impact. ATLM should be designed in accordance with RDN 03-10 - Audio Tactile Line Marking.

6.16.3 Provision for Roadside Stops

<u>Local Guidance</u>

The preferred layout of an Emergency Stopping Bay (ESB) should be in accordance with RDN 06-16 Appendix E, which includes a desirable offset of 5m-6m from traffic lane edge line and length of 55m. No additional sealing is required and ESBs should have advanced signing where appropriate to advise drivers of their locations. The precise frequency and locations of ESBs should be determined with consideration of; minimising the cost of earthworks required, providing safe entry and egress and adequate sightlines; and the likelihood of vehicles stopping, such as steep grades.

Provision for heavy vehicle stopping should also be considered where the heavy vehicle percentage is high. Opportunities for heavy vehicle stopping may be provided less frequently and the layout of ESBs should be modified to consider the length and width of expected vehicles and any existing truck rest area strategy that might exist for a corridor.

6.17 Vulnerable Road Users

6.17.1 Motorcyclists

<u>Supporting Guidance</u>

DTP is supportive of the ongoing objective to improve motorcyclist safety, therefore new ideas and innovations are encouraged with an aim to better use resources efficiently for the greatest benefit.

While the incidence of motorcyclists hitting safety barriers is a very small part of the overall motorcyclist crash incidents, the following locations can warrant additional motorcyclist intervention:

- Where the risk of a motorcyclist leaving the road and impacting a roadside hazard is considered high risk, such as on a tight curve (<200mR) or demonstrated by a crash history, and
- Where the volume of motorcyclists is high; including popular motorcycle routes listed in Appendix VA or routes designated as Motorcycle Tourist Routes as per the Movement and Place Framework.

Where median barriers are proposed on popular motorcycle routes and areas of higher risk for motorcyclists, flexible guard fence (FGF) is the preferred treatment due to product availability and suitability. See RDN 06-04 for the list of approved motorcycle safety products.

Refer AGRD Part 6 for additional treatments and considerations.

6.19 Barriers Across Drainage Structures and to Avoid Underground Conflicts

<u>Supporting Guidance</u>

In urban environments, designers are likely to encounter underground drainage systems.

Where pits and pipes are perpendicular to the barrier, the designer should consider providing a 'single clear span' variant. While the omission of one post is acceptable, some proprietary products have been accepted with single 6m clear spans. Refer to the product TCUs.

Where pits and pipes are parallel to the barrier, the designer may have to adjust the barrier offset to traffic lane and/or barrier setback to kerb. As such, the following guidance is provided.

V6.19.1 Subsurface drains

<u>Local Guidance</u>

When locating barriers directly behind a kerb, and the barrier post conflict with the location of longitudinal pavement drain, the following options should be considered (in order of precedence);

1. Install the subsurface drain and filter material under the kerb, noting that this may not be practical in all locations, particularly in brownfield locations. Pavement advice should be sought in this case.
2. Install the subsurface drain pipe 100mm below the intended barrier post and install the post within the filter material. Use the following post depths when the barrier system is unknown:

Proprietary Guard Fence:	870mm post depth + kerb height
Thrie-Beam Barrier:	1030 mm post depth + kerb height
GF Terminal:	1000mm post depth + kerb height *Or adopt terminal flare to avoid conflicts*

3. Install the barrier behind the subsurface drain and/or subsurface filter material, noting that approval may be required and limitations on barrier type selected might be relevant if the barrier is located within an EDD barrier-kerb setback distance. Refer Section 6.8.4.
4. Install a base-plated variant above the subsurface drain, noting that this is only suitable for short sections (15-30m) and is not a viable option for long lengths. Refer to the product manual for minimum lengths.

V6.19.2 Side entry pits

<u>Supporting Guidance</u>

When locating barriers directly behind a kerb, the barrier may be required to straddle a side entry pit such that maintenance teams can clean the pit using a vacuum truck.

In general, locating the barrier in-line with the back of kerb is considered suitable as this provides enough room to access the pit from behind the rail. Lightweight pit lids should be installed.

Where a new drainage system is being installed, or an existing system is being modified, barrier conflicts may be mitigated by offsetting the stormwater system behind the barrier or by using haunched pits to position the pit access behind kerb.

Where a barrier rail is located directly over the pit cover opening and an alternative solution is not possible, designers should engage the maintenance team to understand the frequency of maintenance and the likely methodology (e.g. removing the barrier rail) that will be used.

Grated side entry pits are accessed from the traffic side, regardless of barrier offset.

6.20 Protecting Critical Infrastructure Close to Barriers

6.20.2 Gantries and Bridge Piers

Supporting Guidance

Gantries and bridge piers are both considered a high-risk sites. The barrier design should be prepared in accordance with the sections above, including minimum containment level, lateral position and length of need.

6.23 Aesthetic Road Safety Barriers

Supporting Guidance & Local Guidance

Aesthetic barriers might be considered in parks, historic communities, scenic areas, or private road developments. If a designer is considering the use of such barriers, it is recommended that the responsible road authority undertakes a site-specific risk assessment of the proposal that includes considering crash test performance, availability of terminals and whole-of-life costs of the system, to make an informed decision.

As a minimum, it is recommended that such barriers be crash tested against recognised crash test criteria such as MASH, NCHRP Report 350 or EN1317 and consideration should be given to any 'conditions of use' published by the Federal Highway Administration (FHWA).

At the time of publishing this supplement, DTP has not assessed or accepted any Aesthetic Road Safety Barriers for use on or outside the declared road network (refer RDN 06-04 – Accepted Safety Barrier Products), therefore their use should be approved using a jurisdiction's design exception process.

Textured concrete barriers are also in this category. DTP has not assessed or accepted any textured concrete barriers, therefore their use should be subject to approval by a design exception. Where textured concrete barriers are being considered, they should be limited to very low speed urban environments (e.g. 40km/h or less). Refer Austroads for additional guidance.

Another method of making a safety barrier aesthetically pleasing is to apply a painted finish. WRSB posts have been powder coated and installed on the network for several years now. Powder coated in heritage green paint, the posts blend in well with the surroundings. However, painting guard fence involves more effort given its size and surface area. Painted guard fence installations are not new in the urban area. There is no reason why a painted guard fence could not be considered in a rural setting, providing any resulting maintenance regimes are accepted. Delineation should not be an issue given most roads have a painted edge line and alignment signs where needed. Guard fence, in powder coated heritage green paint, could be aesthetically pleasing when installed on scenic installations, particularly on popular motorcycle routes. As such, both the w-beam and motorcycle rub rail would need to be painted, but not the posts as they effectively would be less visible from the roadway. If a project is considering installing painted guard fence in a rural setting, then its maintenance, potential for bushfire damage, the potential for reduced delineation and whole-of-life costs need to be considered. DTP does not have a policy to paint or powder coat road safety hardware, beyond that supplied from initial manufacture of components to meet the design life requirements.

Barrier aesthetics

Attractive roadsides strengthen a sense of place and give travellers and tourists a more pleasant driving experience. These are important factors for both the tourism industry and for the quality of life of Victorians. The presence of continuous safety barrier will have a large influence on the road identity and community perception, hence, providing a pleasant and enjoyable roadside is an important consideration.

At high speeds, the large scale of the landscape is what typically attracts the motorist's attention. A landscape that is characterised as being untouched, unspoiled, or original, usually evokes a positive reaction, whilst if a landscape is changed, it can be perceived that the values have been diminished or lost.

A driver's ability to maintain attention is stimulated by variation but dulled by monotony, therefore, it can be important to avoid the use of unnatural roadside variation, such as regular changes of barrier types and offsets which can detract from this experience.

Continuous lengths of similar barrier types and designs are desirable to allow focus on the natural landscape. Hence, the type of barrier selected and the design should carefully consider the following, with the intent of providing a consistent roadside barrier design:

- existing barrier types present and their lengths
- the potential to replace those existing barrier types
- the number of transitions required for each barrier type.

Recognising that barrier types will eventually need to change to suit specific site constraints and barrier performance requirements, a general aim should be to vary the barrier type no more than once every 5 km (i.e. three minutes of travel at 100km/h), but this is not mandatory.

6.24 Additional Barrier Design Considerations

6.24.3 Delineation

<u>Local Guidance</u>

Delineators shall be installed to the top of the w-beam at 15 m spacing, in accordance with the TEM v2 Part 2.02 – Supplement to AS1742.2.

In general, delineators should only be installed on tangential sections of road safety barrier when the offset to the nearest traffic lane is ≤ 4 m.

6.24.4 System Height

<u>Clarification</u>

The height of barrier is critical to performance and it is essential that this be maintained at the correct level throughout the life of the installation. The system height, including individual rope heights and rail height, is detailed in the associated product installation and maintenance manual.

Where the barrier is erected within 0 to 1 m (inclusive) behind the back of kerb, the barrier height shall be referenced off the projected line of the shoulder or pavement surface at the kerb face. Where the barrier is erected within 0 to 1.5 m (inclusive) from edge of carriageway without kerb, the barrier height shall also be measured from the projected line of the shoulder or pavement surface.

For distances beyond 1.5 m, or 1.0m with kerb, the barrier height shall be measured from the nominal ground surface at the barrier location.

Within a median, where back-to-back barrier is located asymmetrically closer to one carriageway, the barrier height should be measured relative to the closest traffic lane, as per above.

It is important to consider the connect details between different barrier systems as the heights of systems may vary over the transition and at the connection points.

6.24.5 Sub-Standard Curves

<u>Clarification</u>

Safety barriers may be installed on either or both sides of the road where a roadside hazard exists and:

- the down grade is 8 per cent or steeper
- the traffic volume exceeds 100 vehicles per day
- the operating speed is 60 km/h or more.

6.24.6 W-beam Barriers Close to or on Embankment Slopes

<u>Local Guidance</u>

Refer Section 6.8.3 and V6.8.9.2.

6.24.9 Maintenance of Barriers

Local Guidance

Where maintenance is required in the area between the face of barrier and edge of traffic lane (e.g. grassed areas), permanent roadside signs should be relocated behind the barrier.

Maintenance strips

While the provision of (generally) concrete barrier maintenance strips is not required, exceptions may be made if it can be shown that maintenance strips offer greater benefits on a whole-of-life comparison, over alternative practices. Applications for an exception must demonstrate the consideration of current technology including mowing equipment and/or alternative maintenance strip materials such as controlled grasses or geotextiles.

Where concrete maintenance strips are to be provided, they shall be installed in accordance with the requirements of Standard Drawing SD 3503, Standard Section 708 and Standard Section 711.

Provision of paving adjacent to safety barriers

Providing a sealed pavement in front of a safety barrier will reduce the frequency of collisions, thereby reducing the rate of repair works and the likelihood that an un-repaired barrier will be impacted. Paving can also support the ongoing maintenance of the road, including eliminating the need to mow grass between the edge of pavement and barrier, or between the barrier and road furniture.

In general, providing pavement for the full width between barrier and traffic lane is desirable and should be provided when the barrier is offset 3m or less from the traffic lane.

Where less than full width pavement is being considered, including when the barrier is offset more than 3m, designers should determine a pavement width in accordance with AGRD Part 3 and DTP Supplements, while also considering the potential safety and maintenance risks of adopting a narrower width. The Occupational Health & Safety implications of the maintenance adjacent to traffic barriers need to be considered in accordance with Section 28 of the OH&S Act 2004. If there is a localised issue that has been identified as high-risk (e.g. sub-standard sight distance), additional pavement width should be provided at that location. For retro-fit barrier installation, the benefit-cost of increasing the existing pavement should be evaluated.

Providing a sealed pavement between barrier and other road furniture or between overlapping barriers should be considered when the gap is difficult to maintain. While this will depend on maintenance practices at the time of design, in general, a gap of 2.5 m or less should be paved. Specialist pavement advice shall be sought where variations in pavement composition between the traffic lane and shoulder are proposed.

6.24.10 Bullnose Treatments for Medians and Short Radius Treatments for Intersections

Local Guidance

Short radius curve treatment for semi-rigid GF can be used at intersecting highways, minor roads and accesses at constrained locations. The treatment aims to redirect a vehicle where possible or absorb the energy of a vehicle impacting at a high angle. For details of DTP accepted arrangement of a short radius curve terminal treatment, refer Standard Drawing SD 4092.

DTP only considers adoption of short radius curves on 70 km/h roads or less (NCHRP 350 Test Level 2). Impact speeds above this can cause the vehicle to override or under-ride the barrier and could become more severe for the occupant than the hazard. Consideration for use in high-speed constrained situations may be acceptable where a documented risk assessment is completed, and after due consideration of the viability of alternative conforming systems.

Access points which cannot be relocated and that must remain open to traffic often prevent the installation of fully effective or compliant safety barrier installations. In such cases, it is critical to provide the most effective barrier installation practical, effectively shielding the primary hazard while adjusting the design to address secondary concerns to the extent practical. In general, a short radius curve treatment that appropriately addresses risk might be considered a better alternative than providing no treatment and results in less severe for the occupants than (for example) a bridge drop off.

Due consideration must be given to the hazard, including consideration of the severity of the hazard, the likelihood of an impact, traffic speed and other appropriate available protection options. The same level of protection might be achieved with an extended barrier and flared crash tested terminal without the concerns resulting from a high-speed impact.

V6.24.12 Treatment of entry and exit ramps

Local Guidance

Entry and exit ramps should be considered for treatment with due consideration of the following:

- treatment of the through carriageway of the road must take priority over the ramps – provision of appropriate sight lines are critical;
- for single lane ramps, the provision of any safety barrier on the ramps must not prevent the ability to overtake any broken-down vehicles, appropriate shoulder run out space shall be provided at merge locations;
- adequate roadside access shall be provided as required.

6.27 Documentation of the Design (Step 16)

Local Guidance

The DTP Final Drawing Presentation Guidelines provide only specific line styles for Guard Fence (GF), Wire Rope Safety Barrier (WRSB) and concrete barriers. As such, to avoid any confusion in the design, review, or construction process when barrier products are specified, they should be accompanied by a note which specifies the type of system designed along with the Test Level.

This note should use the terminology as follows:

- “TL-# WRSB" for Wire Rope Safety Barrier products
- “TL-# FGF" for Flexible Guard Fence products
- "TL-# GF" for non-proprietary public domain (legacy) products
- ‘TL-# Thrie-beam, for thrie-beam products
- “TL-# Concrete barrier” for test level concrete barriers.
- “PL-# Concrete barrier” for performance level concrete barriers
- “PL-# Steel barrier” for performance level steel barriers
- “PL-# Combined barrier” for performance level combined steel and concrete barriers

The '#' symbol specifying test level would be filled in as appropriate by designers (e.g. TL-3 or TL-4). It is important to include the minimum test level as this is a design decision and may limit the number of suitable products that can be selected.

In general, DTP prefers that all barrier designs are product-agnostic and are notated as per above. This promotes value for money solutions and ensures that the most cost-effective product that meets the performance levels in the required design is used.

However, where a proprietary system is required to meet a particular need or constraint relevant to that particular system, the note can specify the system by name and include the terminology "or equivalent" to allow for other products with the same variant or configuration.

In addition, a system specific notation may be used when the proprietary product is already known, and the barrier has been designed with consideration of product specific crash testing and design values.

System specific designs should be made clear on the design plans (to avoid incorrect product substitution) and should be used in isolation of other systems (e.g. not connected). Any alterations made to a system specific design must be endorsed by the original designer, to ensure the specific need has been addressed.

‘As built’ drawings need to capture the product system that has been installed at the time of construction to help facilitate maintenance and asset management.

7. Installation of Other Roadside Safety Devices

7.4 Permanent Bollards

Local Guidance

Refer Appendix VC.

7.5 Security Bollards

Local Guidance

Refer Appendix VC.

7.6 High Profile Kerbs and Low Profile Barriers

Local Guidance

For additional information, refer RDN 03-01 – High Profile Barrier Kerbs.

7.7 Traversable Culvert End Treatments

Local Guidance

Refer SD1991 and SD 1992, Driveable Culvert Endwalls Type 1 and Type 2.

7.8 Audio Tactile Line Marking

Local Guidance

Audio tactile line marking (ATLM) should be installed along the entire barrier length to reduce the likelihood of impact. ATLM should be designed in accordance with RDN 03-10 - Audio Tactile Line Marking.

9. Work Zone Safety Barrier Systems

Local Guidance

Work zone safety barrier systems and variants accepted for use in Victoria are contained in RDN 06-04 Accepted Safety Barrier Products.

Refer RDN 06-12 - Worksite Safety Barrier Screens (2018) for guidance on the requirements for the provision of screens on barriers.

References

Acronyms

AGRD: Austroads Guide to Road Design
AGTM: Austroads Guide to Traffic Management
DTP: Department of Transport and Planning (Head, Transport for Victoria)
FGF: Flexible Guard Fence
GF: Guard Fence
RDN: Road Design Note
SD: Standard Drawings for Roadworks
WRSB: Wire Rope Safety Barrier

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Pajouh, MA, Bielenberg, RW, Schmidt, JD, Lingenfelter, J, Faller, RK, & Reid, JD 2017, Placement of Breakaway Light Poles Located Directly Behind Midwest Guardrail System (MGS) Midwest Roadside Safety Facility (MwRSF) University of Nebraska-Lincoln Report Number TRP-03-361-17

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Victorian Government (2010), Road Safety Act 2004, Code of Practice, Worksite Safety – Traffic Management.

Appendix VA – Popular motorcycle routes in Victoria

The routes listed below have been identified as roads favoured by motorcyclists. This list was ratified by Stakeholders in January 2019.

Gippsland Region (formerly Eastern Region)

Municipality	Route	Length Km	Road No
Bass Coast Shire	Bass Hwy	86.1	2710
Bass Coast Shire	Cape Paterson-Inverloch Rd (Bunurong Rd)	22.2	4025
Bass Coast Shire	Inverloch-Venus Bay Rd	23.5	5662
Bass Coast Shire	Korumburra-Inverloch Rd	14.4	5697
Baw Baw Shire	Brandy Creek Rd	12.3	5532
Baw Baw Shire	Drouin-Korumburra Rd	35.8	5688
Baw Baw Shire	Korumburra-Warragul Rd	40.6	5682
Baw Baw Shire	Westernport Rd, Ripplebrook	29.8	5707
Baw Baw Shire	Main Neerim Rd	33.8	5529
Baw Baw Shire	Jindivick-Neerim South Rd	7.2	159062
Baw Baw Shire	Rokeby-Jindivick Rd	4.1	200722
Baw Baw Shire	Jindivick Rd	3.8	185744
Baw Baw Shire	Mirboo North-Trafalgar Rd	21.4	5916
Baw Baw Shire	Moe-Rawson Rd	34.8	5537
Baw Baw Shire	Moe-Willowgrove Rd	12.7	5536
Baw Baw Shire	Mt Baw Baw Rd	52.1	4526
Baw Baw Shire	Tyers-Thomson Valley Rd	40.0	3004
Baw Baw Shire	Walhalla Rd	12.0	4019
Baw Baw Shire	Willowgrove Rd	42.6	5535
Baw Baw Shire	Yarra Junction-Noojee Rd	38.0	5525
East Gippsland Shire	Bengworden Rd	63.4	5613
East Gippsland Shire	Bonang Rd	114.3	5952
East Gippsland Shire	Bruthen-Nowa Nowa Rd	29.0	5113
East Gippsland Shire	Buchan Rd	27.3	5565
East Gippsland Shire	Dargo Rd	85.4	5559
East Gippsland Shire	Metung Rd	9.4	4004
East Gippsland Shire	Omeo Hwy	65.8	2560
East Gippsland Shire	Paynesville Rd	16.3	4003
East Gippsland Shire	Wy Yung Rd	8.0	5561
Latrobe Shire	Boolara - Churchill Rd	19.0	5907
Latrobe Shire	Boolara - Mirboo Rd	14.0	5643
Latrobe Shire	Churchill-Traralgon Rd	17.5	5913
Latrobe Shire	Maryvale Rd	12.6	5909
Latrobe Shire	Moe-Glengarry Rd	32.9	5539
Latrobe Shire	Morwell-Thorpdale Rd	22.8	5641
Latrobe Shire	Strzelecki Hwy	55.8	2180

Latrobe Shire	Traralgon-Maffra Rd	60.5	5543
South Gippsland Shire	Fish Creek-Foster Rd	13.7	5652
South Gippsland Shire	Korumburra-Wonthaggi Rd	32.3	5698
South Gippsland Shire	Meeniyan-Promontory Rd	42.8	5591
South Gippsland Shire	Meeniyan-Mirboo North Rd	27.4	5666
South Gippsland Shire	Boolarra South Mirboo North Road		
South Gippsland Shire	Nerrena Road		
South Gippsland Shire	Wilsons Promontory Rd	29.6	4001
Wellington Shire	Grand Ridge Rd	23.2	4023
Wellington Shire	Hyland Hwy	59.8	2170
Wellington Shire	Licola Rd	52.7	5954
Wellington Shire	Longford-Loch Sport Rd	50.9	5915
Wellington Shire	Traralgon-Balook Rd	19.6	4026
Wellington Shire	Traralgon-Creek Rd	6.0	5635
Wellington Shire	Rosedale-Heyfield Rd	13.6	5544
Wellington Shire	Rosedale-Longford Rd	27.2	5590
Wellington Shire	Stratford-Bengworden Rd	9.4	5615
Wellington Shire	Tarra Valley Rd	25.3	4018

Metro North West

Municipality	Route	Length Km	Road No
Nillumbik Shire	Eltham-Yarra Glen Rd	32.3	5790
Nillumbik Shire	Heidelberg-Kinglake Rd	35.6	5811
Nillumbik Shire	Kangaroo Ground-Warrandyte Rd	6.2	5810
Nillumbik Shire	Kangaroo Ground- St Andrews Rd	11.1	5436
Whittlesea City	Epping-Kilmore Rd	42.3	5515
Whittlesea City	Whittlesea-Yea Rd	59.0	5793

Metro South East

Municipality	Route	Length Km	Road No
Yarra Ranges Shire	Maroondah Hwy (Healesville to NER)	32.8	2720
Cardinia Shire	Beaconsfield-Emerald Rd	19.4	5771
Cardinia Shire	Belgrave Gembrook Rd	24.2	5774
Cardinia Shire	Healesville-Kooweerup Rd	73.3	5770
Mornington Peninsula Shire	Rosebud-Flinders Rd (Boneo Rd)	22.0	5750
Mornington Peninsula Shire	Arthurs Seat Rd	8.9	4941
Mornington Peninsula Shire	Purves Rd	5.7	195359
Yarra Ranges Shire	Acheron Way	35.3	4811
Yarra Ranges Shire	Belgrave-Hallam Rd	11.0	5773
Yarra Ranges Shire	Gembrook-Launching Place Rd	25.3	5522
Yarra Ranges Shire	Healesville-Kinglake Rd (Chum Creek Rd)	32.85	5791
Yarra Ranges Shire	Healesville-Yarra Glen Rd	11.7	5787
Yarra Ranges Shire	Lilydale-Monbulk Rd	17.5	5776
Yarra Ranges Shire	Myers Creek Rd	13.4	183065
Yarra Ranges Shire	Marysville-Woods Point Rd	18.9	4961
Yarra Ranges Shire	Mountain Hwy	18.2	5783
Yarra Ranges Shire	Mount Dandenong Rd	21.9	4991
Yarra Ranges Shire	Mount Donna Buang Rd	33.4	4831
Yarra Ranges Shire	Emerald-Monbulk Rd	10.2	5778
Yarra Ranges Shire	Monbulk-Lilydale Rd	17.5	5776
Yarra Ranges Shire	Monbulk-Seville Rd	11.9	5777
Yarra Ranges Shire	Olinda-Monbulk Rd	6.3	5779
Yarra Ranges Shire	Warburton-Woods Point Rd	102.5	5957
	South Gippsland Hwy		
	Wellington Rd		
	Yarra Blvd, Kew		
	Esplanade, Mount Martha		

Hume Region (formerly North Eastern Region)

Municipality	Route	Length Km	Road No
Murrindindi Shire	Maroondah Hwy (MSE to Goulburn Valley Hwy)	38.7	2720
Indigo Shire	Murray Valley Hwy (Border to Nathalia)	318.9	2570
Alpine Shire	Bogong High Plains Rd	33.3	4010
Alpine Shire	Bright-Tawonga Rd	21.5	5475
Alpine Shire	Great Alpine Rd	303.9	4005
Alpine Shire	Kiewa Valley Hwy	78.6	2790
Alpine Shire	Mount Buffalo Rd	36.1	4871
Alpine Shire	Happy Valley Rd & Running Creek Rd	33.8	5470 & 5471
Greater Shepparton City	Echuca-Mooroopna Rd	34.0	5366
Greater Shepparton City	Katamatite-Shepparton Rd	31.6	5419
Greater Shepparton City	Shepparton Alternative Route	18.9	5982
Indigo Shire	Barnawartha-Howlong Rd	1.7	5425
Indigo Shire	Beechworth-Wangaratta Rd	23.7	5524
Indigo Shire	Beechworth-Wodonga Rd	38.9	5463
Indigo Shire	Murray Valley Hwy (Nathalia to Border)	342.0	2570
Indigo Shire	Rutherglen-Wahgunyah Rd	8.6	5420, 5585, 252828
Indigo Shire	Wahgunyah-Wangaratta Rd	37.4	5585
Indigo Shire	Wodonga-Yackandandah Rd	25.0	5464
Mansfield Shire	Mt Buller Rd	46.1	4951
Moira Shire	Benalla-Tocumwal Rd	68.6	5397
Mitchell Shire	Wallan-Darraweit Rd	0.5	129816
Mitchell Shire	Bolinda-Darraweit Rd	15.5	112399
Mitchell Shire	Broadford-Flowerdale Rd	30.5	5514
Mitchell Shire	Broadford-Kilmore Rd	13.9	5427
Mitchell Shire	Northern Hwy	164.5	2540
Mitchell Shire	Seymour-Tooborac Rd	33.3	5388
Mitchell Shire	Upper Goulburn Rd	12.7	5512
Mitchell Shire	Wallan-Whittlesea Rd	19.9	5816
Murrindindi Shire	Killingworth Rd, Yea	22.9	162585-9
Murrindindi Shire	Lake Mountain Rd	10.6	4083
Murrindindi Shire	Marysville Rd	21.0	4008
Murrindindi Shire	Taggerty-Thornton Rd	13.4	5509
Murrindindi Shire	Whittlesea-Kinglake Rd	12.6	579
Murrindindi Shire	Whittlesea-Yea Rd	59.0	5793
Murrindindi Shire	Eildon-Jamieson Rd	55.6	135774-6
Strathbogie Shire	Euroa-Mansfield Rd	31.8	5505
Strathbogie Shire	Goulburn Valley Hwy	61.5	2640
Strathbogie Shire	Heathcote-Nagambie Rd	48.0	5378
Towong Shire	Murray River Rd	116.5	5748

Towong Shire	Omeo Highway	97.0	2560
Towong Shire	Talgarno Road	32.2	5481
Towong Shire	Shelley-Walwa Rd	32.5	3005
Wangaratta Rural City	Buckland Gap Rd	15.0	5465
Wangaratta Rural City	Glenrowan-Myrtleford Rd	43.9	5575
Wangaratta Rural City	Mansfield-Whitfield Rd	61.4	5498
Wangaratta Rural City	Wangaratta-Whitfield Rd	48.9	5491
Wangaratta Rural City	Wangaratta-Yarrawonga Rd	36.3	5403
Wodonga Rural City	Yackandandah Rd	10.6	122400

Loddon Mallee Region (formerly Northern Region)

Municipality	Route	Length Km	Road No
Central Goldfield	Ballarat Maryborough Rd		
Central Goldfield	Dunach Eddington Rd		
Central Goldfield	Bendigo Maryborough Rd		
Central Goldfield	Maryborough Dunolly Rd		
Central Goldfield	Maryborough St Arnaud Rd		
Mount Alexander Shire	Midland Hwy	127.4	2590
Greater Bendigo City	Bendigo-Redesdale Rd	43.1	5175
Loddon Shire	Loddon Valley Hwy	123.5	2630
Mildura Rural City	Sturt Hwy	116	2610
Mildura Rural City	"Spiders Web" route	20.3	124484, 128465/6
Macedon Ranges Shire	Cameron Drive Mount Macedon	3.3	4981
Macedon Ranges Shire	Gisborne-Melbourne Rd	2.1	5049
Macedon Ranges Shire	Gisborne-Melton Rd	24.4	5827
Macedon Ranges Shire	Lancefield-Woodend Rd	23.3	5158
Macedon Ranges Shire	Kilmore-Lancefield Rd	21.5	5393
Macedon Ranges Shire	Mount Macedon Rd	10.6	4013
Macedon Ranges Shire	Mount Macedon - Hanging Rock Rd	7.6	4014
Macedon Ranges Shire	Sunbury-Riddells Creek Rd	14.1	5291
Macedon Ranges Shire	Romsey Rd	19.0	200826
Macedon Ranges Shire	Tylden-Woodend Rd	12.3	5253
Mount Alexander Shire	Bridgewater-Maldon Rd	50.7	5203
Mount Alexander Shire	Castlemaine-Maldon Rd	12.8	5204
Mount Alexander Shire	Creswick-Newstead Rd	44.9	5154
Mount Alexander Shire	Maldon-Newstead Rd	12.8	5206
Mount Alexander Shire	Pyrenees Hwy	149.2	2740

Barwon South Western Region (formerly South Western Region)

Municipality	Route	Length Km	Road No
Geelong and Golden Plains	Midland Hwy	46.6	2590
Colac-Otway Shire	Beech Forest Rd	21.7	4028
Colac-Otway Shire	Colac-Forrest Rd	31.9	5017
Colac-Otway Shire	Colac-Lavers Hill Rd	55.6	5017
Colac-Otway Shire	Skenes Creek Rd	13.0	5022
Colac-Otway Shire	Forrest-Apollo Bay Rd	19.2	5023
Colac-Otway Shire	Birregurra-Forrest Rd	24.6	5017
Colac-Otway Shire	Corangamite Lake Rd	26.0	126281 &126284
Colac-Otway Shire	Cape Otway Road – GOR inland route		
Glenelg Shire	Glenelg Hwy	248.9	2670
Glenelg Shire	Portland Nelson Road		
Golden Plains Shire	Fyansford-Gheringhap Rd	8.0	5063
Golden Plains Shire	Shelford-Bannockburn Rd	20.7	5072
Golden Plains Shire	Steiglitz Rd	27.6	4017
Golden Plains Shire	Meredith-Steiglitz Rd	9.0	177666
Golden Plains Shire	Thompson Rd / Pringles Rd	11.2	216631 & 216571& 194974
Golden Plains Shire	Geelong-Ballan Rd	61	5062
Golden Plains Shire	Slate Quarry Rd	11.6	207655
Golden Plains Shire	Parkers Rd	5.5	190239
Greater Geelong City	Barwon Heads Rd	20.4	5007
Greater Geelong City	Drysdale-Ocean Grove Rd	9.3	5857
Greater Geelong City	Geelong Portarlington Road		
Greater Geelong City	Hamilton Highway		
Queenscliffe Borough and Greater Geelong City	Bellarine Hwy	32.5	2730
Surf Coast Shire	Deans Marsh-Lorne Rd	22.5	5958
Surf Coast Shire	Great Ocean Rd	240	4890
Surf Coast Shire	Winchelsea-Deans Marsh Rd	22.6	5012
Surf Coast Shire	Anglesea Road – crashes (GOR route)		
Warrnambool City	Warrnambool-Caramut Rd	52.2	5111
Warrnambool City and Moyne Shire	Princes Highway – Allansford (Great Ocean Road intersection) to Heywood		
Corangamite Shire	Timboon-Colac Rd	53.7	5037
Corangamite Shire	Cobden-Port Campbell Rd	37.5	5034
Corangamite Shire	Princetown Road – crashes (GOR inland route)		

Grampians Region (formerly Western Region)

Municipality	Route	Length Km	Road No
Ararat Council	Glenelg Hwy		
Ararat Council	Ararat Halls Gap Rd (Ararat Pomonal Rd)		
Ararat Council	Pomonal Rd		
Ararat Council	Ararat St Arnaud Rd		
Ararat Council	Grampians Rd		
Moorabool, Ballarat, Hepburn	Midland Hwy	115.4	2590
Ballarat	Ballarat Buninyong Rd		
Ballarat	Ballarat Carngham Rd		
Ballarat	Ballarat Maryborough Rd		
Ballarat	Clunes Creswick Rd		
Ballarat City	Ballarat-Burrumbeet Rd	26.4	5087
Ballarat City	Daylesford-Ballarat Rd	21.6	5220
Golden Plains Shire	Fyansford-Gheringhap Rd	8.0	5063
Golden Plains Shire	Shelford-Bannockburn Rd	20.7	5072
Golden Plains Shire	Steiglitz Rd	27.6	4017
Golden Plains Shire	Meredith-Steiglitz Rd	9.0	177666
Golden Plains Shire	Thompson Rd / Pringles Rd	11.2	216631 & 216571& 194974
Golden Plains Shire	Geelong-Ballan Rd	61	5062
Golden Plains Shire	Slate Quarry Rd	11.6	207655
Golden Plains Shire	Parkers Rd	5.5	190239
Hepburn Shire	Ballarat-Maryborough Rd	62.8	5237
Hepburn Shire	Clunes-Creswick Rd	17.4	5222
Hepburn Shire	Springhill Rd, Tylden	11.6	209449
Hepburn Shire	Daylesford-Malmsbury Rd	26.4	5197
Hepburn Shire	Daylesford-Newstead Rd	18.6	5212
Hepburn Shire	Daylesford-Trentham Rd	23	5195
Hepburn Shire	Hepburn Springs Rd (to Daylesford-Newstead Rd) Sheperds Flat	3.7	4015
Hepburn Shire	Kyneton-Trentham Rd	21.6	5194
Hepburn Shire	Myrniong-Trentham Rd	30.4	5956
Hepburn Shire	Dunach Eddington Rd		
Hepburn Shire	Creswick Newstead Rd		
Hepburn Shire	Dimboola Rainbow Rd		
Hepburn Shire	Nhill Jeparit Rd		
Hepburn Shire	Nhill Netherby Rd		
Hepburn Shire	Nhill Yanac Rd		
Moorabool City	Bacchus Marsh-Gisborne Rd	32.3	5190
Moorabool City	Ballan-Daylesford Rd	31.5	5189
Moorabool City	Geelong-Bacchus Marsh Rd	49	5060

Moorabool City	Geelong-Ballan Rd	61	5062
Moorabool City	Glenmore Rd	22.6	145465
Moorabool City	Bacchus Marsh Werribee Rd		
Moorabool City	Daylesford Ballarat Rd		
Moorabool City	Myrniong Trentham Rd		
Northern Grampians Shire	Ararat-Halls Gap Rd	46.9	5136
Northern Grampians Shire	Grampians Rd	89.4	4851
Northern Grampians Shire	Northern Grampians Rd	56.3	4002
Northern Grampians Shire	Wartook Rd	3.3	4931
Northern Grampians Shire	Stawell Avoca Rd		
Northern Grampians Shire	Lake Fyans Rd		
Northern Grampians Shire	Silverband Rd		
Northern Grampians Shire	Stawell Warracknabeal Rd		
Northern Grampians Shire	Murtoa Glenorchy Rd		
Pyrenees Shire	Beaufort-Lexton Rd	24.6	5240
Pyrenees Shire	Lexton-Talbot Rd	22	5226
Pyrenees Shire	Stawell Avoca Rd		
Pyrenees Shire	Stawell St Arnaud Rd		
Pyrenees Shire	Maryborough St Arnaud Rd		
Pyrenees Shire	Skipton Rd		
West Wimmera Shire	Casterton-Naracoorte Rd	79	5243
West Wimmera Shire	Edenhope-Penola Rd	32.7	5253
West Wimmera Shire	Wimmera Hwy	323.6	2110
Yarriambiack Shire	Stawell Warracknabeal Rd		
Yarriambiack Shire	Warracknabeal Rainbow Rd		
Yarriambiack Shire	Henty Hwy	18.3	2620

Appendix VB – Higher risk roadside areas

While the area of interest and the hazard identification process is no longer limited a higher-risk area of the roadside, there is a general recognition that about 80-85% of the out-of-control vehicles leaving a high-speed roadway should recover within a certain lateral distance.

As such, the following lateral distances may be useful in the following applications:

1. When defining the roadside area that is of highest risk for the purpose of prioritising treatments, or
2. When calculating the barrier length of need for a perpendicular hazard, such as a river or channel, and it is not practical to measure the protected width (back of hazard) using the area of interest values.

For this reason, the lateral distances from AGRD Part 6 (2010) have been re-published below for information. These values must not be used unless specified within a specific process requirement.

Table VB1: Higher risk lateral distances from edge of through travelled way (from Austroads Guide to Road Design Part 6 - 2010)

Design speed (km/hr)	Design ADT (3)	Lateral distance from edge of through travelled way (m)(4)					
		Fill batter			Cut batter		
		6:1 to flatter	4:1 to 5:1	3:1 and steeper (2)	6:1 to flatter	4:1 to 5:1	3:1 and steeper (2)
<60	< 750	3.0	3.0	(2)	3.0	3.0	3.0
	750 – 1500	3.5	4.5	(2)	3.5	3.5	3.5
	1501 – 6000	4.5	5.0	(2)	4.5	4.5	4.5
	>6000	5.0	5.5	(2)	5.0	5.0	5.0
70-80	< 750	3.5	4.5	(2)	3.5	3.0	3.0
	750 – 1500	5.0	6.0	(2)	5.0	4.5	3.5
	1501 – 6000	5.5	8.0	(2)	5.5	5.0	4.5
	>6000	6.5	8.5	(2)	6.5	6.0	5.0
90	< 750	4.5	5.5	(2)	3.5	3.5	3.0
	750 – 1500	5.5	7.5	(2)	5.5	5.0	3.5
	1501 – 6000	6.5	9.0	(2)	6.5	5.5	5.0
	>6000	7.5	10.0(1)	(2)	7.5	6.5	5.5
100	< 750	5.5	7.5	(2)	5.0	4.5	3.5
	750 – 1500	7.5	10.0(1)	(2)	6.5	5.5	4.5
	1501 – 6000	9.0	12.0(1)	(2)	8.0	6.5	5.5
	>6000	10.0(1)	13.5(1)	(2)	8.5	8.0	6.5
110	< 750	6.0	8.0	(2)	5.0	5.0	3.5
	750 – 1500	8.0	11.0(1)	(2)	6.5	6.0	5.0
	1501 – 6000	10.0(1)	13.0(1)	(2)	8.5	7.5	6.0
	>6000	10.5(1)	14.0(1)	(2)	9.0	9.0	7.5

(1) Where a site-specific investigation indicates a high probability of continuing crashes, or such occurrences are indicated by crash history, the higher risk roadside area is likely to be greater than the lateral distances shown in Table VB1.

(2) Since recovery is less likely on the unshielded, traversable 3:1 slopes, recovery of high-speed vehicles that encroach beyond the edge of the shoulder may be expected to occur beyond the toe of these slope. Determination of the recovery area at the toe of the slope should take into consideration available land reservation, environmental concerns, economic factors, safety needs, and crash histories. Also, the distance between the edge of the travelled lane and beginning of the 3:1 slope should influence the

recovery area provided at the toe of the slope. While the application may be limited by several factors, the fill slop parameters which may enter into determining a maximum desirable recovery are illustrated in Figure VB1.

(3) The design ADT in the table is the average daily traffic volume in both directions and all lanes, other than for divided roads where it is the total traffic in one direction.

(4) Where the road is curved, the values in Table VB1 should be adjusted by the curve correction factors in Table VB2. These curve correction factors only applies to roadsides on the outside of curves.

Table VB2: Curve correction factors for higher risk roadside areas (from Austroads Guide to Road Design Part 6 - 2010)

Radius (m)	Design speed (km/h)					
	60	70	80	90	100	110
900	1.1	1.1	1.1	1.2	1.2	1.2
700	1.1	1.1	1.2	1.2	1.2	1.3
600	1.1	1.2	1.2	1.2	1.3	1.4
500	1.1	1.2	1.2	1.3	1.3	1.4
450	1.2	1.2	1.3	1.3	1.4	1.5
400	1.2	1.2	1.3	1.3	1.4	–
350	1.2	1.2	1.3	1.4	1.5	–
300	1.2	1.3	1.4	1.5	1.5	–
250	1.3	1.3	1.4	1.5	–	–
200	1.3	1.4	1.5	–	–	–
150	1.4	1.5	–	–	–	–
100	1.5	–	–	–	–	–

Source: AASHTO (2006).

Appendix VC – Roadside Bollards

Bollards are being installed on the roadside for a variety of reasons. Given that roadside bollards do not have the same energy management or redirection capabilities as a road safety barrier, they should only be used in situations where a safety barrier is not feasible and where the hazard cannot be removed, relocated or redesigned. This technical alert clarifies the types of bollards that have emerged and their preferred application. Before using a bollard, it is important to clearly define the key objective and show that the most suitable product has been selected. This technical alert provides guidance to assist in the selection process.

In general, there are four main categories of bollard.

Category	Testing	Objective
Road Safety Bollard	Compliant crash testing to AS/NZS 3845.2:2017.	Used to shield hazards and/or other roadside features from an errant vehicle
Pedestrian Protection Bollard	Compliant or Modified crash testing based on AS/NZS 3845.2:2017. (may not comply with occupant injury criteria)	Used to protect pedestrians or high-severity hazards from errant vehicles in low-speed environments.
Roadside Furniture	Non-compliant testing, engineering analysis or not tested.	Used for delineation, physical obstruction or minor asset protection in product suitable locations.
Vehicle Security Barrier	Compliant crash testing for 'Hostile Vehicle' purposes - IWA14–1: Vehicle security barriers. Impact severity for errant vehicles to be minimised through design.	Used to stop a hostile vehicle attack in accordance with IWA 14-2 and relevant guidelines. Impact likelihood and severity for errant vehicles to be minimised via speed and location or roadside protection.

Preface

All bollards have an element of risk. As such, bollards should only be used when the objective of the bollard is achieved, and the associated risk can be managed. While DTP prefers bollards with greater energy absorption capabilities, it recognises the benefit of product customisation to suit certain objectives. Product developers often choose a balance between containment capacity, energy absorption and practicality, realising that higher containment will cost more, and greater energy absorption will require a more complex and less practical system. Bollard selection requires an understanding of the bollard benefits/limitations and the site conditions.

AS/NZS 3845 notes that modern vehicles are designed with multiple crashworthy systems, such as airbags, seat belt pretensioners and crumple zones, that can tolerate impact speeds up to 50km/h. As such, a generic bollard (set in an appropriate foundation) with no energy dissipation characteristics could pass some crash test requirements.

Acknowledging that the majority of vehicles can manage energy transfer during a head-on low speed impact (<50km/h), it is critical that ALL bollards (& other devices) can prove a maximum level of containment and ensure that when they are impacted, they do not penetrate or show potential to penetrate the occupant compartment or present an undue hazard to other traffic, pedestrians or personnel in a work zone. Likewise, the collision with a bollard should not cause the vehicle to excessively roll or pitch in order to provide the driver every opportunity to regain control of their vehicle. Tested products, with a known performance level and behaviour, must be used, especially where vulnerable road users are being protected.

Bollard Categories

The performance requirements, assessment process and acceptance conditions for bollard products are specified in RDN 06-04.

Road Safety Bollard

Application

- Road safety bollards may be used in locations up to the tested speed (e.g. TL-1 at 50km/h) and can be considered in situations where safety barriers are inappropriate due to space limitations, pedestrian accessibility and/or aesthetics.

All road safety bollards must be submitted to the Austroads Safety Barrier Assessment Panel (ASBAP) for national assessment. Road Safety Bollards accepted by DTP are published in RDN 06-04. These devices must be installed as tested to ensure an equivalent performance.

At present, DTP is unaware of any bollard that satisfies current crash test protocols. As such, the Energy Absorbing Bollard (EAB) has been recognised for meeting a previous standard (AS3845:1999) to Test Level 0: 1600kg car at 50km/h. Given that this standard has been superseded, the EAB is no longer considered a compliant road safety bollard and is now considered a Pedestrian Protection Bollard, - refer below.

Pedestrian Protection Bollard

Bollards used to protect vulnerable road users are classified as a ‘Pedestrian Protection Bollard’. They should only be considered when a road safety barrier is not feasible.

Given the necessity to have pedestrians near the road, there is a need for products to protect high volume pedestrian areas from errant vehicles, with negligible deflection. While these bollards are not considered a ‘road safety bollard’, without passing all the occupant evaluation criteria, they do offer a proven containment level and may be suitable to protect pedestrians from errant vehicles in low-speed environments (refer application).

Pedestrian Protection Bollard: Vehicle contained, crumple zone and airbags deployed, bollard did not spear or cause undue risk to others.

While energy absorption characteristics are desirable, via a cartridge or steel deformation, pedestrian protection bollards are unlikely to pass the minimum occupant injury criteria per AS/NZS 3845, given the need to test unrestrained occupants. As such, protection bollards may be used in certain applications and must be able to contain an errant vehicle and not present an undue risk during impact.

Pedestrian protection bollards often balance containment level, energy absorption characteristics and cost. As such, specific performance is dependent on the product design. These bollards must be considered on product merit in accordance with this alert. For this reason, pedestrian protection devices should not be substituted during construction without seeking comment from the original designer. Consultation with the product supplier is essential, to understand the products capabilities, benefits and limitations.

Application

Pedestrian Protection Bollards must be installed on roadsides with an operating speed of 50km/h or less. This allows the impact energy to be managed by the vehicle, assuming the bollard does not fail, penetrate the vehicle or present an undue risk to others. Vehicle occupants are most vulnerable during side impacts (some research suggests 30km/h); therefore, the risk of side impact should be minimised, e.g. not near an intersection or tight curve.

- Pedestrian Protection Bollards may be installed on roadsides with an operating speed of 60km/h when the offset is greater than 6m from the traffic lane. This offset minimises the likelihood of an impact occurring.
- Pedestrian Protection Bollards may be installed in close proximity to tram stops in 60km/h posted speed environments. In this context, the operating speed is often lower than 60km/h.
- Pedestrian Protection Bollards must only be used to shield vehicles from pedestrian frequented areas (e.g. dining areas and tram stops).

- Pedestrian Protection Bollards must not be used to shield roadside hazards, unless the impact severity of the hazard has been demonstrated to be substantially more than the impact severity of the bollard, e.g. large drop-off or spearing hazard. Hazards such as trees, poles, piers and other rigid point hazards do not have a substantially higher impact severity.
- Pedestrian Protection Bollards must be installed in accordance with the manufacturers' guidelines and specification. Adequate foundation strength is critical for performance, and any differences to the crash tested conditions must be factored into containment level or design.

DTP does publish a list of Pedestrian Protection Bollards in RDN 06-04. They are conditionally accepted until such time as a MASH equivalent product is accepted. Refer Section 5. Miscellaneous products.

Road Furniture

Bollards that have NOT been crash tested are classified as 'road furniture'. They may only be used in situations where there is no requirement for protection from/for errant vehicles. These bollards are made from various materials and are often used for delineation, minor asset protection or to create a physical obstruction.

Plastic Bollard: Flexible design, often used for delineation.

Delineation

Bollards used for delineation, often made from plastic, must be designed such that they do not create an undue hazard for the vehicle occupants or nearby traffic when impacted. While crash testing would provide a better understanding of impact behaviour, lightweight and flexible materials (e.g. plastic) are generally considered satisfactory.

Steel Bollard: Access restriction, containment unknown, impact behaviour unknown.

Access Restriction

Bollards used for access restriction, often made from steel or timber, are considered hazardous to all road users and must be treated as such. Without crash testing, these bollards do not have an established level of containment (cannot guarantee protection from an errant vehicle), nor a certain impact behaviour or mechanism of failure (potentially hazardous). While there may be situations where these devices are appropriate, they should be labelled 'not a road safety device' and are only recommended in very low-speed environments or where they cannot be impacted (e.g. behind barrier). These bollards are also hazardous to cyclists and other vulnerable road users and their location should be carefully considered.

Frangible bollards

Some bollards are considered 'frangible' (e.g. 100m x 180m timber post with a 75mm dia. hole) given their size and/or weakness in one direction. These bollards cannot guarantee protection from an errant vehicle and the impact behaviour is unknown. To be deemed frangible, these devices must be manufactured and installed in accordance with Australian Standards and DTP's guidance. DTP recommends their use is limited to very low-speed environments or where they cannot be impacted (e.g. behind barrier).

Timber Bollard: Access restriction, unknown containment, impact behaviour unknown- deemed frangible in one direction.

Road furniture products are not listed on RDN 06-04.

Vehicle Security Barriers (VSB)

Unfortunately, vehicles can be used with hostile intent to breach a perimeter, ram and damage infrastructure or as a weapon to injure and kill people.

Refer to https://www.nationalsecurity.gov.au/crowded-places-subsite/Files/hostile-vehicle-guidelines-crowded-places.pdf for more information.

Hostile Vehicle Management (HVM) uses a blend of traffic calming measures to slow down hostile vehicles and Vehicle Security Barriers (VSB) to stop those hostile vehicles progressing further. VSBs provide the hard stop for penetrative vehicle attack, they are structural in nature and can be either Active (powered or manual) or Passive (static). Active measures include hinged and sliding gates, boom barriers, retractable blockers and retractable bollards. Passive measures include structural wall, passive bollards and planters.

Although VSBs are designed and tested with the intent of stopping hostile vehicles, they are often used in locations where they may be impacted by an errant vehicle and therefore should be designed to diminish impact severity. Unlike hostile vehicle attack, errant vehicle impacts can be predicted from the road characteristics (e.g. posted speed) and can be managed through other factors such as speed calming and control.

Like pedestrian protection bollards, it is acknowledged that many vehicles can manage energy transfer during a low-speed impact, assuming the device does not present an undue risk during impact such as the potential to penetrate the vehicle or cause harm to others. As such, it is critical that VSBs are designed (shaped), positioned and orientated with an errant vehicle impact in mind. This includes smooth surfaces, rounded edges and a large contact surface that will distribute energy. Components that are likely to leave the system during impact or may spear a vehicle must be avoided. Physical crash testing is the preferred method of testing.

VSB Bollard: Similar severity to other roadside hazards, does not present undue risk to occupants or others, must be located within a low speed environment.

VSB Wedge: Smooth surface will distribute impact energy, can be deactivated as needed. Edges are shielded and cannot be impacted head on

VSB Gate: Narrow impact point will focus energy into the occupant compartment causing undue risk to errant vehicles. This device should be located such that it cannot be impacted by errant vehicles.

Application

- VSBs must be used in accordance with IWA 14 and other relevant hostile vehicle guidelines. i.e. There must be an evidence based threat of attack.
- VSBs must be installed on roadsides with an operating speed of 50km/h or less. This allows the impact energy to be managed by the vehicle, assuming the device does not penetrate the vehicle or present an undue risk to others.

  Higher operating speeds must be crash tested or require roadside protection such as an accepted safety barrier.
- VSBs must be installed in accordance with the manufacturers guidelines and specification. Adequate foundation strength is critical for performance and any differences to the crash tested conditions must be factored into containment level or design.

DTP does not publish a list of accepted VSBs. Asset owners should engage a qualified security consultant, consider the conditions above and document their design and decision process.

Summary

1. All bollards have an element of risk and should only be used in situations where there is a need and a safety barrier is not feasible.
2. Before selecting and installing a bollard, designers and/or asset owners must clearly define the objective of the bollard (what it is trying to achieve) and demonstrate that a suitable product has been used. Objectives may include shielding a vulnerable road user or hazard, providing delineation or preventing hostile vehicle attack.
3. Currently DTP maintains a list of Pedestrian Protection Bollards in RDN 06-04. They are conditionally accepted until such time as a MASH equivalent product is accepted.
4. Bollards must meet the performance requirements as specified in RDN 06-04.
5. Bollards must be used in an application specified in the technical alert.
6. Given the differences in product performance, bollards must not be substituted without seeking comment from the original designer, as this may affect the original intent.

Appendix VD – Applying the NRRIT during planning, development, and delivery of projects

> Note: this section contains examples of how to apply the NRRIT during planning, development, and delivery of projects. It is not meant to be interpreted as a prescriptive methodology, but to be used as information to assist project teams.

VD.1 Applying the NRRIT during Project Scoping and Planning

It is vital that the NRRIT be used to inform Network Safety Plans (NSP) and Corridor Plans as noted Step 1 of Section 1.8 of this supplement (unless already identified in the NSP and corridor plan).

Generally, the NRRIT ranges as noted in Section 2.4 of this supplement, Table V2.4 should be adopted during the planning and scoping of projects.

Developing a NSP or Corridor Plan using the NRRIT will depend on whether the route is a;

1. New Corridor or Significant upgrade (such as a duplication)
2. An Existing Corridor

Below is additional guidelines for developing a NSP or Corridor plan for either scenario.

VD.1.1 New Corridors or Significant Upgrades

Below are the steps for developing a NSP or Corridor Plan using the NRRIT for new corridors or significant upgrades.

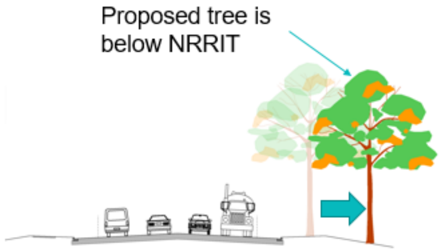
1. Apply a continuous barrier strategy (where appropriate)
   Continuous barrier should be the preferred road safety strategy for roads with a posted speed of 80km/h or greater (see Section 4.2 of this supplement)
2. Where continuous barriers have not been applied, apply a cross sections that;
   a. Include targeted barrier where hazards are likely to exceed the NDD[1] NRRIT range
   b. Locate hazards so that roadside risk scores are within the NDD[1] NRRIT range
3. Establish a corridor plan and footprint/boundaries based on these cross sections
4. Document the assumptions (NRRIT which was adopted and associated cross sections) and how the plan aligns with the NRRIT in the design report

[1] It may be that during the planning stage an alternative NRRT is established for the corridor due to planning objectives, available funding or unreasonable costs, impact on constraints (particularly environmental footprint).

Below are some examples of how to use the NRRIT to inform the development of cross sections to apply to the corridor.

Providing barrier where hazard is above NRRIT

The first example shows a proposed tree that would result in a risk score for the section of to be above the NRRIT for the corridor. Therefore, a road safety barrier is proposed to shield the hazards. This scenario may be preferable where there is a restricted ROW.



Locating hazard so it is below the NRRIT

The second example shows how the tree is located (or offset) far enough from the edge of the travel lane that results in risk scores for that section of road being below the NRRIT. This scenario might be preferable where there are regular driveway accesses which would prevent road safety barriers from being installed.

Using the NRRIT to determine the cross section

The third example shows how the NRRIT is used to determine the offsets for trees (without installing road safety barriers) to be placed within the verge and median. This may be useful in lower speed environments where it is not desirable to place safety barriers and restrict access across the corridor.

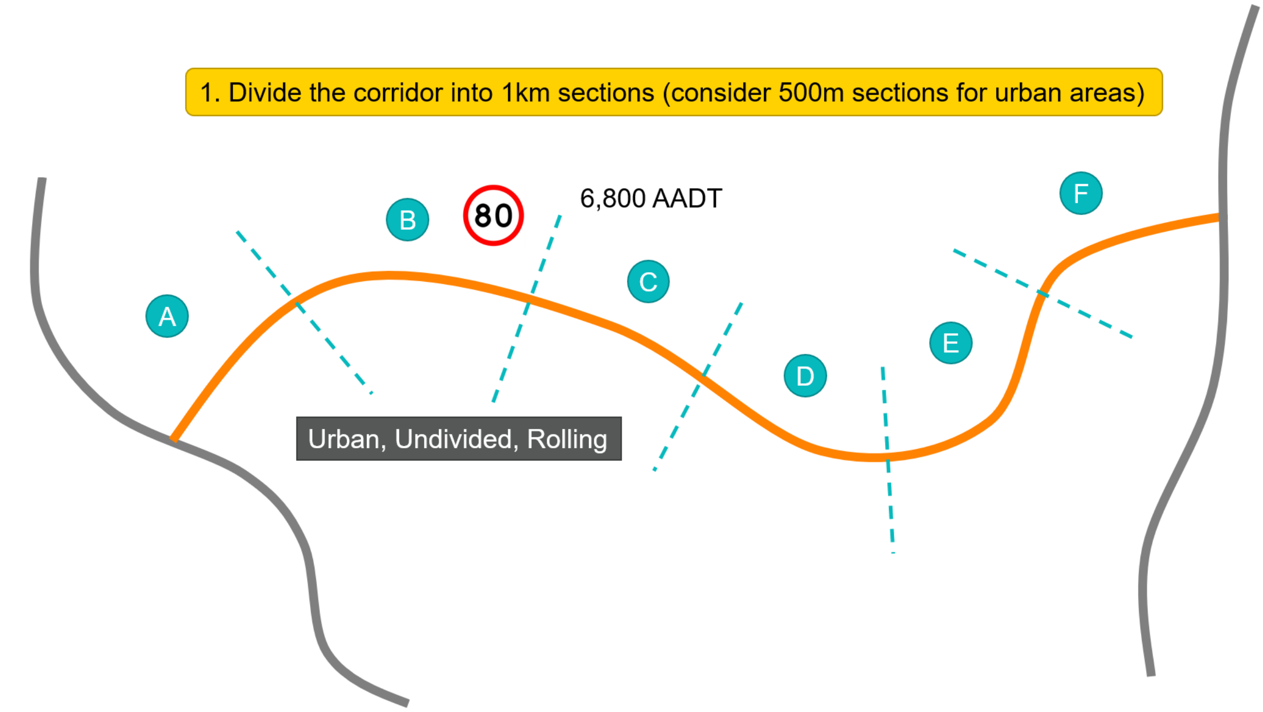
VD.1.2 Existing Corridors

Below are the steps for developing a NSP or Corridor Plan using the NRRIT for existing corridors.

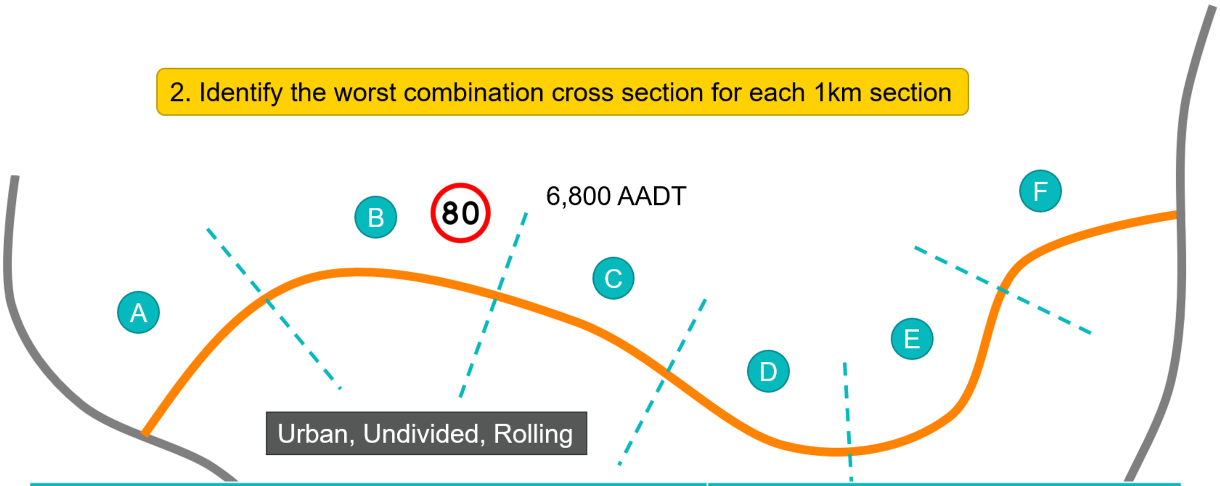
1. Divide the corridor into 1km sections (consider 500m sections for urban areas)
2. Identify the worst combination typical cross section from each 1km section
3. Calculate the risk scores for each section based on the worst (highest risk score) cross section
4. Compare the scores of each cross section against DTP's NRRIT ranges (Table V2.4). This will identify higher risk sections. Develop practical cross sections to address higher risk sections
5. Determine whether;
    a. DTP's NDD NRRIT range will apply to the corridor
    b. A different NRRIT will be applied to the corridor based on constraints, practicalities of upgrading the corridor to meet the NDD NRRIT range, crash history, available funding
6. Establish a corridor plan and document in the design report the assumptions (including cross sections) and the NRRIT range that will apply to the corridor.

Below is an example of how a planning study could be conducted on an existing corridor using the NRRIT.

A planning team may be looking at this urban undivided rolling road which is posted at 80km/h and carrying 6,800 AADT. The planning team are looking at undertaking some minor upgrades by widening the sealed shoulder, adding some turning lanes and installing a wide centre line to reduce the likelihood of head on crashes. As part of the planning study, they are looking at the risk of hazards along the corridor.

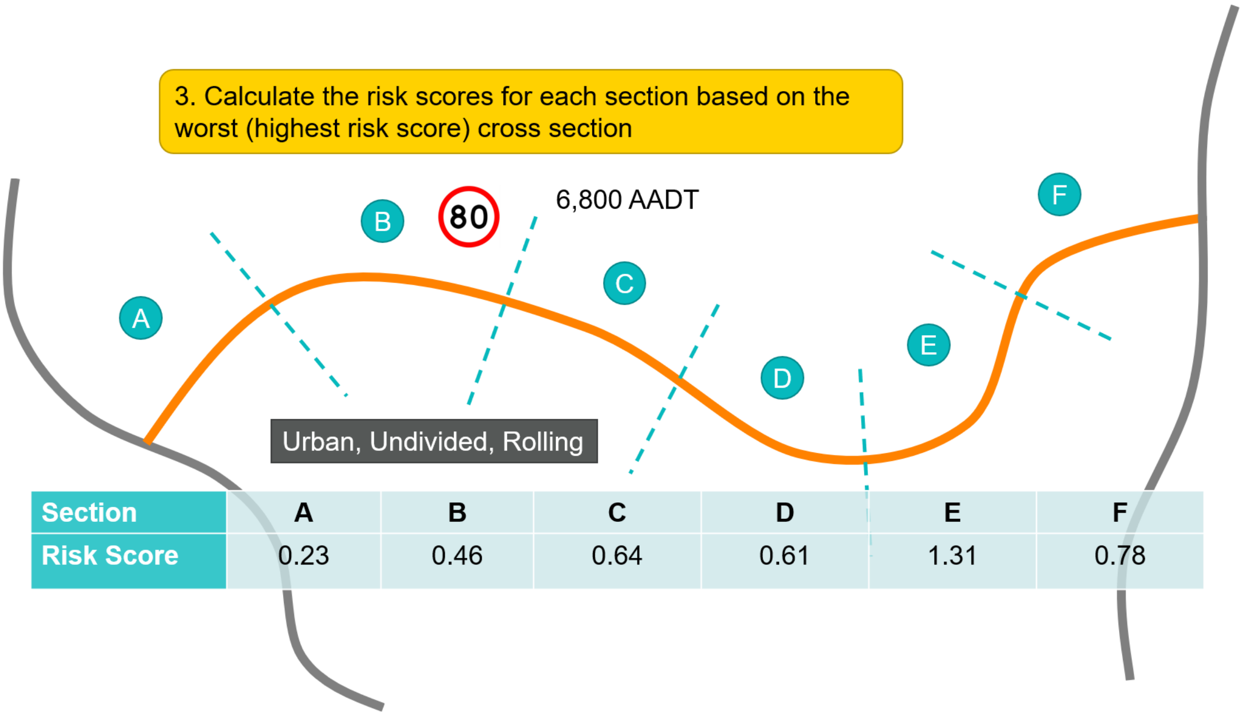


For this example we have 6x 1km sections for this corridor labelled A to F.

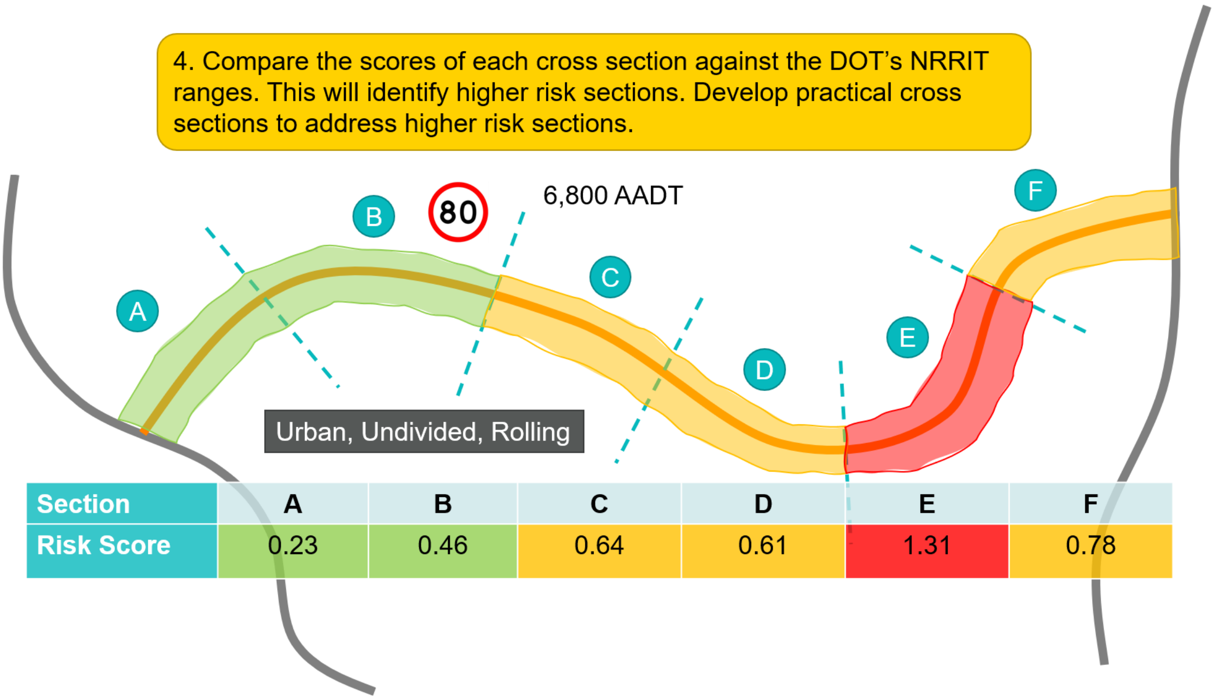


Significant "Isolated" Hazards	Significant "Background" Hazards
Isolated trees with trunk diameters of 250 mm or larger	Tree Lined Edges
Utility poles	2:1 fill batters more than 5 m high
Fixed base lighting columns	1.5:1 fill batters more than 2 m high
Exposed culvert headwalls and wing walls	Vertical drops of more than 2 m

Identify all the significant hazards (and less significant hazards where necessary) and identify the worst combination typical cross section for each 1km section. The significant hazards will most likely produce the highest risk score for the section. The worst typical cross section will also depend on the offset of the hazard (how close it is to the travel lane) and the geometry of the road at this cross section



Section	A	B	C	D	E	F
Risk Score	0.23	0.46	0.64	0.61	1.31	0.78



Section	A	B	C	D	E	F
Risk Score	0.23	0.46	0.64	0.61	1.31	0.78

Step 5 is to determine whether the NDD NRRIT range will apply or something else. In this case, 3 of the 6 sections of road fall into the EDD range. After undertaking some design work using cross sections with risk scores that are in the NDD range, and comparing them with cross sections with risk scores in the EDD range, it was determined that it was not practical to implement NDD cross sections to the corridor. The corridor also has a very good safety record which will be improved by the sealed shoulders and WCLT. Therefore, it was determined that the EDD range would be appropriate for this corridor. Develop the corridor plan based on cross sections which adopt the EDD NRRIT range and determine the footprint/boundaries for the corridor. DTP approval for EDD NRRIT range is not required where it has already been agreed for the route or corridor

Finally, Step 6 is to document the analysis, cross sections and justification in the design report of the project.

VD.2 Applying the NRRIT during Project Development and Delivery

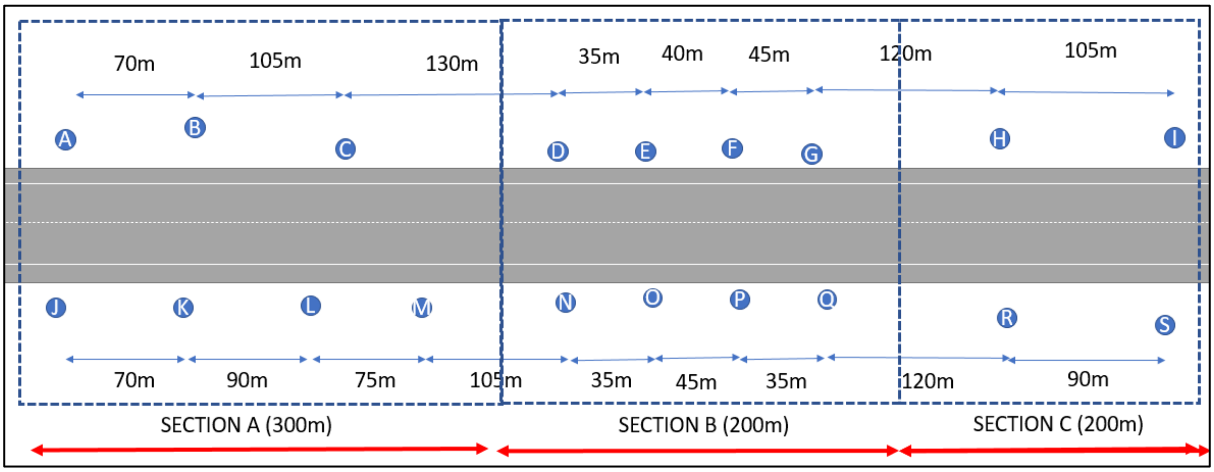
Examples of how to apply the NRRIT

Below are three examples of how to use the NRRIT scores set in Step 3 from Section 1.8 of this supplement. The NRRIT assessment is only used after assessing the road against the NSP, corridor plan and NRRIT (Step 1) and DTP policies and guidelines for continuous or targeted barriers (Step 2).

DTP has developed a "Appendix VF AGRD Part 6 Risk Calculator" (excel file) to help evaluate the roadside risk scores. For more information, see Appendix VF. The excel file is available on the VicRoads website.

1. Urban Road Context Example

The figure below shows a section of 80km/h undivided road carrying 10,000 AADT in an urban rolling context with large, isolated trees with trunk diameter of 250mm or larger at various spacings and offsets. There is assumed to be no significant background hazards.



When undertaking a planning exercise to determine the sections of highest risk, the worst typical cross section per km would be used to determine the high-level sections of highest risk. Note, that the cross section should not be of an isolated hazard, but the worst typical cross section which is representative of the length.

For this example, the worst cross section is in Section B and has the following characteristics and risk score.

Risk Score for worst cross section (Rolling, 80km/h, Urban, 40m spacing, 2m offset) = 2.13

This would indicate to the project that this section of 1km would require significant treatment to reduce the score below the NDD NRRIT of 0.5.

During the development and delivery of the project, the project team could break up the section of road into smaller sections of similar cross-sectional attributes (see Section 3.1, Step 5 of this supplement).

In this example, the section of road has been divided into three sections based on the offset and spacing of the significant trees. The tree offsets and spacing have been averaged for the sections.

Section A - 300m			
Tree	Calcs	Spacing (m)	Offset (m)
A		70	2.8
B	70/2 + 105/2	87.5	3.4
C	105/2 + 130/2	117.5	2.6
J		70	3.1
K	70/2 + 90/2	80	2.9
L	90/2 + 75/2	82.5	2.7
M	75/2 + 105/2	90	2.9
	Average	85.36	2.91
NRRIT (Rolling, 80km/h, Urban, 75m spacing, 3m offset) = 0.91			

Section A is in the EDD NRRIT range for an urban undivided context. This section would require treatment to reduce the risk score into the NDD range. This would require approval from DTP if it was proposed that this section remained untreated.

Section B - 200m			
Tree	Calcs	Spacing (m)	Offset (m)
D	130/2 + 35/2	82.5	2.2
E	35/2 + 40/2	37.5	2.1
F	40/2 + 45/2	42.5	2.6
G	45/2 + 120/2	82.5	1.9
N	105/2 + 35/2	70	2.5
O	35/2 + 45/2	40	1.9
P	45/2 + 35/2	40	2
Q	35/2 + 120/2	77.5	1.9
	Average	59.06	2.14
NRRIT (Rolling, 80km/h, Urban, 40m spacing, 2m offset) = 2.13			

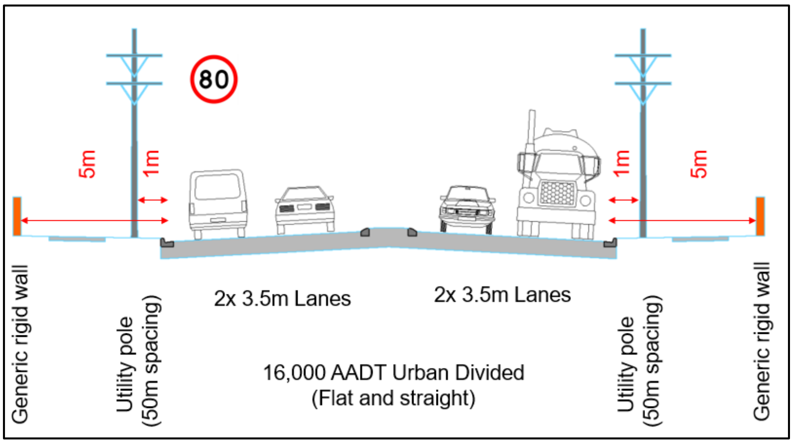
Section B is significantly over the NDD NRRIT range of 0.5 and is in the Design Exception range. This section is the highest risk and would usually be expected to be treated, even on minor upgrade projects.

Section C - 200m			
Tree	Calcs	Spacing (m)	Offset (m)
H	120/2 + 105/2	112.5	3.8
I		105	3.6
R	120/2 + 90/2	105	4.2
S		90	4.5
	Average	103.13	4.03
NRRIT (Rolling, 80km/h, Urban, 100m spacing, 4m offset) = 0.54			

Section C is just above the NDD NRRIT range. Although it is in the EDD NRRIT range, it would require minor justification to leave this section untreated.

2. Urban Road Context Example

An existing urban divided road carrying 16,000 AADT has two 3.5m lanes in each direction. It has posted speed of 80km/h. There are unprotected utility poles at 1m offset from the edge of the carriageway and spaced at 50m spacing. There is a property boundary fence offset from the carriageway at 5m. The context is straight and flat (with minimal vertical grades).



Let's consider a 1km section of straight carriageway. The biggest contributor to the roadside risk score is the utility poles. Figure D.3.5 shows that the risk score of the utility pole only at a 1m offset is 0.86. This is above the urban divided NDD score of 0.5.

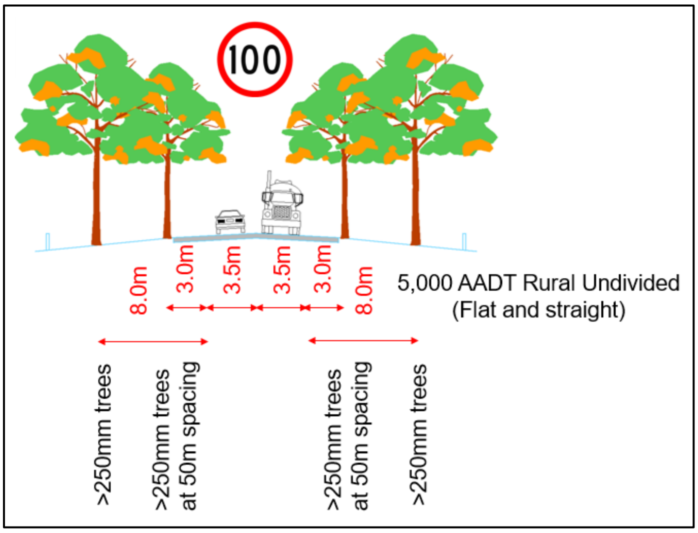
When assessing the section of road using the 'Detail Method' (AGRD Part 6 Appendix B) the score for the carriageway is 0.96. This is above the urban divided NDD NRRIT of 0.5. For the section of the carriageway to be below the recommended NRRIT, there are four options.

Option	**Risk Score**
1. Underground the power to eliminate most[1] of the significant roadside hazards (utility poles)	0.10
2. Relocate the utility poles to 2m and shield the poles with road safety barriers	0.35 (from Chart 27 using a 0.5m offset)
3. Relocate the utility poles to at least 4m from the travel lane	0.52 (marginally higher than the NDD and may require DTP acceptance)
4. Reduce the posted speed limit[2] to 70km/h	0.53 (marginally higher than the NDD and may require DTP acceptance)
Notes 1. Lighting poles may still be required and should be frangible or slip based where possible 2. Reduction of the posted speed limit will need to be in accordance with the guidance and governance in DTP's *Speed Zoning Technical Guidelines (Edition 2, December 2021*	

As this example is an existing road in a constrained environment, it may be acceptable for the roadside risk to be in the Extended Design Domain range (EDD), particularly where it is unlikely that the rest of the corridor will be upgraded to meet the NDD NRRIT range. For a new project or a major upgrade such as duplication, it would be expected that the design would be in the NDD NRRIT range.

3. Rural Road Context Example

A rural divided road carrying 5,000 AADT as one 3.5m lane in each direction. It has a posted speed of 100km/h. There are large, isolated trees (>250mm in diameter) at 3m offset from the carriageway and spaced at 50m. There is a second continuous row of large trees (>250mm in diameter) at 8m. The context is straight and flat (with minimal vertical grades).



The NRRIT score for the carriageway is 2.08. This is above the rural undivided NDD NRRIT of 1.25 and also above the DE NRRIT score of 1.5. For the carriageway to be in the NDD NRRIT range, there are four options.

Option	Risk Score
1. Install continuous safety barrier with regular larger offsets for break down locations	0.50 (from Chart 25)
2. Remove the large trees[1] and shield the background trees with continuous safety barrier	0.50 (from Chart 25)
3. Reduce the posted speed limit[2] to 80km/h	0.64
4. Remove the large[1], isolated trees at 3m offset from the carriageway	1.14

Notes:
1. Any proposal to remove trees must be done in conjunction with an analysis considering the Community Wellbeing (Section 1.5.3) and Environmental Sustainability (Section 1.5.4) Principles of Context Sensitive Design. Trees which are identified for removal should not be trees of high environmental or heritage significance (unless environmental approval is granted)

2 The reduction of the posted speed limit will need to be in accordance with the guidance and governance in DTP's Speed Zoning Technical Guidelines (Edition 2, December 2021).

To allow this section of road to be untreated with the posted speed remain at 100km/h would be a Design Exception and require DTP's approval.

4. NRRIT and single point hazard assessments

The strength of the NRRIT risk assessment is not for assessing isolated single point hazards and determining the risk to road users. The NRRIT risk assessment considers the risk of a roadside over a section of road. Using the NRRIT to assess the risk of an individual hazard may provide some comparison of relative risk to road users but it should not be used as the main justification for proposing or retaining hazards in the roadside. A risk assessment of isolated hazards should consider;

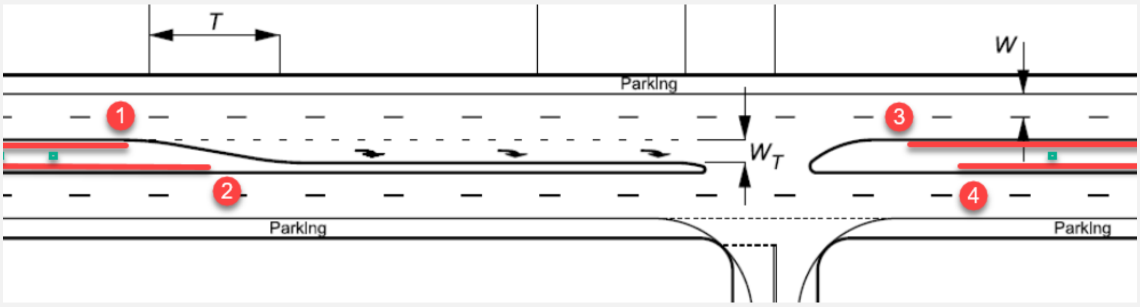
- The risk to road users of the hazard (the likelihood and severity of outcome if the hazard is impacted)
- The risk to the asset (the outcome of an impact with the asset to safety, operations and asset network performance)
- The risk to other road users if impacted (such as a secondary impact and/or the risk proposed pedestrians and cyclists near the impacted asset)
- If the hazard is classified as a high risk site (See AGRD Part 6 Section 5.13.2)
- The context of the hazard in relation to the route or corridor strategy

Appendix VE – Examples of barrier layouts in medians in urban environments

To help designers select the extent of barriers in urban medians and the location of terminals near an intersection, or access break, the following layout examples have been detailed and discussed below.

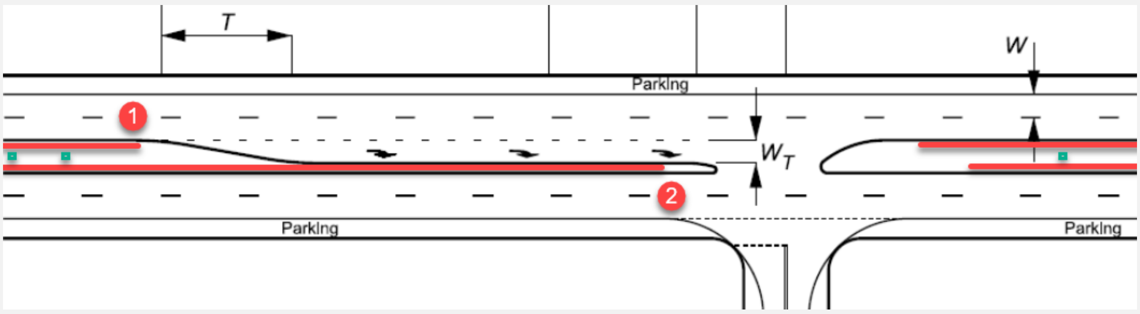
These examples support Section V6.9.6.

Layout Example 1



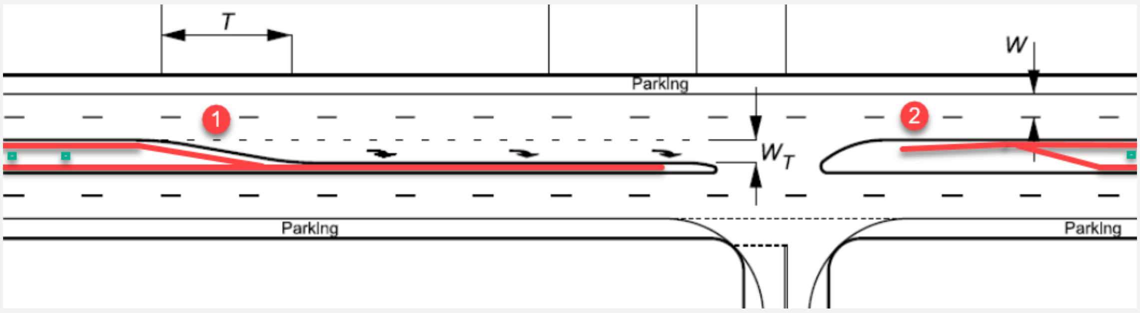
Features:	Typical applications:
• Safety barriers 1 & 2 are terminated prior to the right turn lane to achieve relevant sight distances. • There are no unprotected rigid hazards. • Maintenance access is provided between the barrier terminals • Safety barrier terminals 1 & 2, and 3 & 4, are staggered such that they shield drivers from the back of the opposing barrier system.	• When the median width is 2.5m or less, adjacent the right turn lane, • Posted speed is 60km/h to 80km/h, • The right turn movement is unsignalized, meaning that drivers will need to select gaps in traffic. • There are no rigid hazards located adjacent the right turn lane. • Heavy vehicles are likely to use the right turn lane. • The road geometry is typical, and head-on risks are low.

Layout Example 2



Features:	Typical application:
• Safety barrier 1 is terminated with a trailing terminal, or is flared and connected to safety barrier 2. • Safety barrier 2 is extended along the median and a back-to-back system is used to protect the opposing carriageway. The barrier is terminated as needed to achieve appropriate sight distances. • Safety barrier 2 is located centrally or closer to the traffic travelling from right to left.	• The median width, adjacent the right turn lane, is greater than 2.5m wide and will support a back-to-back terminal. • The intersection is fully signalised, meaning that drivers are not required to select gaps within traffic. MGSD and SISD need to be considered and the terminal location for barrier 2 adjusted to suit. • Lighting poles or other infrastructure are not required adjacent the right turn lane. • The cross section is relatively flat, allowing back-to-back barrier to perform in both directions.

Layout Example 3



Features:	Typical application:
• Safety barrier 1 is connected and extended along the median. • Safety barrier 2 is terminated as needed to achieve appropriate sight distances. The terminal may be flared slightly. • Safety barrier 2 is separated and flared to the appropriate offset. In this case, the risk of vaulting is extremely low. • Safety barriers 1 and 2 provide full protection of all median hazards.	• The median width, adjacent the right turn lane, is greater than 2.5m wide and will support a back-to-back terminal. • Maintenance access is not required. • Rigid hazards are located close to the intersection. • Terminal location for barriers 1 and 2 may need to be adjusted to provide appropriate sight distance (MGSD/SISD).

Appendix VF – AGRD Part 6 Risk Score Calculator

What is the "Appendix VF – AGRD Part 6 Risk Score Calculator"?

The "Appendix VF – AGRD Part 6 Risk Score Calculator" is a Microsoft Excel file which automates the tables and graphs contained in *Austroads Guide to Road Design Part 6 Appendix B*.

The risk excel file was developed to;

- Assist industry to adopt and implement the AGRD Part 6 risk assessment processes in all stages of planning and design
- Ensure there is a consistent methodology and output to calculating risk scores
- Reduces time spent on checking calculations and excel files for errors
- Shift the conversation from calculating a risk score to a conversation about risk management
- Provide quality control to the industry with a fully protected and version-controlled file, removing the need for consultants to develop their own risk score calculator

Development of the "Appendix VF – AGRD Part 6 Risk Score Calculator"

The excel spreadsheet was calibrated using the tables and graphs in *AGRD Part 6 Appendix B*.

The exposure for divided and undivided roads was extracted from Figure's B.1 and B.2 at 1,000 vehicle increments.

For speeds of 100km/h, Figure B.6 was used to determine the likelihood of reaching a lateral distance.

For speeds of 80km/h, Figure B.7 was used to determine the likelihood of reaching a lateral distance.

For speeds of 60km/h, Figure B.8 was used to determine the likelihood of reaching a lateral distance.

Where the geometry of the road is a radius that is in between two of the radius plot lines, for example 500m radius curve in a 70km/h speed environment, then the likelihood value was determined by interpolating between the 300m radius plotline and the 900m radius plotline on Figure B.8.

To determine the severity trauma index for speed environments not mentioned in *AGRD Part 6 Appendix B Section B.4.5*, the following factors were used.

Table VF.1: Severity Trauma Index Factors

Speed	110 km/h	100km/h	90km/h	80km/h	70km/h	60km/h
Factor	1.0	0.733	0.548	0.372	0.258	0.189

Speed factors for the likelihood of a rollover were interpolated from Table B.10 for speeds not listed in the table.

Note, that the risk of head-on crashes is not calculated using this calculator.

How to use the "Appendix VF – AGRD Part 6 Risk Score Calculator"?

The instructions on the "Instructions" tab of the excel should be followed to calculate the risk from the inputs on the "Risk Score Calculator" tab.

The "Roadside Risk Checklist" tab encourages designers and project officers to consider the risk score for that particular section of road and how it should be managed.

The "Print Sheet" tab is in the same format as the table in *AGRD Part 6 Appendix B*. Designers and project officers should select the printable area and copy the "Print Sheet" table into their Design Report for the project. This ensures that all assumptions for calculating the risk score are captured as a record of the risk assessment.

Appendix VG – AGRD Part 6 Length of Need (LoN) Calculator

What is the "Appendix VG – AGRD Part 6 Length of Need Calculator"?

The "Appendix VG – AGRD Part 6 Length of Need Calculator" is a Microsoft Excel file which automates the tables and graphs contained in Austroads Guide to Road Design Part 6 Appendix G.

The risk excel file was developed to;

- Better assist practitioners in the use of the new rationale used to determine Length of Need.
- Reduce the likelihood of misinterpretation of AGRD Part 6 and the Guideline Drawings
- Reduces time spent on checking calculations and excel files for errors.
- Provide quality control to the industry with a fully protected and version-controlled file, removing the need for consultants to develop their own length of need calculator.

Development of the "Appendix VG – AGRD Part 6 Length of Need Calculator"

The Department of Transport and Planning (DTP) has developed this Length of Need calculator.

This calculator applies to all roadside barrier types. For bridge approach barriers, refer BTN001.

This calculator has been developed based on the information contained in Austroads Guide to Road Design Part 6.

The excel spreadsheet was calibrated using the tables and formulae in AGRD Part 6 Appendix G.

This calculator applies to straight sections of road. For curved sections refer to Austroads Guide to Road Design Part 6 Section 6.9.3.

Values provided by this calculator are minimum lengths. Acceptance of values below those given in this calculator will require approval through appropriate governance.

This calculator DOES NOT provide the Total Length of Barrier, which will be longer depending on the type of barrier and specific products chosen.

The calculator has been checked and reviewed but may still contain errors. These will be updated in subsequent releases of the calculator.

It is the responsibility of the user to check values from this calculator against the guidance in Austroads Guide to Road Design Part 6.

It is the responsibility of the user to ensure they are using the most current Length of Need calculator.

How to use the "Appendix VG – AGRD Part 6 Length of Need Calculator"?

The instructions on the "Instructions" tab of the excel should be followed to calculate the length of need from the inputs on the "Length of Need Calculator" tab.

The "LoN Schedule" tab allows the designers and project officers to calculate multiple barrier lengths of need in a single tab.

Designers and project officers should select the printable area and copy the "Print Sheet" table into their Design Report for the project. Create a PDF of the "Length of Need Calculator" and/or "LoN Schedule" or copy and paste the worksheets into the project report.

Commentaries

Commentary V1 – Justification for lengths of barrier in urban medians

Section V6.9.6 provides guidance on the extent (length) of barriers in urban medians and the location of terminals near an intersection, or access break. It provides a series of objectives that should be considered and balanced, in order of priority.

This order of priority was developed based on the frequency and type of casualty crashes that occurred on arterial roads in Victoria between 01/07/2016 and 30/06/2021.

- Right-through crashes (DCA 121) made up approximately 11% of crashes on country roads and approximately 18% of crashes on metro roads (over 4 times the number of head-on crashes on metro roads).

  In addition, up to 90% of the information used by a driver to control their vehicle is visual. Therefore, providing sufficient sight distance should be the priority for ensuring drivers don't make mistakes and can avoid possible conflict, especially at un-signalised intersections where drivers need to make critical decisions, such as gap selection or avoid an unexpected hazard.
- Collisions with fixed and other objects made up approximately 14% of all crashes on arterial roads (Hwy and other), with a lower percentage in lower speed environments (e.g. 8% on 60km/h roads).
- Head-on crashes (DCA 120) make up approximately 10% of crashes on country roads and 4% of crashes on metropolitan roads.
- While the number of crashes involving roadside workers is significantly less than above, this outcome has been mostly realised from cross-sections in which maintenance staff are able to freely access median infrastructure. As such, the objectives related to maintenance intervention and access have been assigned to priority no. 3 and 4.
- While the barrier setback from kerb is another important design element to consider, the exposure is minimal in this context as there are several other factors that influence the potential for vaulting, including the speed, angle and vehicle suspension type. As such, this is the lowest priority objective when selecting the length of barrier in relatively low speed urban environments.

Commentary V2 – Barrier Offsets in urban and rural environments

Barrier offsets in urban environments

In urban environments, the performance benefits from a larger barrier offset is diminished. Meanwhile other risks and constraints are more common, such as kerb setback distances (vaulting), underground services and sight distances. As such, the minimum offset value in Table 6.5 is significantly lower for urban roads than rural roads.

- **Provision for stopping**: Urban roads typically have frequent access points for vehicles to pull over, rather than relying on the barrier offset. More importantly, motorists should be able to identify safe locations to stop which will depend on the access types, intersecting roads and signage scheme.
- **Nuisance impacts**: Motorists are generally more alert on urban roads which reduces the frequency of nuisance impacts. Instead, motorists have more distractions, decisions, and manoeuvres to manage, and nuisance impacts are more frequent near turning movements or where lane widths are below minimum. As such, designers should focus on locations with compounding factors such as reduced lane widths, regular lane changing and turning manoeuvres.
- **Sight distances**: Safe intersection and gap selection sight distances are critical in urban environments.
- **Maintainability**: On urban roads, barrier inspection and repairs are often undertaken adjacent to high volumes of traffic. Where the barrier offset is below minimum, an appropriate barrier type should be considered and the barrier layout should enable safe maintenance. Refer Section 5.7.
- **Barrier Type:** Where minimum or EDD offsets are proposed for an urban road and a decision needs to be made between adoption of flexible W-beam and WRSB, a flexible W-beam system shall be adopted.

Before adopting the minimum offset in urban environments, the designer should undertake an assessment in accordance with Table V6.8.1b. Where the assessment results in a 'Yes' for all questions, the risk is relatively low. If the assessment results in a 'No' for any question, mitigation must be implemented and the assessment must be provided to DTP.

Continuous barrier offsets on high-speed rural roads

In rural environments, continuous safety barrier will transform how people use and maintain the road, therefore, providing an effective, operational and maintainable barrier offset is especially important.

- **Provision for stopping**: Rural roads typically have fewer access points than urban roads, therefore road users are more likely to stop on the roadside. Every effort should be made to achieve the desired barrier offset of 4.0 m, particularly on freeways/highways, as it allows broken down vehicles to pull over clear of traffic lanes and provides space for maintenance vehicles. Where the barrier offset is below minimum, regular 'emergency stopping bays' should be provided in accordance with Section V5.7.14 and motorists must be able to identify safe locations to stop. Median barrier offsets between 2.0 m-3.0 m should be avoided to discourage vehicles from pulling over into a narrow shoulder.
- **Nuisance impacts**: Fatigue-related crashes are more common on rural roads/highways than on urban roads. Drivers leaving the road require time (and lateral distance) to recover. Where the barrier offset is below minimum, audio tactile line marking is particularly important.
- **Sight distance**: Road debris and fauna is more common in rural environments, therefore below minimum barrier offsets must be avoided on crests and curves where available sight distance is already deficient.
- **Maintainability**: On rural roads, barrier inspection and repair is often undertaken adjacent to high speed traffic. Where the barrier offset is below minimum, an appropriate barrier type should be considered, and the barrier layout should enable safe maintenance.
- **Over Size Over Mass (OSOM) and Heavy Vehicle (HV) access:** Barrier offsets may be influenced by the size of OSOM vehicles permitted to use a route. DTP Freight maps should be checked for vehicle classifications permitted to use the road corridor prior to establishing barrier offset locations. Note that OSAM or HV access to properties is often needed along rural roads, this can also influence where barriers can be located.

This document is also available in an accessible format at transport.vic.gov.au