VicRoads Supplement to Austroads Guide to Road Design

Part 6: Roadside design, safety & barriers

February 2019

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This VicRoads Supplement must be read in conjunction with the Austroads Guide to Road Design.

Reference to any VicRoads or other documentation refers to the latest version as publicly available on VicRoads website or other external source.
Table of Contents

Table of Contents...........................................................................................................................................3

References..........................................................................................................................................................6

1. Introduction..................................................................................................................................................7
   1.0 Purpose ..................................................................................................................................................7
   1.2 Scope of this Part ..................................................................................................................................7
   1.3 Road Safety .........................................................................................................................................7
       1.3.1 Providing for a Safe System ........................................................................................................7
   1.4 Terminology ..........................................................................................................................................7

2. Roadside Design...........................................................................................................................................7
   2.1 General ..................................................................................................................................................7
   2.2 Roadside Facilities and Infrastructure .................................................................................................7

3. Designing for Safety....................................................................................................................................7
   3.1 General ..................................................................................................................................................7
   3.2 A Safe Road Environment ....................................................................................................................7
   3.3 Design for Risk Reduction ....................................................................................................................8
   3.4 Design to Keep Vehicles on the Road ....................................................................................................8

4. Design to Mitigate Hazards..........................................................................................................................8
   4.1 Hazard Mitigation Process ....................................................................................................................8
   4.2 Design Step D1: Determine Area of Interest .......................................................................................8
       4.2.1 General .........................................................................................................................................8
       4.2.2 Determine the Clear Zone .............................................................................................................9
       4.2.3 Application of Clear Zones to Design ..........................................................................................9
   4.3 Design Step D2: Identify Hazards ..........................................................................................................10
       4.3.1 General .........................................................................................................................................10
       4.3.2 Types of Hazards ..........................................................................................................................10
       4.3.3 Embankment Warrant for High-speed Roads .............................................................................10
       4.3.4 Embankment Assessment Process ..............................................................................................10
       4.3.5 High-consequence Hazards ........................................................................................................11
       V4.3.6 Motorcyclist Hazards .................................................................................................................11
   4.4 Design Step D3: Identify Treatment Options .......................................................................................12
   4.5 Design Step D4: Evaluation of Treatment Options .............................................................................12
       4.5.1 General .........................................................................................................................................12
       4.5.2 Qualitative Assessment .................................................................................................................12
       4.5.5 Simple Manual Method .................................................................................................................12
   4.6 Hazard Risk Assessment .......................................................................................................................13
   4.7 Design Step D5: Rank Treatment Options and Recommended Preferred Action13
   4.8 Design Step D6: Design the Roadside Treatments .............................................................................13

5. Treatment Options.......................................................................................................................................13
   5.1 General ..................................................................................................................................................13
   5.2 Summary of Treatment Options ..........................................................................................................13
   5.3 Effectiveness of Treatment Options ....................................................................................................14
   5.4 Types of Treatment ................................................................................................................................15
       5.4.1 Treatments for Trees ......................................................................................................................15
       5.4.3 Treatments for Medians .................................................................................................................15
5.4.4 Treatments for Verges .................................................................15
5.4.6 Treatments for Drainage Features .............................................15
5.4.7 Treatments for Fill Slopes ..........................................................16
5.4.13 Treatments for Poles .................................................................16

6. Road Safety Barriers .......................................................................16
6.1 Introduction ..................................................................................16
6.1.1 General .......................................................................................16
V6.1.3 Warrants – General .................................................................16
V6.1.4 Design notation ........................................................................17

6.2 Factors Considered in Barrier Selection ............................................17
6.2.1 Site Conditions ...........................................................................17

6.3 Road Safety Barrier Design Process ................................................17
6.3.4 Step B3 - Determine the lateral position of the barrier ......................17
6.3.5 Offset to Travel Lane ...................................................................18
6.3.6 Support Width ............................................................................22
6.3.8 System Width .............................................................................23
6.3.10 Narrow Medians .......................................................................23
6.3.11 Wider Medians ..........................................................................23
6.3.13 Step B5 – Determine the Barrier Containment Level ......................23
6.3.14 Step B6 – Choose the Barrier Type .............................................25
6.3.15 Steps B7 to B9 – Determine the Working Width .............................28
6.3.16 Step B8 – Determine Vehicle Roll Allowance and System Width ........34
6.3.17 Step B9 – Determine the Working Width .......................................34
6.3.19 Step B11 – Determine the Barrier Points of Need ...........................34
6.3.20 Step B12 – Check that the Minimum Length of Barrier is Provided ....35
6.3.21 Step B13 – Check Sight Distance ..............................................36
6.3.22 Step B14 – Choose Terminal Treatments .....................................36
6.3.23 Step B15 – Design the Transitions between Barriers ....................37

6.4 General Access through Road Safety barriers ....................................37
V6.4.1 General ....................................................................................37
V6.4.2 Emergency Services Operation and Access .................................37
V6.4.3 Maintenance and Service Authority Access ..................................38

6.5 Road Safety Barriers for Vulnerable Road Users .................................39
6.5.1 Motorcyclists .............................................................................39

6.6 Aesthetic Road Safety Barriers ........................................................40
V6.6.1 Barrier Aesthetics .....................................................................40
V6.6.2 Aesthetic Barriers .................................................................41

6.7 Other Road Safety Barrier Design Considerations ..............................41
6.7.1 Barriers at Intersections and Driveways ........................................41
V6.7.10 Sub-Standard Curves ..............................................................42
V6.7.11 Curves on Steep Downgrades ................................................42
V6.7.12 Provision of Paving Adjacent to Traffic Barriers .........................42
V6.7.13 Audio Tactile Line Marking ......................................................43
V6.7.14 Provision for Stopping ............................................................43

7. Design for Steep Downgrades .........................................................44

8. Work zone safety barrier systems ......................................................44

9. Appendices ......................................................................................44

10. Commentaries .................................................................................44

APPENDIX VA: Popular Motorcycle Routes in Victoria ..........................45
References

Acronyms
AGRD: Austroads Guide to Road Design
AGTM: Austroads Guide to Traffic Management
RDN: Road Design Note
SD: Standard Drawings for Roadworks

Sources:

Documents:
Australian Standard AS/NZS 3845.1: 2015 Road Safety Barrier Systems
Austroads (2016), Guide to Road Design Part 3 – Geometric design
Austroads (2011a), Guide to Road Design Part 6 – Roadside design, safety and barriers
VicRoads (2018), Bridge Technical Note 001: Bridge Traffic Barriers.
VicRoads (2016), Tree Policy.
VicRoads (2018), Road Design Note 03-08: Central Barrier in Narrow Medians.
VicRoads (2019), Road Design Note 03-09: Wide Centre Line Treatment (WCLT).
VicRoads (2016), Road Design Note 06-02: Use of Wire Rope Safety Barriers (WRSB).
VicRoads (2013), Road Design Note 06-03: Roadside Utility Poles.
VicRoads (2018), Road Design Note 06-04: Accepted Safety Barrier Products.
VicRoads (2010), Road Design Note 06-07: Performance Safety Barrier Treatments at Bridge Approaches.
VicRoads (2017), Road Design Note 06-08: The use of flexible and semi-rigid Guard Fence.
VicRoads (2019), Road Design Note 06-15: Continuous safety barrier for high speed roads.
VicRoads (2018), Safe System Assessment Guidelines.
1. **Introduction**

1.0 **Purpose**

VicRoads has no supplementary comments for this section.

1.2 **Scope of this Part**

Additional Information

Features and objects that are both within and beyond the road reservation boundary must be considered if they pose a hazard for an errant vehicle.

1.3 **Road Safety**

1.3.1 **Providing for a Safe System**

Additional Information

VicRoads 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.

1.4 **Terminology**

VicRoads has no supplementary comments for this section.

2. **Roadside Design**

2.1 **General**

Additional Information

The design of the roadside must take into consideration any features or objects that are beyond the road reservation boundary that are likely to result in fatal or serious injuries if struck by an errant vehicle. While road authorities may have limited powers with respect to infrastructure outside the road reservation, measures such as the installation of roadside safety barriers to mitigate the outcome of potential crashes should be considered.

2.2 **Roadside Facilities and Infrastructure**

VicRoads has no supplementary comments for this section.

3. **Designing for Safety**

3.1 **General**

VicRoads has no supplementary comments for this section.

3.2 **A Safe Road Environment**

Additional Information
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).

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.

3.3 Design for Risk Reduction
VicRoads has no supplementary comments for this section.

3.4 Design to Keep Vehicles on the Road
VicRoads has no supplementary comments for this section.

4. Design to Mitigate Hazards

4.1 Hazard Mitigation Process

Substitute Information

In AGRD Part 6, Step 1 and Step D1 of Figure 4.1 shall be replaced by “Determination of the area of interest”.

Additional Information:

Designing to eliminate or mitigate roadside hazards is a significant challenge. Historically, the general approach has been to identify and address hazards that are within a relatively narrow roadside corridor known as the clear zone. The clear zone approach, which was first developed during the 1960s and 1970s, is based on the premise that 80 to 85 per cent of errant vehicles would be able to recover or stop within a prescribed lateral distance from the roadway. Based on the Safe System philosophy and the vision of eliminating fatalities and serious injuries from road crashes, an outcome in which 15 to 20 per cent of run-off-road crashes are at risk of being high severity is considered unacceptable. Accordingly, roadsides must be designed to eliminate the risk of fatal and serious injuries from run-off-road events, as far as is practicable.

4.2 Design Step D1: Determine Area of Interest

4.2.1 General

Substitute Information

A prerequisite to the identification and assessment of hazards for both new roads and existing roads is to ensure that the road itself is designed and maintained in a way that should enable drivers to keep their vehicles on the road when travelling at an appropriate speed. Refer to Section 3.4 of AGRD Part 6 (Austroads 2011).

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 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 band of interest has been taken as the clear zone. However, research has indicated that the distance that vehicles may travel is well in excess of the width of the clear zone.
The area of interest shall include all locations that can be feasibly accessed by an errant vehicle. It shall comprise the longitudinal extent under consideration and the lateral extent, being the roadside from the edge of the travelled way to the property boundary of the road and beyond if there are hazards present that pose a risk of fatal or serious injury. Both sides of the road must be assessed.

There is limited information or research available relating to the lateral distance that may be traversed by an errant vehicle that leaves that roadway. The distance travelled will depend upon a range of variables, including speed, angle of departure and the surface type / condition. Table V4.1 provides suggested values that can be used for the area of interest for different operating speeds. Table V4.1 relates to roadsides that are relatively flat. A wider band of interest may need to be considered where the roadside slopes away from the roadway and there are high risk hazards (e.g. deep water) located beyond the distances shown.

<table>
<thead>
<tr>
<th>SPEED LIMIT</th>
<th>LATERAL EXTENT OF THE AREA OF INTEREST</th>
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<tbody>
<tr>
<td>110 km/h</td>
<td>50 - 60 m</td>
</tr>
<tr>
<td>100 km/h</td>
<td>40 - 50 m</td>
</tr>
<tr>
<td>90 km/h</td>
<td>32 - 40 m</td>
</tr>
<tr>
<td>80 km/h</td>
<td>18 - 27 m</td>
</tr>
<tr>
<td>70 km/h</td>
<td>14 - 20 m</td>
</tr>
<tr>
<td>60 km/h</td>
<td>10 - 15 m</td>
</tr>
</tbody>
</table>

It must be noted that it is not intended that all hazards within the area of interest should be treated or removed. In many situations, it is highly unlikely to be practical or cost effective to do so. 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.

4.2.2 Determine the Clear Zone

Substitute Information

The area of interest shall be determined as specified in Section 4.2.1 of this Supplement. Clear zone shall not be used to determine the area of interest.

4.2.3 Application of Clear Zones to Design

Substitute Information

As described in Section 4.2.1 of this Supplement, the area of interest shall include all locations that can be feasibly accessed by an errant vehicle. All potential hazards within the area of interest shall be identified and assessed for consideration for treatment.

AGRD Part 6 is currently being revised and it is anticipated that clear zone approach to roadside safety will be discontinued. However, in the interim, clear zones may be used to identify the part of the roadside that is of greatest risk to errant vehicles and to inform decisions on prioritising treatment options, noting that it is estimated that 15 to 20 per cent of vehicles that leave the road will travel beyond the clear zone.

Determination of the clear zone shall be in accordance with AGRD Part 6, Section 4.2.2.
4.3 Design Step D2: Identify Hazards

4.3.1 General

Substitute Information

The area of interest shall be as defined in Section 4.2.1 of this Supplement and not confined to the clear zone or the road reserve boundary. All roadside hazards within the area of interest shall be identified.

Additional information

In addition to the list in AGRD Part 6 of the types of hazards that may be encountered, the quality of the roadside surface shall be included. Issues such as surface irregularities and non-compacted surfaces will increase the likelihood that errant vehicles may roll over.

While road safety barriers may be classified as hazards (as stated in AGRD Part 6) they are often the preferred treatment. On high speed, high volume roads in particular, continuous barriers are usually the treatment option that most closely aligns with Safe System principles.

4.3.2 Types of Hazards

Additional Information

In addition to the hazards listed in AGRD Part 6, Table 4.3, common roadside hazards also include but are not limited to:

Wide areas of relatively flat terrain (i.e. roadsides that have previously been categorised as recoverable or traversable) where errant vehicles are travelling at high speed (> 80 km/h) and may rollover before stopping or recovering.

4.3.3 Embankment Warrant for High-speed Roads

Additional Information

Even when an embankment is considered driveable (4:1 or flatter), research has found that on high speed roads vehicles may not be able to safely traverse the roadside because of the risk of overturning or striking a hazard that is within the area of interest (Austroads 2014). As such, continuous flexible safety barriers are usually the preferred treatment on high speed roads (>80 km/h) as they are generally less hazardous than an embankment. AGRD Part 6, Figure 4.6 and Appendix E may be used for general guidance and to assist with the identification of higher risk locations along routes where it may not be cost-effective or practical to install continuous barriers. Care must be taken when using Figure 4.6 as it relates specifically to a 3:1 embankment slope which is smooth and firm in all seasons, and the risk of the slope is compared to semi-rigid W-beam safety barrier. While Figure 4.6 indicates that fill heights of less than 1 metre do not require treatment, in practice it is expected that the batter slope would be flattened to minimise the probability of vehicle rollover.

On lower speed roads, a site-specific assessment is required, given that vehicles are less likely to roll and the impact speed into a hazard may not exceed the serious injury threshold.

4.3.4 Embankment Assessment Process

Additional Information

The decision as to whether a safety barrier should be installed to protect errant drivers from traversing embankments depends on the relative crash severity of striking the barrier as compared to the embankment. This will depend on the speed of the road, the slope of the embankment and the quality of the embankment surface.

When assessing the need to treat existing embankments, any proposed works will need to be considered on their potential to reduce the risk of fatal and serious injuries and prioritised against
other road safety initiatives on a benefit / cost basis. The use of safety barriers is generally the preferred option to treat hazardous embankments, particularly on high-speed roads. However, consideration of other measures such as batter flattening, verge rounding and improved delineation may be appropriate if the installation of safety barriers cannot be justified or is not practical.

In assessing the likelihood and consequences of vehicles encroaching onto existing batter slopes, the factors to be taken into account include:

- whether the horizontal alignment is substandard, see Section 6.7.10 of this Supplement;
- whether steep down grades are combined with curves, see Section 6.7.11 of this Supplement;
- whether operating speeds exceed 60 km/h;
- whether there can be adverse climatic conditions such as ice, snow or fog;
- whether there are significant hazards just beyond the clear zone: and
- the potential for an errant vehicle to roll over.

Substitute Information

In AGRD Part 6, Figure 4.7 and Table 4.4 ‘clear zone’ shall be replaced by ‘area of interest’.

4.3.5 High-consequence Hazards

Substitute Information

Roadside hazards

As described in Section 4.2.1 of this Supplement, the area of interest shall include all locations that can be feasibly accessed by an errant vehicle. All potential hazards within the area of interest shall be identified and assessed for consideration for treatment.

Additional Information

Opposing vehicles and medians

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

- Section 5.4.3 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 06-15 Continuous Safety Barrier for High Speed Roads,
- RDN 03-09 Wide Centre Line Treatment (WCLT),

V4.3.6 Motorcyclist Hazards

Additional Information

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

- The concept of a hazard free zone beside a road is based providing a driver the opportunity to regain control of a vehicle. For motorcyclists, it also provides an area free of obstructions in the event that 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, who do not have a second pair of wheels to remain on the road 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 unsealed shoulders.
- 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 from traffic to pedestrians. Where possible, semi-mountable kerb profiles should be used in preference to barrier kerb.
• 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.

VicRoads publication Making roads motorcycle friendly (December 2014) provides additional information and guidance regarding hazards and treatments to improve safety for motorcyclists. Section 6.5.1 of this Supplement provides guidance relating to barriers and motorcyclist safety.

4.4 Design Step D3: Identify Treatment Options

Substitute Information

All hazards within the area of interest as defined in Section 4.2.1 of this Supplement shall be considered for treatment.

Additional Information

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.

While the ultimate objective is to eliminate the risks associated with roadside hazards, in practice it will be necessary to consider the order of priority for treatment options. This will depend on the context of the road, the likelihood of an errant vehicle encountering an identified hazard and the likely severity of a crash involving the hazard.

For high speed roads, particularly those with high volumes such as M-Class and A-Class roads, continuous safety barrier is the preferred treatment to reduce the risk of fatal and serious injuries from run-off-road and head-on crashes (refer to RDN 06-15 Continuous Safety Barrier for High Speed Roads, VicRoads 2019).

4.5 Design Step D4: Evaluation of Treatment Options

4.5.1 General

Additional Information

VicRoads practice is to minimise the risk of fatal and serious injury as far as practically possible in accordance with best practice and up-to-date knowledge.

4.5.2 Qualitative Assessment

Additional Information

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 Vic Roads Safe System Assessment Guidelines (VicRoads 2018) to evaluate treatment options.

4.5.5 Simple Manual Method

Substitute Information

In AGRD Part 6, Section 4.5.5 and Figure 4.8, “clear zone” shall be replaced with “area of interest”.

VicRoads publication Making roads motorcycle friendly (December 2014) provides additional information and guidance regarding hazards and treatments to improve safety for motorcyclists. Section 6.5.1 of this Supplement provides guidance relating to barriers and motorcyclist safety.

4.4 Design Step D3: Identify Treatment Options

Substitute Information

All hazards within the area of interest as defined in Section 4.2.1 of this Supplement shall be considered for treatment.

Additional Information

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.

While the ultimate objective is to eliminate the risks associated with roadside hazards, in practice it will be necessary to consider the order of priority for treatment options. This will depend on the context of the road, the likelihood of an errant vehicle encountering an identified hazard and the likely severity of a crash involving the hazard.

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4.5 Design Step D4: Evaluation of Treatment Options

4.5.1 General

Additional Information

VicRoads practice is to minimise the risk of fatal and serious injury as far as practically possible in accordance with best practice and up-to-date knowledge.

4.5.2 Qualitative Assessment

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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 Vic Roads Safe System Assessment Guidelines (VicRoads 2018) to evaluate treatment options.

4.5.5 Simple Manual Method

Substitute Information

In AGRD Part 6, Section 4.5.5 and Figure 4.8, “clear zone” shall be replaced with “area of interest”.

VicRoads publication Making roads motorcycle friendly (December 2014) provides additional information and guidance regarding hazards and treatments to improve safety for motorcyclists. Section 6.5.1 of this Supplement provides guidance relating to barriers and motorcyclist safety.
4.6 Hazard Risk Assessment
VicRoads has no supplementary comments for this section.

4.7 Design Step D5: Rank Treatment Options and Recommended Preferred Action

Additional Information
The ranking 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 should be ranked higher than supporting treatments 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 VicRoads Safe System Assessment Guidelines (VicRoads 2018) to evaluate treatment options and assist with ranking.

4.8 Design Step D6: Design the Roadside Treatments

Additional Information
Refer to VicRoads Standard Drawings (VicRoads 2019) on VicRoads website for relevant design details of roadside treatments. A list of standard drawings can be found on the following link:

5. Treatment Options

5.1 General
VicRoads has no supplementary comments for this section.

5.2 Summary of Treatment Options

Additional Information
While the clear zone approach is not to be used to determine the area of interest, it may be used to define the roadside area that is of highest risk for the purpose of prioritising treatments. Removing hazards from the clear zone or modifying them to reduce the risk of fatal and serious injuries may be a cost-effective treatment option. The width of the clear zone shall be determined in accordance with AGRD Part 6, Section 4.2.2. However, research shows that around 30% of run-off-road casualty crashes occur on roads where there are clear zones greater than 13 m (Austroads 2011). In addition, the research indicates that there is an increase in roll-over crashes as the clear zone increases. Accordingly, treatment options for all hazards within the area of interest shall be considered (refer to Section 4.2 of this Supplement).

Continuous Safety Barrier

Continuous safety barrier refers to the design and installation of longitudinal barriers (including median and centreline barriers) along an entire or extended length of road. All roadsides contain various elements that contribute to the risk of fatal and serious injuries for occupants of errant vehicles. The intent of continuous barrier is to maximise protection against all roadside risks and head-on crashes by installing a device that is forgiving.
A continuous safety barrier will incorporate provisions for access for emergency and maintenance purposes. Breaks at adjoining roads and properties may also be provided but should be minimised as far as is practically possible.

Continuous barriers are generally recognised as a Safe System treatment for vehicles that encroach into the roadside. They are often the preferred treatment option, particularly on high volume, high speed roads (refer to RDN 06-15 Continuous Safety Barrier for High Speed Roads, VicRoads 2019).

Treatment types (other than continuous barrier) to address specific hazards are discussed in Section 5.4 of AGRD Part 6 (Austroads 2011) and this Supplement.

5.3 Effectiveness of Treatment Options

Additional Information

To be consistent with the Safe System approach, treatment options should be classified as primary (or transformational) or supporting treatments.

Primary treatments are those measures that have the potential to eliminate or come close to eliminating the risk of fatal and serious injury (FSI) crashes.

Supporting treatments are effective in reducing the risk of FSI crashes but not to the extent of a primary treatment (i.e. there is a residual moderate or significant FSI crash risk). Implementation of a primary treatment should be given priority over a supporting treatment that may be targeting a similar crash risk.

Table V5.1 shows a list of run-off-road treatments, classified in accordance with their alignment with Safe System principles. Refer to Austroads Safe System Assessment Framework (Austroads 2016) for treatments for head-on crashes and further information regarding primary and supporting treatments in general.

<table>
<thead>
<tr>
<th>Hierarchy</th>
<th>Treatment</th>
<th>Influence (E = exposure, L = likelihood, S = severity)</th>
</tr>
</thead>
</table>
| Safe System options (‘primary’ or ‘transformational’ treatments) | • Flexible roadside and median barriers (or equally better performing future equivalent)  
• Very high quality compacted roadside surface, very gentle to flat side slopes and exceptionally wide run-off areas  
• Very low speed environment/speed limit. | S  
L, S |
| Supporting treatments which move towards better Safe System alignment (compatible with future implementation of Safe System options) | • Wide run-off areas, with well-maintained shallow drainage and gentle side slopes  
• Wide sealed shoulders with audio-tactile edgeline  
• Lower speed limit. | S  
L, S |
| Supporting treatments (does not affect future implementation of Safe System options) | • Non-flexible safety barrier  
• Consistent design along the route (i.e. no out-of-context curves)  
• Consistent delineation for route  
• Skid resistance improvement  
• Improved superelevation  
• Audio-tactile centreline  
• Audio-tactile edgeline  
• Vehicle activated signs. | S  
L  
L  
L  
L  
L  
L  
L |
| Other considerations | • Speed enforcement  
• Rest area provision  
• Lane marking compatible with in-vehicle lane-keeping technology. | L, S  
L  
L |
5.4 Types of Treatment

5.4.1 Treatments for Trees

Additional information

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

5.4.3 Treatments for Medians

Additional information

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. Refer to RDN 06-15 Continuous Safety Barrier for High Speed Roads (VicRoads 2019) for detailed guidance.

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.

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).

5.4.4 Treatments for Verges

Additional Information

When considering treatments for verges, the risk of roll-over crashes shall be taken into account. While it may be possible to remove rigid hazards such as poles and trees, on many roads it is not practical to maintain verges 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. Refer to RDN 06-15 Continuous Safety Barrier for High Speed Roads (VicRoads 2019) for further information.

5.4.6 Treatments for Drainage Features

Additional Information

Recoverable Slopes

To be recoverable, batter slopes desirably should be 4:1 or flatter. To be relatively safe for trucks, batter slopes should be 6:1 or flatter.

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 height of the culvert. Beaching will be required to prevent erosion of the batter and the channel. Beaching within the area of interest or, as a minimum, the clear zone must be traversable, relatively smooth and no steeper than 4:1. Any rough textured beaching for energy dissipation shall be located beyond area of interest of the clear zone.

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, it is preferable to extend the pipe or box culvert to the edge of the area of interest or, as a minimum, the clear zone, and to warp the batter around the culvert using driveable batter slopes.
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.

Safety barrier protection may be provided as an alternative where the height is between 0.6 metres and 2.0 metres, and shall 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, as a minimum, the clear zones of traffic flows in both directions. If the endwall cannot be located beyond the clear zone, provide a traversable endwall with transverse bars as shown on Standard Drawing SD1991.

### 5.4.7 Treatments for Fill Slopes

**Additional information**

When considering treatments for fill slopes, the risk of roll-over crashes shall be taken into account. While it may be possible to remove rigid hazards such as poles and trees, on many roads it is not practical to maintain fill slopes 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. Refer to *RDN 06-15 Continuous Safety Barrier for High Speed Roads* (*VicRoads 2019*) for further information.

### 5.4.13 Treatments for Poles

**Additional Information**

For details relating to the assessment and treatment of utility poles, refer to *RDN 06-03 Roadside Utility Poles* (*VicRoads 2013*). All poles within the area of interest as defined in *Section 4.2.2* of this Supplement should be assessed and considered for treatment. The assessment methodology set out in RDN 06-03 should be applied but not restricted to poles within the clear zone.

### 6. Road Safety Barriers

#### 6.1 Introduction

#### 6.1.1 General

**Additional Information**

Only road safety barriers, variants and end treatments accepted by VicRoads shall be used on the declared road network.

For further details on acceptable barrier systems, refer to *RDN 06-04 Accepted Safety Barrier Products* (*VicRoads 2019*) and VicRoads Standard Drawings (*VicRoads 2019*).

The protection of pedestrians and cyclists should also be considered during design (e.g. barriers may be required to be provided where a shared path is adjacent to an urban freeway). Care should be taken in the selection of barrier type in high pedestrian and cyclist areas to ensure appropriate barriers are selected. Safety barriers shall not be used to shield commercial developments and private residences unless there is an established accident history, the potential for accidents is high or the potential for harm is high.

#### V6.1.3 Warrants – General

**Additional Information**
Engineering judgement based on the particular site conditions and current road safety practice needs to be exercised in determining where a safety barrier is required. The warrants to install barrier may not apply where traffic volumes are low, a consistent road environment is provided, and speeds are restricted by the road alignment to less than 60 km/h; or where the benefit-cost is extremely low.

V6.1.4 Design notation

Additional Information

The VicRoads 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 shall be accompanied by a note which specifies the type of system designed along with the Test Level. This note shall use the terminology as follows:

- “TL-# Flexible WRSB” for Wire Rope Safety Barrier products.
- “TL-# Flexible GF” for Flexible Guard Fence products.
- “TL-# Semi-Rigid GF” for public domain, semi-rigid, Guard Fence.
- “TL-# Concrete barrier” for roadside 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. e.g. Thrrie-beam products fall under the ‘semi-rigid’ category.

Alternatively, where a proprietary system has been specifically included in a design to meet a particular requirement, the note can specify the system by name and optionally include the terminology “or equivalent” where an alternative may be used.

6.2 Factors Considered in Barrier Selection

6.2.1 Site Conditions

Additional Information

Maintenance

While the provision of barrier maintenance strips, concrete or otherwise, 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 VicRoads Standard Drawing SD 3503 and VicRoads Standard Section 708 and Standard Section 711.

6.3 Road Safety Barrier Design Process

6.3.4 Step B3 - Determine the lateral position of the barrier

Additional Information

The objective of barrier design is to minimise both the probability of a barrier being impacted by an errant vehicle and the severity of any collision with the barrier. In general, provided that the roadside would enable an errant vehicle to recover, it is desirable that road safety barriers be located (e.g. offset, lateral position) as far as possible from the edge of the traffic lane as site conditions permit. This will maximise the opportunity for drivers to regain control of the vehicle and minimise the frequency of barrier impacts. However, it is to be noted that a greater offset from the edge of the lane
can result in larger impact angles, higher impact severity and a higher probability of the barrier being penetrated.

Figure V6.1 below illustrates some of the cross-section elements relating to barriers installed on verges.

Varying offsets to road safety barriers along a length of road may cause delineation issues at night. Varying offsets of delineators on barriers may be confusing in the dark because steps in the barrier offset create a broken line of reflectors that is not consistent with the lane marking. In such circumstances designers should consider omitting the delineators on barriers and use alternative delineation (e.g. raised reflective pavement markers and guideposts).

At night a large offset between a road safety barrier and the edge of the travelled way can give the impression that an extra lane is available between the edge line and the offset barrier. This may lead to crashes where drivers have moved onto the shoulder and verge in the mistaken belief that an extra lane is available. Hence in situations with large offsets, delineators shall not be used. Alternative delineation should be provided closer to the road.

6.3.5 Offset to Travel Lane

Additional Information

Safety barriers should be placed at appropriate distances from the edge of the traffic lane. The ongoing maintenance of the areas on both sides of the barrier should be considered. The cost, practicality and Occupational Health & Safety implications of these areas must be considered in accordance with Section 28 of the OH&S Act 2004.

Barrier offsets should be maximised where possible. The desirable offset for safety barriers from the nearest traffic lane shall be 4.0m-6.0m, with a minimum offset of 3.0m. Every effort should be made to achieve the desirable offset of 4.0m as it 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 6.0m should be avoided but may be limited to a specific need such as an emergency stopping bay or maintenance access.

Provision of a sealed surface should be considered between the edge of shoulder and the safety barrier (particularly where this distance is 3.0m or less). The appropriate VicRoads region should be consulted to establish acceptable maintenance practices when determining the surfacing treatment to be adopted between the edge of shoulder and barrier.

Barrier offset requirements between traffic lanes and all barrier types for rural and urban roads are set out in Table V6.2. The design domain details are also given.

<table>
<thead>
<tr>
<th>Location</th>
<th>Rural</th>
<th>Urban</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>NDD</td>
<td>Desirable: 4.0 – 6.0</td>
<td>3.0 – 6.0</td>
<td>Maximum length of offset &lt;3m to be 500m.</td>
</tr>
<tr>
<td></td>
<td>Minimum: 3.0 – 4.0</td>
<td>1.0 – 3.0</td>
<td>Maximum length of offset &lt;2m to be 200m.</td>
</tr>
<tr>
<td>EDD</td>
<td>1.0 – 3.0</td>
<td>0.6 – 1.0</td>
<td></td>
</tr>
<tr>
<td>DE</td>
<td>0.6 – 1.0</td>
<td>0.0 – 0.6</td>
<td></td>
</tr>
</tbody>
</table>

Notes:
1. NDD = Normal Design Domain, EDD = Extended Design Domain and DE = Design Exception. Further information can be found in Commentary 12.1 of this Supplement.
2. Barrier offsets are measured to the closest part of the barrier. GF is measured to face of W-beam or Thrie-beam. WRSB is measured to face of barrier post.

**Continuous safety barrier**

Continuous safety barrier refers to the design and installation of barrier along the entire road length. Rather than designing a barrier to shield a specific hazard(s), continuous safety barrier is designed as a longitudinal element of the road to maximise driver protection and to contain errant vehicles before they roll, impact a hazard or cause a head-on collision.

Continuous barrier installations will transform the way in which people use and maintain our roads, therefore providing an operational barrier offset is especially important on Freeways/Highways, and projects should consider greater barrier offsets (4.0m-6.0m) where existing conditions permit.

Refer RDN 06-15 – Continuous safety barrier for high speed roads (VicRoads 2019).

**Median barrier offsets**

Median barrier offsets must be designed the same as verge barriers and in accordance with Table V6.2.

Where a divided carriageway has three or more lanes in one direction, it is preferable to have desirable offsets on both sides of the carriageway. This limits the number of lanes a vehicle may have to cross in the event of breakdowns to stop clear of the traffic lanes.

Where a divided carriageway has two or less lanes in one direction, median barrier offsets may be less than minimum when a barrier offset 3.0m or greater is provided on the verge.

Continuous median barrier offsets between 2.0m-3.0m should be avoided to discourage vehicles from pulling over into a narrow shoulder.

**Below minimum barrier offsets**

The following issues must be addressed when below minimum barrier offsets are being considered to ensure that reasonable steps have been taken to achieve the most appropriate offset for the roadside.
All discussions and actions should be carried out and documented to address the following issues:

a) Can the site constraints (e.g. trees, poles, batters, etc) be removed, relocated or modified to enable a greater barrier offset?

b) Has the appropriate type of barrier been used (Below minimum barrier offsets will have greater frequency of nuisance impacts)?

c) Has offset been maximised where it is less than 4m?

d) Have emergency stopping bays, wider offsets within the barrier length, or breaks in the barrier been used to provide areas where vehicles can stop?

e) On divided roads where a 3m offset cannot be provided on the median side, have stopping opportunities on the left side of the road been maximised or vice versa?

f) Has the probability of conflict between moving and stopped vehicles where the barrier is installed been considered?

g) Have traffic volumes (including truck volumes), and vehicle speeds been considered? – There are higher risks on roads with high traffic volume, speed and high percentage of trucks

h) Have traffic lane widths been considered? – Wider lane widths are desirable to minimise nuisance impacts.

i) Has sealing shoulder between traffic lane and barrier to provide areas for errant vehicles to re-gain control been considered?

j) Has sight distance on the approach to barriers been considered to ensure that a parked vehicle protruding onto traffic lane can be seen by approaching traffic? (Refer AGRD - Part 3: Geometric Design, Section 5.5 for sight distance requirements).

k) Have the needs of pedestrians, cyclists, motorcyclists (especially at bends), horse riders, etc. been considered?

l) Has the need and ability for a vehicle with disabled driver/passenger to stop on the side of the road and the risk of a collision involving such a vehicle been considered?

m) Has the ability for maintenance activities (including repairs to barrier, grass mowing and weeds spraying) to be carried out safely been considered?

n) Has the ability for motorists to identify safe locations to stop both at day times and night times been considered?

o) Have mitigation measures, such as speed reduction, signs or other advisory information, freeway management systems (e.g. Variable speed/lane use), stakeholder education.awareness (e.g. Maintenance/CFA) and user education/public awareness, been considered?

**Barrier Setback from Kerb**

**Additional/substitute information**

Barrier systems should not be placed in proximity to kerbs, particularly in environments with speed limits above 70km/h.

When a vehicle strikes a kerb, its trajectory will depend on several variables such as speed, angle, height & shape of kerb, and the vehicle tyre & suspension characteristics. This makes it difficult to accurately predict the trajectory path, especially on high speed roads. Hence the use of a kerb no higher than 100mm (mountable kerb) is recommended.

Where the road design cannot eliminate the need for ‘kerb-safety barrier’ interaction, the position of the barrier setback from kerb should consider the following principles;

**Zone 1:** Preferred. The kerb’s ability to deviate the bumper height is diminished as the safety barrier is already engaged. Preferred offset is as close to back of kerb as possible.
Zone 2: Preferred. The barrier is sufficiently far away that for most bumper trajectory paths, the vehicle has returned to the ground and collides with the barrier at the expected bumper bar height.

Zone 3: Tolerable. While the vehicle has commenced or not quite completed the vaulting process, the height and dynamic behaviour of the vehicle bumper is in conjunction with the safety barrier tolerable collision zone. This may vary between barrier types given the mechanism of engagement.

N.C.: Non-conformance. The zone between the preferred and tolerable limits. In this zone, there is an unacceptable risk that a run off road vehicle will collide with and breach the barrier. Rise of the bumper may cause it to ramp or vault the barrier while lowering of a bumper may cause it to underrun the barrier. For these reasons a safety barrier should not be installed in this “Non-conformance” zone.

In theory, the desirable safety barrier outcome would be a combination of ‘Zone 1’ located with sufficient offset to the traffic lane to avoid an increased incidence of nuisance hits and financial liability. However, this outcome is often not practicable, especially in urban environments, therefore the ‘desirable’ offset in most circumstances is either ‘Zone 1’ with barrier offset exemption, or ‘Zone 2’.

The following table provides the prescriptive VicRoads’ requirements.

### Table V6.3: Barrier setback from kerb

<table>
<thead>
<tr>
<th>Kerb type</th>
<th>Speed (km/h)</th>
<th>Barrier type</th>
<th>Zone Offset Distances</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td>1</td>
</tr>
<tr>
<td>Barrier</td>
<td>&gt; 80</td>
<td>GF &amp; WRSB</td>
<td>Not recommended</td>
</tr>
<tr>
<td></td>
<td>70-80</td>
<td>GF &amp; WRSB</td>
<td>0m³</td>
</tr>
<tr>
<td></td>
<td>&lt; 70</td>
<td>GF &amp; WRSB</td>
<td>0m³</td>
</tr>
<tr>
<td>Semi-mountable</td>
<td>&gt; 80</td>
<td>GF</td>
<td>0m</td>
</tr>
<tr>
<td></td>
<td></td>
<td>WRSB</td>
<td>0m³</td>
</tr>
<tr>
<td></td>
<td>70-80</td>
<td>GF</td>
<td>0m</td>
</tr>
<tr>
<td></td>
<td></td>
<td>WRSB</td>
<td>0m³</td>
</tr>
<tr>
<td></td>
<td>&lt; 70</td>
<td>GF</td>
<td>0m</td>
</tr>
<tr>
<td></td>
<td></td>
<td>WRSB</td>
<td>0m³</td>
</tr>
<tr>
<td>Mountable</td>
<td>No restrictions</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Notes:
1. Offsets are measured to back of kerb. This creates an offset of 300mm to line of kerb which reduces the likelihood of nuisance impacts. In low speed areas, such as car parks, there are no restrictions on the location of kerbs and barriers.
2. Guard fence offsets are measured to the face of W-beam.
3. WRSB offsets are measured to face of barrier post. Post foundations are typically 450mm-600mm in diameter, hence ‘Zone 1’ includes the foundation install at back of kerb.

Shy line offset

Substitute Information

The following table substitutes AGRD Part 6, Table 6.4 as it includes shy line distances to both sides of a road.

<table>
<thead>
<tr>
<th>85th Percentile Speed (km/h)</th>
<th>Shy Line Distance (m)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Nearest (Left)</td>
</tr>
<tr>
<td>≤ 70</td>
<td>1.5</td>
</tr>
<tr>
<td>80</td>
<td>2</td>
</tr>
<tr>
<td>90</td>
<td>2.5</td>
</tr>
<tr>
<td>≥ 100</td>
<td>3</td>
</tr>
</tbody>
</table>

6.3.6 Support Width

Additional/Substitute Information

Support width is the distance from the rear of the barrier to hinge point (i.e. back of guard fence or WRSB foundation) for the system to gain structural strength and to ensure the barrier system will perform as intended. The support width (6:1 or flatter verge) may be more or less than dynamic deflection.

While each barrier system may have a different support width (refer VicRoads Detail Sheets), VicRoads adopts a desirable support width for each barrier type in accordance with Table V6.5.

<table>
<thead>
<tr>
<th>System type</th>
<th>Support width</th>
</tr>
</thead>
<tbody>
<tr>
<td>WRSB</td>
<td>1.0m</td>
</tr>
<tr>
<td>Flexible W-beam Public domain W-beam Thrie-beam</td>
<td>0.5m</td>
</tr>
<tr>
<td>Concrete</td>
<td>Varies</td>
</tr>
<tr>
<td></td>
<td>0m where barrier is part of a structure (e.g. Retaining wall) and designed in accordance with AS5100 and BTN's.</td>
</tr>
</tbody>
</table>

The desirable support width should be provided on all Greenfields projects and high risk retrofit projects.
When the full width of dynamic deflection cannot be provided on the verge, deflection should be managed in accordance with Section 6.3.15 and consideration needs to be given to the provision of adequate ground support as, over time, softening of the verge may occur.

Lesser support widths should only be implemented in a constrained location with risk assessment and design exception. Documented evidence should be sought from the supplier to support any decisions. This may include product specific requirements, testing and long term performance as justification.

Post embedment depth may be an option to provide sufficient lateral support in semi-rigid systems.

6.3.8 System Width

Additional Information

The width of each road safety barrier system can be found in the VicRoads Detail Sheets.

6.3.10 Narrow Medians

Additional Information

Narrow medians are defined as medians with a width less than 6.2m measured between edge lines of opposing traffic lanes.

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

6.3.11 Wider Medians

Additional Information

Wider medians are defined as medians with a width of 6.2m or greater.

To minimise the risk of fatal and serious injuries, safety barriers in medians should be located such that they satisfy the offset requirements for both traffic directions (e.g. 6m-4m offset) which will result in the use of two barrier runs where the median is greater than 10m.

While two runs are desirable, it may not be practical for all road sections, therefore, one run of barrier may be considered in the median where the following conditions are all met:

- There are no fixed hazards within the median OR all fixed hazards can be removed
- The grade throughout the median is no steeper than 10:1 OR can be re-graded as such.
- The barrier can be located such that it satisfies the offset requirements for one direction and will allow for the retrospective installation of a second run of safety barrier should there be a future need.
- The barrier can withstand impacts from both directions (e.g. back-to-back variant).

Where any one of the above conditions is not met, two runs of safety barrier should be installed in the median. Both runs of barrier should be designed to meet the principles contained within this document.

6.3.13 Step B5 – Determine the Barrier Containment Level

Additional information

Barrier containment level selection cannot be defined prescriptively for an entire network; rather it must be determined using engineering judgement and information obtained from a site-specific risk assessment. Over the length of a route, the containment level may vary based on the combination of risk factors and site-specific conditions.

The following situations are excluded from this process:

- Where the barrier is shielding a bridge pier or structure, designers must use AS5100 and VicRoads 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 Road Design Note 06-13.

• Where the barrier is shielding a rail corridor, the relevant rail authority guidance must be used.

• Where the containment level is already specified in the Contract documentation.

In general, the barrier containment level should be determined by taking into account the;

• **design vehicle** to be retained by the road safety barrier

• **operating speed** of the site

• **consequences of penetration** e.g. whether the consequence of a barrier penetration will result in a catastrophic outcome, such as a structure collapse or third-party injury?

• **adjacent land use** e.g. whether there are high volumes of pedestrian or cyclist traffic such as schools, playgrounds, parks, shopping centres that might increase the probability of an errant vehicle hitting a person.

• **critical infrastructure** e.g. whether a barrier penetration may result in damage to critical infrastructure, such as a sub-station, which may cause a catastrophic outcome?

Designers must review the available traffic count data to determine the % of heavy vehicles. If no counts are available for the site, then roads with similar characteristics should be used (e.g. location, route type & road function). The speed environment and % of heavy vehicles should be used to determine the minimum containment level for the route.

In addition, designers must identify any high-risk locations using the considerations above (e.g. land use) to determine the need for a higher containment level. Figure 6.3 shows an example sketch of a TL-3 route minimum containment and three high-risk locations for higher containment.

![Figure V6.3: Containment level route plan (sketch)](image)

**Route containment level**

In Victoria, the minimum 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 70km/h or lower, AND where the likelihood of a heavy vehicle run-off-road is low. Designers will need to justify when this is applicable.

If the % of heavy vehicles is forecasted to be 20% and greater, 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 highways, TL-4 and TL-5 concrete barriers have become the typical minimum containment level given the AADT and % of heavy vehicles.
**High-risk site containment level**

The containment level for high-risk sites must be determined using engineering judgement and information obtained from a site-specific risk assessment. While a detailed methodology has not been prescribed, other risk assessment methods are available; including AS5100.1 Appendix B: Road Barrier Performance Level Selection Method. Designers should take reasonable steps to ensure an appropriate containment level is selected, using available guidance and/or risk workshops.

Figure V6.4 provides a general overview of the information above.

![Figure V6.4: Barrier containment level selection (summary)](image)

### 6.3.14 Step B6 – Choose the Barrier Type

**Additional Information**

If a safety barrier is warranted, then the appropriate barrier type needs to be determined. Only road safety barriers, variants and end treatments, accepted in the current list contained in *VicRoads RDN 06-04 Accepted Safety Barrier Products* (*VicRoads 2019*), shall be used.

To determine the barrier type, the designer needs to consider the minimum containment level required, estimate the barrier performance needs (e.g. allowable barrier deflection), and assess the consequences of barrier penetration.

Given the suite of barrier types and products available, it is important that the most suitable and effective barrier is selected for the site. Performance values may vary between specific products. Generally, flexible systems should be adopted where its performance and serviceability are appropriate to the constraints of the site. Designers need to note the design limitations of WRSB and GF contained in *RDN 06-02* and *RDN 06-08* respectively.

Detail Sheets are provided for all VicRoads accepted safety barrier products. These provide designers with a set of crash tested performance values and should be considered ‘desirable’ in conjunction with this document. Where a tested value or range cannot be achieved (e.g. shorter length or different pavement condition), designers may consider the ‘extended design domain’ and should understand the potential effects to the barrier and make an informed assessment. This includes working closely with VicRoads, the product owner and supplier.
Irrespective of the type of barrier being used, it is preferable that the approach terrain is essentially flat, as safety barriers perform best when impacted by vehicles that have not been destabilised by traversing uneven terrain.

Factors to be considered when choosing a barrier type include:

- Restraint (flexible, semi-rigid or rigid) Requirements
- Site Conditions
- Safety Performance
- Continuity and Consistency
- End Treatments
- Maintenance
- Sight Distance
- In Service Performance
- Meteorological and Environmental considerations
- Aesthetics
- Cost

**Maintenance, Repair and Upgrade**

Items to consider include:

- Product maintenance requirements in accordance with the system owner’s specifications,
- Product repair requirements (e.g. tools needed) in accordance with the system owner’s specifications,
- The effect of road and roadside maintenance (pavement overlays, etc) on the barrier performance,
- The ability to extend or modify the barrier for future needs. This is important when the project limit of works may prevent the desirable barrier design.

In accordance with Section 28 of the [OH&S Act 2004](https://www.legislation.wa.gov.au/Legislation/Statutes/a00/ohsa002004/s028), designers should consider the OH&S implications of maintenance and repair of safety barriers. This may influence the choice and location of the type of safety barrier to be installed.

**Whole-of-Life Cost**

When determining barrier type, the life cycle cost of alternative systems together with their probable average injury level and property damage performance need to be assessed, as initial cost is only one component of the economic evaluation.

Flexible barrier systems typically have the preferred whole-of-life cost when installed in an unconstrained location; desirable offset, installation and maintenance. While other barrier systems should be considered in more constrained locations, such as likely nuisance impacts or difficult (costly) barrier repair.

**V6.3.14.1 Barrier Types**

Road safety barrier systems can generally be divided into three broad types comprising flexible, semi-rigid and rigid barriers. The below table outlines generic characteristics of longitudinal barrier types.
### Table V6.6: Generic characteristics of longitudinal barrier types

<table>
<thead>
<tr>
<th>Characteristic</th>
<th>Flexible</th>
<th>Semi-Rigid</th>
<th>Rigid</th>
</tr>
</thead>
<tbody>
<tr>
<td>Product type</td>
<td>WRSB</td>
<td>Guard fence</td>
<td>Concrete (with foundation)</td>
</tr>
<tr>
<td></td>
<td>Flexible Guard Fence (FGF)</td>
<td>Thrie-beam (proprietary)</td>
<td>Steel Beam</td>
</tr>
<tr>
<td>Deflection (typical)</td>
<td>High</td>
<td>Moderate</td>
<td>Low</td>
</tr>
<tr>
<td>Passenger Car Occupant Severity</td>
<td>Low</td>
<td>Moderate</td>
<td>High</td>
</tr>
<tr>
<td>Typical (relative)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Containment Capacity (typical</td>
<td>TL-2, TL-3, TL-4</td>
<td>TL-2, TL-3, TL-4</td>
<td>TL-4, TL-5, TL-6</td>
</tr>
<tr>
<td>Typical range)</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

#### V6.3.14.2 Flexible Systems

Flexible safety barriers comprise both wire rope safety barrier and weak post W-beam guard fence systems. Refer to *RDN 06-04 Accepted Safety Barrier Products* (VicRoads 2019).

Flexible barrier types are preferred in Victoria. Due to the relatively low decelerations experienced by vehicle occupants, flexible systems provide lower injury risk to vehicle occupants than both the rigid and semi-rigid systems, along with acceptable vehicle trajectories after impact. While there may be slight differences between each barrier type (WRSB or FGF), it is important that the right product is chosen for reasons other than forgiveness and cost alone.

WRSB systems are preferred given their effectiveness for errant vehicle occupants, Test Level 4 containment and low installation cost, however, flexible w-beam systems can have advantages over WRSB systems, including potentially lower maintenance costs, a lower minimum offset required from batter hinge points and lower deflection requirements for long lengths and on the inside of curves.

The selection of WRSB or flexible w-beam should take whole-of-life costs (installation, maintenance, repair) into consideration and the most suitable system for the road length should be selected.

**WRSB:** Guidelines for the use of wire rope safety barrier are set out in RDN 06-02.

**Flexible W-beam:** Guidelines for the use of flexible guard fence are set out in RDN 06-08.

#### V6.3.14.3 Semi-Rigid Systems

Guidelines for the use of semi-rigid guard fence are set out in RDN 06-08.

The deflection of semi-rigid barriers is less than that of flexible systems, but more than rigid systems. The barrier redirects colliding vehicles by some of the collision forces being transferred to the support posts of the barrier, which either break away or bend on impact releasing the barrier rails, which under tension contain and redirect the vehicle. As these systems are stiffer than flexible systems, resistance is achieved through the combined flexure and tensile strength of the rail. The undamaged adjacent posts provide support. The tension in the rails is dependent on the correct installation of the end anchorages, so attention needs to be directed to this aspect when installing these systems.

**Type-B guard fence:**

W-beam guard fence comprises strong posts and is the system most commonly used in Australia. It is capable of restraining vehicles in the 800 kg to 2000 kg range, has deflections somewhat less than flexible systems and is considerably cheaper to install than rigid barrier – refer *RDN 06-04 Accepted Safety Barrier Products* (VicRoads 2019). Guidelines for the use of Type-B guard fence are set out in RDN 06-08.
**Thrie-beam**

Public domain thrie-beam is not an accepted barrier system in Victoria.

Proprietary thrie-beam products that are accepted in Victoria are listed in RDN 06-04 Accepted Safety Barrier Products. As they are capable of restricting vehicles in the 1100kg to 10000 kg range, thrie-beam may be considered where Test Level 4 containment is required. Guidelines for the use of thrie-beam are set out in RDN 06-08.

**V6.3.14.4 Rigid Systems**

The following concrete barriers represent this group:

- F-Shape Concrete Barrier;
- Constant Slope Safety Barrier; and
- Vertical Face Concrete Barrier

The F-shape is the preferred profile for concrete barriers and therefore shall be used. Constant slope and vertical face 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 is to be treated as a design exception requiring approval by VicRoads. Rigid systems are suitable where there is limited width for barrier deflection, and traffic volumes are high, or a higher containment barrier is needed, as maintenance and repair costs are small.

The following restrictions apply:

a) The approach surface must be paved to allow vehicles to ride up the lower safety profile, and then be redirected by the upper sloped face.

b) Concrete barriers should not be located more than 4 metres from the edge of the traffic lane as at larger angles of impact, the safety profile becomes less effective and the severity of impact increases. Also, a wide paved shoulder could be exploited as a through lane;

c) Kerb and channel must not be placed in front of concrete safety barriers as it could cause errant vehicles to strike it in such a way that the vehicle will overturn. When a vehicle crosses kerb and channel, vehicle roll and pitch can be developed, which could lead to the concrete barrier being vaulted. This risk increases significantly where vehicle speeds exceed 70 km/h. The toe of a concrete barrier can be used as a kerb.

**6.3.15 Steps B7 to B9 – Determine the Working Width**

Additional/Substitute Information - This section has been modified to include steps B7, B8 and B9.

When a vehicle strikes a barrier, it requires sufficient area behind the barrier to accommodate the redirection process. This area is called the ‘working width’ and varies according to the characteristics of the impacting vehicle, including mass, impact speed, angle of impact and the characteristics of the barrier system.

Working width values are provided in the VicRoads Detail Sheets for all safety barrier products.

In all cases, the designer should make reasonable attempts to align the barrier installation with the crash tested conditions. Therefore, no hazard, including rigid or frangible objects, paths or non-traversable slopes, should be placed within the working width unless it has been tested.

Working width is comprised of three sub-components; dynamic deflection (Step B7), vehicle roll allowance (Step B8) and system width (Step B8). To select a suitable working width, designers will need to consider the tested performance, all three sub-component and the hazard type.

Table V6.7 includes indicative working width values for concept/feasibility design only. It does not consider product specifics, or any site-specific effects related to the barrier.
### Table V6.7: Indicative deflection for concept/feasibility design

<table>
<thead>
<tr>
<th>Barrier</th>
<th>Permanent</th>
<th>Temporary</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>WRSB</td>
<td>FGF</td>
</tr>
<tr>
<td>Deflection</td>
<td>1.5 – 4.0+</td>
<td>1.0 – 1.5</td>
</tr>
</tbody>
</table>

FS: Free standing, P: Pinned

#### V6.3.15.1 Crash Tested Performance

Crash testing provides the most accurate method to determine working width. Crash tested values (including each sub-component) will often vary based on the crash test level and the characteristics of the barrier. The following figures show typical crash test outcomes. It is important to understand the crash test performance values and behaviour to ensure they are applied appropriately in the field.

**Figure V6.5: Typical Test Level 3 performance**

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

**Figure V6.6: Typical Test Level 4, 5 & 6 performance**

**Product comparisons**

Performance values obtained from crash tests conducted under different testing protocols (e.g. NCHRP350 vs MASH) cannot be easily compared. Comparisons made based on impact energy (where vehicle mass, speed and impact angle are critical considerations) are possible, but such comparisons do not result in an equal level of predictable performance that crash tests provide.
For example, the deflection value for a barrier system tested to both NCHRP350 and MASH is not expected to be the same given the differences in impact energy. Similarly, the roll allowance for a TL-3 system and a TL-4 system are not expected to be the same given the vehicle type.

AS/NZS 3845.1:2015, Appendix D, Table D1, shows each Test Level impact condition and the impact severity. VicRoads RDN 06-04 provides a summarised version.

**V6.3.15.2 Dynamic Deflection**

Dynamic deflection is defined as the largest transverse deflection of any part of a road safety barrier system recorded during full-scale crash testing (AS/NZS 3845.1:2015).

Dynamic deflection values are observed and measured during every crash test and are provided in the VicRoads Detail Sheets. Due to the variability of WRSB, dynamic deflection should be determined in accordance with Section 6.3.15.6.

**V6.3.15.3 Vehicle Roll Allowance**

Vehicle roll allowance is the lateral distance between the deflected face of a road safety barrier and the maximum extent of vehicle body roll during impact.

Vehicle roll allowance is observed and measured during the TL-4, TL-5 and TL-6 crash tests and is included in the VicRoads Detail Sheets within the working width value. Due to the variability of WRSB, working width should be determined in accordance with Section 6.3.15.6.

For TL-1, TL-2 and TL-3 barrier systems (e.g. w-beam barrier), an additional factor of safety (FoS) for vehicle roll should be considered. While this FoS does not deliver a higher test level than tested, it caters for heavier vehicles on the network when the impact energy is less than the barrier's capacity.

This FoS is additional to the crash tested performance and is desirable for above ground hazards on greenfield projects, where the designer can influence the location of roadside objects, especially where an impacted object may collapse onto a road user.

- For w-beam barriers, the FoS for vehicle roll allowance should be based on Table 6.8 of the Austroads Guide to Road Design, Part 6.
- For concrete barriers, the FoS for vehicle roll allowance should be based on a barrier "point of contact method". The point of contact method adopts a projected roll line that contacts the face of the barrier and is extended to a height of 4.6m above the pavement surface.

On brownfield projects, the FoS is often not practical and the tested working width may be adopted at minimum for TL-1, TL-2 and TL-3 barrier systems.

**V6.3.15.4 System width**

System width is the front to back dimension of the road safety barrier including the supporting posts. The system width may vary before, during and after an impact due to barrier deformation (e.g. bending posts).

Wire rope, w-beam and thrie-beam barrier systems will often deform and embed within the vehicle resulting in an effectively zero system width during impact. Rigid and temporary barrier systems will often retain their shape during the impact and slide laterally along the ground surface. System width should be considered when it will interact with the environment. Refer Figure ##

**V6.3.15.5 Hazard type**

The type of hazard being shielded will also influence the composition of working width. Where the hazard protrudes above ground (e.g. pole or tree), the vehicle roll allowance (section 6.3.15.3) is critical and must be used. Where the hazard is low enough that it does not interfere with the vehicle roll allowance (e.g. batter), the system width may be used in priority of the roll allowance. Deflection must always be used. Figure V6.7 shows a typical working width composition for a TL-4 product and the application for an above and below ground hazard.
V6.3.15.5  Constrained locations

Constrained locations, often brownfield, have roadside elements that are impractical or unfeasible to remove, relocate or modify.

Local stiffening

In constrained locations, where standard working width cannot be accommodated, it may be possible to locally stiffen some barrier products (not all) with additional posts or anchors. This may alter the performance values and should be used sparingly if the variant has been tested and/or accepted. Where the post spacing is reduced along the length of an installation to meet the offset requirements, the following must be met:

Where the hazard is at least 10m long, the reduced post spacing must apply for the full length of the hazard plus a minimum of 10m either side of the hazard.

For hazards less than 10m long, the minimum length of reduced spacing required is 30m, with 10m past the hazard.

Designers should refer to VicRoads Detail Sheets (VicRoads 2019) and contact product suppliers for guidance.

Extended design domain

If the designer has systematically considered all barrier configurations/designs (e.g. barrier offset, type, variant, etc) and cannot practically provide the required working width values, a risk assessment must be undertaken to evaluate the risk/benefit of installing a barrier. Often, the installation of safety barrier will still provide an overall benefit, especially if the probable impact conditions are less than the tested conditions or if the risk exposure is limited to a short section.
In this case, working width is considered within the extended design domain (EDD) and designers need to make informed decisions. In general, the use of EDD working width values (including each sub-component) should, in preferential order, be based on Figure V6.8.

EDD design reports may also demonstrate that the impact conditions expected on-site are less severe than the crash tested conditions. Including, but not limited to a:

- small future vehicle fleet mix,
- reduced operating speed,
- lesser likely impact angle, and
- input from product supplier.

**Working width on fill batters**
The desirable verge width required between barrier and batter hinge point is the full width of dynamic deflection and system width.

Where a barrier system has been successfully crash tested with the barrier located on or near the batter, a comparable installation may be considered. The following conditions must be met before adopting this barrier configuration/design:

- Batter slope no steeper than the crash tested slope.
- Barrier offset to batter hinge point no less than the crash tested offset.
- Adequate support width available for post foundations (refer Section 6.3.6), confirmed by side load testing.
- Pavement/verge crossfall being similar to the crash tested system.
- Barrier height equivalent to the crash tested configuration.

Where a barrier system has NOT been successfully crash tested with the barrier located near the batter, the designer must systematically consider all barrier configurations/designs. The recommended order of precedence for reducing verge widths to fill batters is as follows. All design decisions must be documented.

1. Provide a 10:1 traversable surface behind the barrier equal to deflection,
2. Provide a 6:1 traversable surface behind the barrier equal to deflection,
3. Consider a reduced post spacing to lower deflection, note an increase in barrier severity,
4. Consider an alternate barrier type to suit available offset; consider the change in barrier severity & performance,
5. If WRSB, deflection may overhang the batter in accordance with RDN 06-02 (*VicRoads 2016*). Batter overhang is considered within the Extended Design Domain.
6. Alternative barrier type required.
6.3.15.6 Working Width for Wire Rope Safety Barriers (WRSB)

During an impact, the working width for WRSB will depend on several factors including the:

- post spacing,
- length of barrier between anchors,
- curvature of barrier,
- wire rope tension,
- ambient temperature, and
- maximum rope height and range.

WRSBs are tested in a single configuration where the above factors are set. For design versatility, VicRoads adopts a harmonised working width for all WRSB products in accordance with this section. WRSB working width must be determined in accordance with the following formula:

\[
W_{\text{max}} = W_{\text{std}} \times F_l \times F_c,
\]

where:
- \(W_{\text{max}}\) = Maximum working width (m)
- \(W_{\text{std}}\) = Standard working width for the nominated TL and post spacing (Table V6.8)
- \(F_l\) = Barrier (rope) length correction factor (Table V6.9)
- \(F_c\) = Barrier curvature correction factor (Table V6.10)

Table V6.8 provides the standard working width (Wstd) values for TL-3 and TL-4 performance, at two standardised post spacings. Using the guidance in Sections 6.3.15.1 to 6.3.15.4, the selection of either TL-3 or TL-4 should be based on the minimum containment level needed and/or the type of hazard being shielded (above or below ground). 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.

Table V6.8: Standard working width values for WRSB

<table>
<thead>
<tr>
<th>Post spacing:</th>
<th>2.0 m</th>
<th>3.0 m</th>
</tr>
</thead>
<tbody>
<tr>
<td>TL-4 Working Width: Deflection + roll allowance</td>
<td>1.9 m</td>
<td>2.3 m</td>
</tr>
<tr>
<td>TL-3 Working Width: Deflection only</td>
<td>1.5 m</td>
<td>1.8 m</td>
</tr>
</tbody>
</table>

Table V6.9: WRSB length correction factor (Fl)

<table>
<thead>
<tr>
<th>Rope length (m)(^1)</th>
<th>Correction factor Fl</th>
</tr>
</thead>
<tbody>
<tr>
<td>0 - 250</td>
<td>1.0</td>
</tr>
<tr>
<td>251 - 350</td>
<td>1.1</td>
</tr>
<tr>
<td>351 – 500</td>
<td>1.15</td>
</tr>
<tr>
<td>&gt; 500(^2)</td>
<td>1.2</td>
</tr>
</tbody>
</table>

Notes:
1. Rope length is the total length of wire rope between anchor connections. (i.e. including terminals).
2. Deflection will continually increase as the wire rope length increases.

Table V6.10: WRSB curvature correction factor (Fc)

<table>
<thead>
<tr>
<th>Barrier radius (m)</th>
<th>Correction Factor Fc</th>
</tr>
</thead>
<tbody>
<tr>
<td>200 - 400</td>
<td>1.5</td>
</tr>
<tr>
<td>401 - 500</td>
<td>1.4</td>
</tr>
<tr>
<td>501 - 600</td>
<td>1.3</td>
</tr>
<tr>
<td>601 - 800</td>
<td>1.2</td>
</tr>
<tr>
<td>801 - 1500</td>
<td>1.1</td>
</tr>
<tr>
<td>&gt; 1500</td>
<td>1.0</td>
</tr>
</tbody>
</table>

Notes:
1. Where the barrier alignment is straight, \(F_c = 1.0\).
2. Where the barrier is on the outside of curve (concave side), \(F_c = 1.0\).

---

\(^1\)Rope length is the total length of wire rope between anchor connections. (i.e. including terminals).

\(^2\)Deflection will continually increase as the wire rope length increases.
6.3.16 Step B8 – Determine Vehicle Roll Allowance and System Width
Refer to Section 6.3.15 above.

6.3.17 Step B9 – Determine the Working Width
Refer to Section 6.3.15 above.

6.3.19 Step B11 – Determine the Barrier Points of Need
Substitute/Additional Information
The Run-Out Length Method shall be used to determine barrier points of need in Victoria. Table 6.9 (below) to be used.

<table>
<thead>
<tr>
<th>Operating Speed (km/h)</th>
<th>Run-out length (Lr) for AADT range (m)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>&gt; 10,000</td>
</tr>
<tr>
<td>110</td>
<td>110</td>
</tr>
<tr>
<td>100</td>
<td>91</td>
</tr>
<tr>
<td>90</td>
<td>81*</td>
</tr>
<tr>
<td>80</td>
<td>70</td>
</tr>
<tr>
<td>70</td>
<td>60*</td>
</tr>
<tr>
<td>60</td>
<td>49</td>
</tr>
<tr>
<td>50</td>
<td>34</td>
</tr>
</tbody>
</table>

*Interpolated

Continuous barrier length of need
Where continuous safety barrier is being adopted, the commencement of barrier lengths should not be determined in accordance with the traditional Length of Need (LON) approach. Safety barrier lengths should commence at the earliest possible location and extend as far as practical. At each barrier terminal, the run-out length method can be used to determine the area of exposed hazards beyond the barrier that may be impacted by errant vehicles. As such, the following solutions should be considered:

- Removal of hazards that are not adequately shielded by the barrier,
- Relocate hazards to ensure they are adequately shielded by barrier,
- Relocate hazards beyond the clear zone,
- For single hazards that may not be practical to remove or relocate, such as power poles, consider additional safety treatments such as RAPTOR Cushions1,
- Provision of the run-out area for vehicles that may impact the gating terminal
- Ensure that the preceding safety barrier has a straight alignment and the succeeding safety barrier is flared as much as feasible. This will reduce the likelihood of an errant vehicle entering the roadside environment.
6.3.20 Step B12 – Check that the Minimum Length of Barrier is Provided

Additional Information

To perform satisfactorily, barrier systems must have sufficient length to enable the strength to be developed through the system and into the posts as impact occurs.

MASH requires the minimum tested barrier length to be at least three times the length in which deformation is predicted, but not less than 30m for steel beam systems and 180m for WRSBs. Tested lengths are published in VicRoads Detail Sheets for each product.

While shorter lengths than the tested length are possible, the designer must consider how this will affect other performance values (e.g. deflection). Designers should consult with the product supplier or mitigate the risk through additional controls such as reducing the posted speed.

In general, an alternate barrier type should be considered when shorter than the following:

- Flexible: 60m (excluding terminals)
- Semi-rigid: 30m
- Rigid: based on the installation method.

Unanchored barrier systems (free-standing temporary) must develop sufficient mass for the barrier to perform and deflect as intended. Impacts within the development length may cause the barrier to deflect further than specified, hence an anchored system or a system with shorter leading development length are preferred in constrained locations.

![Figure V6.9: Typical terminal configurations](image-url)
Where the leading development length cannot be achieved before the hazard/work zone, designers should consult with the product supplier and mitigate the risk through additional controls such as reducing the posted speed.

**Maximum barrier length**

While most barrier systems don’t have a maximum physical length, the maximum installation length in Victoria depends on the effects to barrier performance and the ability for the system to be maintained and repaired.

If WRSB is hit, particularly at the end anchor, the ability of the barrier to resist subsequent impacts before the barrier is repaired is uncertain. To reduce the risk of long lengths of WRSB being disabled by a single vehicle impact, a maximum WRSB length of 1 km should generally be adopted. A new length should commence thereafter via an overlap of PON between the separate lengths.

While the decision to use WRSB lengths longer than 1km is not prohibited, designers must first consider the effects on barrier performance (i.e. increased deflection) and the risk of secondary impacts. Where the majority of risks can be managed, a WRSB length of up to 2km is possible, especially where the number of terminals can be minimised.

Guard fence systems do not have a maximum length, given that barrier performance is unchanged and impact damage is localised.

**6.3.21 Step B13 – Check Sight Distance**

**Additional Information**

All barriers shall be considered non-permeable to the highest point on the barrier (e.g. top of post or W-beam) for the purposes of assessing sight distance.

In vicinity of side roads and private property access points, safety barrier should be installed and / or flared to a minimum offset of 3.0m from traffic lane to reduce impact on sight lines for vehicles exiting from the side road or property access. Where this is not possible, individual risk assessments are recommended.

In cases where sight distance is already sub-standard and the installation of a roadside barrier is likely to reduce sight lines below what is currently available, consideration to relocate the access road must be the priority, before accepting that a lower level of protection is the most cost-effective solution.

The potential for safety barriers to impact sight lines on horizontal curves must be considered in accordance with the relevant Austroads and VicRoads guidelines. When sight lines on the inside of horizontal curves are below substandard, a barrier system that reduces deflection and maximises offset to the traffic lane should be considered.

**6.3.22 Step B14 – Choose Terminal Treatments**

**Additional Information**

Refer to *RDN 06-04 (VicRoads 2019)* for accepted terminal systems and the relevant product manual for alternative terminal treatments. Where rigid barriers need to be terminated (e.g. at bridge end posts), it is normal to transition the stiffness of the barrier system to a semi-rigid barrier, e.g. SD4081.

Where an end treatment is designed to allow an impacting vehicle to pass through the terminal, i.e. a gating terminal, an appropriately graded run-out area free of hazards is required behind the barrier. Refer to *Standard Drawings SD 3571 and SD 3573* for details.
Where the minimum run out area as specified in SD 3571 is not achievable, consideration in order of precedence shall be given to:

1. Extending the barrier upstream of the proposed location to achieve the minimum run out area in accordance with SD 3571
2. Providing the maximum achievable run out area given existing site constraints also supported with a documented risk evaluation, or
3. The area should at least be similar in character to the adjacent unshielded roadside area, supported with a documented risk evaluation.

Where the rigid barrier is to be terminated in a constrained location and the appropriate lengths of barrier transition cannot be accommodated, the barrier shall be protected by a crash cushion. Refer to RDN 06-04 for accepted safety barrier products (VicRoads 2019) and the associated product manual for system details. Bridge Technical Note 2009/002 provides additional guidance for the design of bridge approach barriers.

6.3.23 Step B15 – Design the Transitions between Barriers

Additional Information

When connecting barrier types, it is important to provide an appropriate transition in barrier stiffness between different barrier types, as described in the Austroads Guide to Road Design, to ensure that the barrier in the overall system with greater stiffness does not become a hazard for errant vehicles.

Accepted transitions for specific situations are provided in the Standard Drawings referred to in Section 4.8 of this Supplement or Product Specific Detail Sheets. Transitions detailed within product manuals may be considered but have not been approved by VicRoads.

Transitions that are not approved are treated as design exception requiring VicRoads approval. Transitions between bridge barriers and road barriers should be designed in accordance with SD 4081, SD 4082 and SD 4084.

6.4 General Access through Road Safety barriers

Additional Information

V6.4.1 General

In general, breaks in a road safety barrier are not desirable and do not provide protection for road users at those locations.

High speed roads should avoid barrier breaks due to this risk except for the following requirements.

V6.4.2 Emergency Services Operation and Access

The roadside can be critical to the operational activity 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). The Occupational Health & Safety implications of the 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 VicRoads guidelines and CFA Position Paper:

- Total barrier lengths should not exceed 1000m.
Where multiple WRSBs are required along a stretch longer than 1000m, a separation between barriers of at least 4m should be provided to allow emergency services vehicle access.

500m lengths between access locations is desirable to prevent delays from barrier dismantling, restricted escape routes and delays from travelling around barriers.

Recognising that most emergency access locations will require a break in continuous barrier, these locations should be selected based on the following:

- locating the break on sags or straights where sight distance is greatest,
- locating the break away from diverge or merge points where RoR is highest, and
- flaring the approach terminal to maximise protection as far as practicable.

**V6.4.3 Maintenance and Service Authority Access**

Due to the nature of continuous safety barrier treatments, there are likely to be long sections of safety barrier without a break in the system. In accordance with Section 28 of the *OH&S Act 2004*, the provision of access to services, assets or for roadside maintenance activities, strategically located gaps in the safety barrier systems should be designed in consultation with and consideration of affected asset owners. These gaps should ideally be designed as overlaps between safety barrier lengths that allow for vehicle access, but still prevent errant vehicles from entering the roadside environment. Depending on the site constraints, the overlaps should be designed as follows (in order of preference):

- 90 degree PON overlap
- 25 degree PON overlap
- 10 degree PON overlap
- No overlap. Start and stop two separate barrier lengths.

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.

Roadside access gaps are designed for frequent use by mowers, tractors, etc. For cranes and excavators, i.e. infrequent plant use, the asset will be temporarily pulled down.

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

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.
6.5 Road Safety Barriers for Vulnerable Road Users

6.5.1 Motorcyclists

Additional Information

Motorcyclists are important to consider during barrier design especially in locations with high numbers of motorcyclists.

VicRoads is mindful of the ongoing challenge to address motorcyclist safety. We encourage new ideas, innovation and aim to use resources efficiently for the greatest benefit.

While the incidence of motorcyclists hitting safety barriers is a very small part of the total motorcycle accident problem, the following locations 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; a list of popular motorcycle routes in Victoria is summarised in Appendix VA.

When designing barrier systems to take into account motorcyclists, the following should be considered:

- Motorcyclist protection devices are evaluated in accordance with procedures listed within AS/NZS 3845.1:2015. This involves a dummy sliding at 60km/h at an angle of 30 degrees. To pass the testing, devices typically include an under-run rail to absorb and redirect motorcyclists away from the posts and the hazards behind the barrier.
- Before a motorcyclist hits safety barrier, they are usually separated from their motorcycle and it is usually the barrier posts which cause injury. As such, safety barriers with continuous motorcyclist protection (i.e. rub-rail) are preferred due to the potential for least injury.
- Flexible W-beam systems are preferred given the posts do not protrude above the W-beam.
- Concerns about adverse effects caused through impacts with the cables of WRSB have not been realised in practice.
- Post cushions on WRSB can provide a softer impact for errant motorcyclists at low speeds only. Effectiveness at higher speeds has not been proven.
- Barriers and their terminals need to have surfaces (sides, tops and under barrier areas) as smooth as possible. Protrusions, added devices or entrapment areas should be avoided or covered. Systems which provide an unbroken surface are preferred where motorcycle impacts are likely.
- Driveable pavement or shoulder surface should be extended up to the barrier.
- The benefit of shrub planting in front of barriers to ‘cushion’ motorcyclist impacts is unknown, although it may have some effect.
- The following table (Table V6.1) outlines additional good practice for consideration of motorcyclists.
### Table V6.1: Good Practice needs for Motorcyclists and Road Users

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<thead>
<tr>
<th>Good Practice</th>
<th>Mandatory Motorcyclist Intervention</th>
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<tbody>
<tr>
<td><strong>Barrier System</strong></td>
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</tr>
<tr>
<td>W-beam barriers (Flexible and semirigid systems)</td>
<td>Delineator brackets need to be frangible, not sharp in case motorcyclist slides along the top. Flexible GF systems; top of post must be mounted below top of w-beam. G.R.E.A.Ts require plastic motorcyclist covers to shield sharp edges and protrusions.</td>
</tr>
<tr>
<td>Concrete barrier systems</td>
<td>Ensure that the surface is smooth and free of obstructions and indentations.</td>
</tr>
<tr>
<td>Wire rope barriers</td>
<td></td>
</tr>
<tr>
<td>Repairs after impact</td>
<td>Repair of the whole system needs to be carried out promptly.</td>
</tr>
<tr>
<td>Kerbing near barriers</td>
<td>Use mountable kerb types where possible.</td>
</tr>
</tbody>
</table>

**Motorcyclist references**


### 6.6 Aesthetic Road Safety Barriers

#### Additional Information

**V6.6.1 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 a critical consideration.

At high speeds, the landscape’s large scale is what typically attracts the motorist’s attention and a landscape that is characterised as being untouched, unspoiled, or original usually evokes a positive reaction, while if a landscape is changed, it could be said that the values have been lost.
Drivers are stimulated by variation but dulled by monotony, therefore it can be important to avoid the use of unnatural roadside variation, such as changing barrier types and offsets regularly 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 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; and
- 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 would be to vary the barrier type no more than once every 5km (i.e. 3 minutes of travel), but this is not mandatory.

### V6.6.2 Aesthetic Barriers

Aesthetic barriers might be considered in parks, historic communities, scenic areas or private road developments. If a road asset owner is considering the use of such barriers, it is recommended that the responsible road authority undertakes a site-specific risk assessment considering crash test performance, availability of terminals and whole-of-life costs of the system, to make an informed engineering decision. As a minimum, it is recommended that such barriers be crash tested against recognised crash test criteria such as in 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, VicRoads has not assessed or accepted for use any Aesthetic Road Safety Barriers for use outside the declared road network. Refer RDN 06-04 – Accepted Safety Barrier Products (VicRoads 2019) for further information.

### 6.7 Other Road Safety Barrier Design Considerations

#### 6.7.1 Barriers at Intersections and Driveways

**Additional Information**

Where it has already been determined that a road safety barrier is warranted and the hazard cannot be removed, when there is a conflict that prevents the proper placement of road safety barrier, the following can be considered:

Preferentially, remove the conflict. For an intersection or driveway, this may involve:

- Closing the intersection or driveway
- Relocating the intersection or driveway
- Curving the barrier to shield the hazard. This treatment should be considered as a last resort option.

Refer to VicRoads Standard Drawings (VicRoads 2019) referred to in Section 4.7 of this Supplement for examples of barrier treatments on tight curves.

**Short radius curved terminals**

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 VicRoads accepted arrangement of a short radius curve terminal treatment, refer VicRoads Standard Drawing SD 4092 (VicRoads 2019).

VicRoads recommends the use of short radius curves on 70km/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 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 is considered a better alternative than providing no treatment and less severe for the occupants than, for example, that of 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 could be achieved with an extended barrier and flared crash tested terminal without the concerns from a high-speed impact.

**V6.7.10 Sub-Standard Curves**

Additional Information

Installation of safety barriers on either or both sides of the road shall be considered where a curve has a safe operating speed 10 km/h or more below the 85th percentile approach speed, and there are potential hazards on the roadside.

**V6.7.11 Curves on Steep Downgrades**

Additional Information

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.

**V6.7.12 Provision of Paving Adjacent to Traffic Barriers**

Additional Information

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 traffic lane and barrier, or between 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 VicRoads 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 2.5m or less should be paved.

**V6.7.13 Audio Tactile Line Marking**

Additional Information

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.

**V6.7.14 Provision for Stopping**

Additional Information

Roadside stopping is expected and therefore must be considered where long lengths of continuous safety barriers are installed so that drivers can safely pull off the road in the event of an emergency, such as a broken-down vehicle. Where the road has 2 lanes or less in each direction, provision for stopping can be managed entirely within the LHS roadside. Where the road has three or more lanes in each direction, it is preferable to have provision for stopping on both sides of the carriageway to limit the number of lanes a vehicle may have to cross in the event of breakdowns.

In the case of non-discretionary stopping (e.g. urgent / emergency stopping), continuous safety barriers should be offset 3m or greater from the edge line so that occupants are able to open the doors of a passenger vehicle clear of the traffic lane. See Section 6.3. Where continuous safety barrier is installed at an offset less than 3m from edge line, stopping should be discouraged by limiting the length of reduced offset and by providing advice to drivers on alternative opportunities.

In the case of elective/discretionary stopping (e.g. the driver has an element of choice and will stop at a location which is perceived as safe), it is desirable that stopping opportunities are available off the main carriageway where the speed environment is low. Where existing off-road opportunities are not available, it is recommended that Emergency Stopping Bays (ESBs) are provided at least every 1km-4km to give drivers additional space to stop further from the traffic lane.

The preferred layout of an ESB should be in accordance with RDN 06-02 Appendix E, which includes a desirable offset of 5m-6m from edge line and length of 55m. No additional sealing is required and ESBs should have advanced signing where appropriate to advise drivers. The precise frequency and locations of ESBs should be determined with consideration of minimising the cost of earthworks required, providing adequate sightlines, and targeting high risk stopping sections, such as steep grades and reduced barrier offsets.

Provision for heavy vehicle stopping should also be considered where the CV 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.
7. **Design for Steep Downgrades**
VicRoads has no supplementary comments for this section.

8. **Work zone safety barrier systems**
Work zone temporary safety barrier systems accepted for use in Victoria are contained in *RDN 06-04 Accepted Safety Barrier Products* (VicRoads 2019). Refer *RDN 06-12 Worksite Safety Barrier Screens* (VicRoads 2018) for guidance on the requirements for the provision of screens on barriers.

9. **Appendices**

   **Appendix B – Hazard Mitigation Worksheet**
   The Hazard Mitigation Worksheet is not generally used in Victoria. Consideration may be given to use this process as part of a risk assessment.

   **Appendix C – RTA Method**
   The RTA Method is not to be used in Victoria.

   **Appendix G – RISC Method and Process**
   The RISC Method and Process is not to be used in Victoria.

   **Appendix I – Examples of Length of Need Calculations**
   The Run Out Length Method shall be used to determine barrier points of need in Victoria. This method has been used to determine length of need shown on *VicRoads Standard Drawings for Roadworks SD3511 and SD3521*.

   **Appendix J – Types of Safety Barrier Terminals**
   Further information can be obtained from *VicRoads Road Design Notes* available on the VicRoads website.

   **Appendix K – Transitions between Barrier Types**
   Figure K1 is not an acceptable transition arrangement in Victoria.

   Further information can be obtained from *VicRoads Standard Drawings for Roadworks* which are available on the VicRoads website.

   **Appendix L – Barriers at Intersections**
   Further information can be obtained from *VicRoads Standard Drawings for Roadworks* which are available on the VicRoads website.

10. **Commentaries**

   **Commentary 12.1 – Constrained Locations**
   Refer to *VicRoads Supplement to AGRD Part 2 regarding the use of Extended Design Domain criteria* (VicRoads 2012).

   Extended Design Domain criteria can only be used with the specific written approval from VicRoads.
Commentary 14 – Breaks in Barrier Systems
Further information can be obtained from VicRoads Standard Drawings (VicRoads 2018) which are available on the VicRoads website.

APPENDIX VA: Popular Motorcycle Routes in Victoria
The routes listed below have been identified as roads favoured by motorcyclists.

Eastern

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<th>Municipality</th>
<th>Route</th>
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<th>Road No</th>
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**Northern**

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