NOTE:
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 the VicRoads website or other external source.
# VicRoads Supplement to the Austroads Guide to Road Design

## Updates Record

### Part 4C – Interchanges

<table>
<thead>
<tr>
<th>Rev. No. Date Released</th>
<th>Section/s Update</th>
<th>Description of Revision</th>
<th>Authorised By</th>
</tr>
</thead>
<tbody>
<tr>
<td>Rev. 1.0 July 2010</td>
<td>First Edition</td>
<td>Development of Supplement</td>
<td>ED – Network &amp; Asset Planning</td>
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<tr>
<td>Rev. 1.1 Sept 2010</td>
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<td>Minor changes to text, references and layouts.</td>
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<tr>
<td>Rev. 2.0 July 2011</td>
<td>Section 10.2.2</td>
<td>Rural left turn treatment</td>
<td></td>
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The VicRoads Supplement to the Austroads Guide to Road Design provides additional, clarification or jurisdiction specific design information and procedures which may be used on works financed wholly or in part by funds from VicRoads beyond that outlined in the Austroads Guide to Road Design guides.

Although this publication is believed to be correct at the time of printing, VicRoads does not accept responsibility for any consequences arising from the information contained in it. People using the information should apply, and rely upon, their own skill and judgement to the particular issue which they are considering. The procedures set out will be amended from time to time as found necessary.
References

AGRD – Austroads Guide to Road Design
AGTM – Austroads Guide to Traffic Management
GTEP – Guide to Traffic Engineering Practice (superseded)
SD – Standard Drawings for Roadworks
VRD/RDG – VicRoads Road Design Guidelines (superseded)


AS5100 Bridge Design (Australian Bridge Design Code).


1.0 Introduction

1.1 Purpose

VicRoads has no supplementary comments for this section.

1.2 Scope of this Part

Additional Information

As the Austroads Guide to Road Design (AGRD) Part 4C does not cover planning and traffic management consideration associated with interchange design, Appendix VA of the Supplement has been included to provide some additional planning and design consideration guidance in a single location.

1.3 Road Safety

VicRoads has no supplementary comments for this section.

1.4 Road Design Objectives

VicRoads has no supplementary comments for this section.

1.5 Traffic Management at Interchanges

VicRoads has no supplementary comments for this section.

1.6 Safety Performance at Interchanges

VicRoads has no supplementary comments for this section.

1.7 Traffic Capacity at Interchanges

Additional Information

For additional guidance on Levels of Service for Victoria, refer to Appendix VB for additional information to supplement the Austroads Guide to Traffic Management (AGTM) – Part 6: Intersections, Interchanges and Crossing, Section 6.8.4 – Levels of Service.

1.8 Staged Development of Interchanges

Additional Information

Freeways

When full funding for a route is not immediately available, freeway carriageways may be staged in several ways:

(a) by constructing progressively lengths of a new route between points on an existing road;

(b) by constructing earthworks for a new rural route but only opening one carriageway as a two-lane two way road;

(c) by constructing progressively a new carriageway and frontage roads beside an existing route to convert it to freeway conditions.

Considerable economies can be made during development of rural routes while still meeting road safety objectives by deferring construction of overpass structures and frontage roads, that is, by creating expressway conditions initially.

1.8.1 Staging Interchange Development

Additional Information

Interchanges

Stage development of interchanges requires careful consideration. In rural areas, wide median treatments may be substituted for overpasses or interchanges provided that the cross road volume is very low and safe intersection sight distance is available, see Appendix VA, Section 2.0 – Warrants.

It may be possible to provide minimum widths of carriageways to suit the initial traffic volumes, and to widen or duplicate as necessary in the future. In some cases, ramps with very low predicted volumes may be omitted. However, if any movement is provided, the ramp for the return movement at the same site also should be provided.

If a freeway is terminated initially at a proposed cross road interchange, it is generally desirable to use the ultimate ramp alignments for the interim intersection treatment to facilitate the later construction.

In urban areas, when converting existing intersections to interchanges, considerable thought must be given to the traffic management required during conversion to the new configuration. Each step should be documented by a drawing and a description of the construction progress relevant to the step/stage and the locations of the traffic movements during staging.

Structures

Refer also to AGRD Part 4C, Section 4 – Structures.

Structures are expensive to construct, but they are even more expensive to lengthen or widen. Where structures are provided over carriageways, it usually facilitates future development to construct the full length of the structure initially. Where dual carriageways are planned to cross the freeway, economies may be made by using
one structure and deferring provision of a
duplicate structure or by building both
structures part width with provision to
facilitate future widening.

An ultimate cross section should be
determined for the structure to ensure that it
can be logically developed over time from any
interim treatments which are considered
appropriate. Where the ultimate development
consists of a single structure, stage
construction may be uneconomical unless
provisions are made in the original design for
the future widening.

2.0 Design Considerations

Process and Principles

2.1 General
VicRoads has no supplementary comments for
this section.

2.2 Design Considerations

2.2.3 Design Considerations Process and
Principles – Stormwater Drainage

Additional Information
Refer to VicRoads Supplement to AGRD Part 5
– Drainage Design and VicRoads Road Design

2.2.5 Public Transport - General

Additional Information
Refer to VicRoads Traffic Engineering Manual
(TEM) and VicRoads Road Based Public
Transport Resource Kit available on VicRoads
website.

2.3 Design Process

2.3.3 Preliminary Design

Additional Information
The choice of interchange types and designs
of interchanges and ramp layouts should
avoid unnecessary complexity.

2.4 Principles

2.4.1 Interchange Elements

Additional Information
In reference to target levels of service, refer
to Appendix VB.

2.4.2 Interchange Uniformity and Spacing –
Spacing

Additional Information
In reference to Sign Requirements that
influence interchange spacing, Refer to
VicRoads TEM Volume 2, Chapter 12.

3.0 Forms of Interchange

3.1 Traffic Considerations

Substitute Figure Reference(s)

For reference AGRD Part 4C, Figure 11.4,
refer to Section 11.1, Figure V11.11 of this
Supplement.

For reference AGRD Part 4C, Figure 11.8,
refer to Section 11.1, Figure V11.12 of this
Supplement.

Additional Information

When considering the interchange form, the
following principles should be applied: (Refer
also to AGTM Part 6, Section 6.3 – Route
Considerations.)

(a) drivers should be able to follow a signed
route along a directional path with a
minimum number of lane changes;

(b) especially where interchanges are closely
spaced, there should be uniformity of
exit and entrance patterns;

(c) it is preferable to place a single exit in
advance of the grade separation
structure;

(d) weaving on the freeway should be
eliminated where possible or placed on
collector-distributor roads;

(e) the layout should allow for adequate
spacing of signs;

(f) every exit from or entrance to the
freeway, should have a corresponding
opposing movement from the arterial
road or local road at the same
interchange;

(g) exit loops from the freeway should be
avoided where possible (for example,
the Parclo B);

(h) the achievable interchange form may be
constrained by the available right of
way.

3.2 Other Considerations

3.2.1 General

Additional Information
Refer also to AGTM Part 6, Section 6.5.5 –
Interchange selection factors.

The factors which should be analysed to
evaluate alternatives include:

• Traffic volumes and characteristics
• Existing and future road networks
• Adjacent development
• Accident rates
• Compatibility of the topography of the site
• Total ramp lengths
• Environmental factors
• Staging requirements and potential
• Costs of implementation and maintenance.

The various options are compared to select the most suitable layout with respect to:
• design features
• volume/capacity ratios
• levels of service
• optimal total travel distances
• minimum delay
• impact on adjacent development
• adaptability to possible changes and
• estimated costs - construction costs, maintenance costs, road user costs and accident costs - direct and consequential.

4.0 Structures

4.1 General

Additional Information

At-grade intersections always have a potential for accidents due to conflicting crossing and turning vehicular movements, regardless of layout, signing and signalization. By separating the levels of intersecting roadways, both accidents and delays can be reduced. However, the structure itself can present a hazard, which can be reduced by providing adequate clearances and safety barriers at bridge abutments and piers.

General considerations regarding bridge structures are set out in AGRD Part 3, Section 10.

The structure should be designed so that it fits the environment functionally and aesthetically. The cross-section shall provide for all applicable motor vehicle and road user movements and include bicycle and shared footways where appropriate.

Structures should have liberal lateral and vertical clearances to carriageways at each level, see also AGRD Part 3, Section 8.2 and VicRoads Supplement to AGRD Part 3.

Bridges with long spans, splays or complex curvature are difficult and costly to design and construct. Where possible, interchange geometry should be arranged so that entrances and exits of ramps and loops are not to be placed under or on structures. These factors should be considered at all phases through planning to detailed design.

Sight Distance

Refer also to AGRD Part 4C, Section 7.1 – Sight Distance: General.

Provision of adequate vertical and horizontal sight distance at interchange structures is essential for road safety.

Sight distance at ramp terminals sometimes is restricted by bridge barriers or guardrail extension or bridge footways with high kerbs. Tapering or flaring the ends of the structure may improve the available sight distance. At a closed diamond, provision of a footway may be advantageous, as the bridge rail is set back further from the traffic lane.

At closed diamond interchanges where concrete barriers extend from the local road overpass structure to the ramp terminals, particular care is required. At suburban interchanges a minimum of V60 SISD should be available for a minimum setback from the edge of through lane to account for signal failure. At rural interchanges available SISD should be equivalent to the operating speed of the crossroad. Although sight distance standards can be met, at rural interchanges approaching drivers on the ramps are placed in some uncertainty, as crossroad traffic is hidden from view until reaching the ramp terminal. The problem is often exacerbated if there is no raised median on the crossroad or left turn traffic island at the ramp terminal, with drivers having difficulty positioning their vehicle due to uncertainty regarding the bounds of the intersection. In these circumstances, at unsignalised ramp terminals, a left turn island should be provided as positive guidance to approaching traffic. Priority to intersection pavement, markings and signing is required.

Sight distance for merging manoeuvres or loop exits can be obstructed by bridge piers or abutments. Spill-through abutments may be better than fully retained abutments in respect of available sight distance. A widened verge may have to be placed in front of retaining walls on curved alignments, to ensure that appropriate horizontal sight distance is available.

Bridge Geometry

Factors to be considered in setting bridge alignments are:
Bridge Alignment
Bridge Cross Sections
Bridge Approaches
Structural Depths
Structural Clearance
Structural Design
Safety Barriers on Bridge Approaches

Bridges with long spans, splays or complex curvature are difficult and costly to design and to construct. These factors should be considered at all phases through planning to detailed design.

Where possible, interchange geometry should be arranged so that entrances and exits of ramps and loops are not placed under or on structures.

4.2 Form of Structure
VicRoads has no supplementary comments for this section.

4.3 Cross-sections on Bridges

Additional Information
The Australian Bridge Design Code allows for reduction of shoulder widths on bridges longer than 75 metres. However, special consideration should be given to the cross section of bridges longer than 300 metres, usually those associated with semi-direct connections or ramps. The appropriate cross section standards should be based on traffic safety and operation with due attention to economy.

Operational factors would include:

- Proportion of commercial vehicles >10 per cent and longitudinal gradient >3 per cent;
- frequency of breakdowns - allow one per 40,000 veh.km;
- whether access for emergency services and maintenance is required - 3.0 metres shoulder width is required in this case;
- possible increase in accident rates due to reduction of shoulder widths;
- whether provision of emergency telephones along the structure is required - 3.0 metres shoulder width is required in this case;
- provision of pedestrian refuge if applicable.

4.4 Pedestrian/Cyclist Grade Separations

4.4.2 Safety Barriers at Pedestrian Bridges

Additional Information
Refer to VicRoads Supplement for AGRD Part 6, Section 6 and Road Design Note (RDN) 06-07: Performance Safety Barrier Treatments at Bridge Approaches regarding protection of central piers for pedestrian overpasses.

4.5 Culverts

Additional Information
Refer to VicRoads Supplement to AGRD Part 5 and VicRoads RDG Part 7.

4.6 Retaining Walls
VicRoads has no supplementary comments for this section.

4.7 Wildlife Crossings
VicRoads has no supplementary comments for this section.

4.8 Services on Structures
VicRoads has no supplementary comments for this section.

5.0 Cross-Section

5.1 Major Road and Minor Road
VicRoads has no supplementary comments for this section.

5.2 Ramp Cross-section

5.2.1 Number of Lanes on Ramps

Additional Information
Guidelines for the number of lanes to be provided on ramps are shown in Table V5.1. This table summarises ramp length considerations and the information shown in AGTM Part 6, Section 6.6.3 – Lane Numbers.
Table V5.1: Warrants for Lanes on Ramps (from RDG Table 5.3.6.1)

| Single Lane Ramp | DHV < 1000 pcu/h and L < 300 m |
| Single Lane Loop | DHV < 900 pcu/h and indirect connection acceptable |
| Single Lane at Nose, Two Lanes on Ramp | 1000 < DHV < 1800 pcu/h OR L > 300 m |
| Two Lane Ramp | DHV > 1800 pcu/h |

*DHV = Design Hourly Volume  
cpu = passenger car units

Exit Ramps

Substitute Information

Single-lane (at the nose) exit ramps should be widened to two lanes on the ramp when the ramp is longer the 300m. Refer also to VicRoads Supplement Table V5.1.

The transition to two lanes from one lane after the nose should be implemented as shown in Figures V11.2 and V11.3.

Substitute Figure Reference(s)

With reference to AGRD Part 4C, Figure 11.1 refer to Figure V11.1 of this Supplement.

With reference AGRD Part 4C, Figure 11.2 refer to Figures V11.2 and V11.3 of this Supplement.

With reference AGRD Part 4C, Figure 11.3 refer to Figure V11.4 of this Supplement.

With reference AGRD Part 4C, Figure 11.4 refer also to Figure V11.4 ((a)-(c)) and Figure V11.12 of this Supplement.

Entry Ramps

Substitute Information

Single-lane (at the nose) entry ramps should be widened to two lanes on the ramp when the ramp is longer the 300m, irrespective of grade and truck acceleration. Refer also to Table V5.1 of this Supplement.

Substitute Figure Reference(s)

With reference AGRD Part 4C, Figure 11.6 refer to Figure V11.6 of this Supplement.

With reference AGRD Part 4C, Figure 11.7(a) refer to Figure V11.6 of this Supplement.

With reference AGRD Part 4C, Figure 11.7(b) refer to Figure V11.9 or V11.10 of this Supplement.

For reference AGRD Part 4C, Figure 11.7(c) refer to Figure V11.7 or V11.8 of this Supplement.

Additional Information

At a ramp to ramp merge it is necessary to install a full width left hand shoulder beyond the end of the merge taper to provide a recovery area for a vehicle that may have failed to merge. The full width shoulder should extend sufficiently far enough for an errant vehicle to safely come to a halt clear of the ramp traffic.

5.2.2 Ramp Lane Widths

Substitute Information

Pavement and shoulder widths for ramps are given in Figures V11.1 to V11.10 of this Supplement.

It is not practice in Victoria to provide shoulders with differing colour and/or texture from the ramp pavement.

Substitute Table/Figure Reference(s)

In reference to AGRD Part 4C, Table 5.1 refer to Table V5.2 and Figures V11.1 to V11.10 of this Supplement.

Table V5.2: Shoulders on Freeway Ramps (from RDG Table 3.6.2.5)

<table>
<thead>
<tr>
<th>Number Of Lanes (One Way)</th>
<th>Left Shoulder (m)</th>
<th>Right Shoulder (m)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Single</td>
<td>3.0</td>
<td>1.0</td>
</tr>
<tr>
<td>Two ADT&lt;2000</td>
<td>3.0</td>
<td>1.0</td>
</tr>
<tr>
<td>Two ADT&gt;2000</td>
<td>3.0</td>
<td>1.0</td>
</tr>
<tr>
<td>Three</td>
<td>3.0</td>
<td>3.0</td>
</tr>
</tbody>
</table>

Kerbs

Substitute Information

All entry and exit ramp noses shall be kerbed. In general, kerbs should be provided on Loop Ramps in urban areas.

Substitute information is provided by VicRoads in Section 11.1 of this Supplement outlining the requirements for kerbs on ramps.

5.3 Clearances on Major Road

VicRoads has no supplementary comments for this section.
Figure V5.1(a): Typical Freeway Ramp Cross Sections Ramps at System (Freeway to Freeway) Interchanges
(from RDG Figure 3.14.2(a))

SINGLE LANE RAMP

TWO LANE RAMP
SINGLE LANE ENTRY OR EXIT

TWO LANE RAMP
TWO LANE ENTRY OR EXIT

NOTES:
(1) KERRING ON OUTSIDE OF CURVES SHOULD BE AVOIDED.
IF KERRING IS ESSENTIAL USE ONLY FULLY MOUNTABLE KERRING.
(2) VERGE WIDTH DEPENDS ON CHANGE OF SLOPE
REFER TO TABLE 3.6.3
Figure V5.1(b): Typical Freeway Ramp Cross Sections Ramps and Loops at Service (Freeway to Surface Road) Interchanges
(from RDG Figure 3.14.2(b))

NOTES:
III VERGE WIDTH DEPENDS ON CHANGE OF SLOPE
REFER TO TABLE 3.6.4.3
6.0 Design Speed

6.1 General
VicRoads has no supplementary comments for this section.

6.2 Major Road
VicRoads has no supplementary comments for this section.

6.3 Minor Road

Clarification Information
In general, the posted speed limit shall not be modified (reduced) in order to achieve a desirable design. A design should be based on the expected operating speed through the interchange, irrespective of the posted speed.

If severe constraints on a design limit the ability to match the design speed of the road, consideration in reducing the posted speed limit shall be complemented by design features that clearly communicate the need for drivers to reduce their speed.

Substitute Information
The secondary road design speed for diamond interchanges is generally 80 km/h. This is based on the assumption that, in most cases, the signs and line markings associated with the interchange and the drivers’ view of the interchange are sufficient to reduce operating speeds to approximately 80 km/hr. 80 km/h stopping sight distance should be provided together with the required safe intersection sight distance (SISD) from the exit ramp terminal across the structure. Where high operating speeds are expected through the interchange or drivers have little warning of the presence of the interchange, designers should endeavour to achieve a design speed as high as practical taking into consideration the economic and other constraints. Refer also to comments for Section 9.2.2 and Figure V9.1 of this Supplement.

6.4 Ramps

6.4.1 Ramp Design Speed

Substitute Information

Entry Ramps
The entry ramp geometry in the vicinity of the nose should have a design speed of at least 70 km/h. The preferred design speed is 80 km/h or even higher provided that it is compatible with the economic and other constraints. The ramp geometry in the vicinity of the nose should be designed based on these speeds.

6.4.2 Other Considerations

Clarification Information
Appropriate ramp geometry should be used to reduce speeds on ramps. The use of reverse curves should be avoided where practicable.

7.0 Sight Distance

7.1 General
VicRoads has no supplementary comments for this section.

7.2 Stopping Sight Distances on the Major Road and Minor Road

Substitute Information
Refer to Section 6.3 of this Supplement for clarification of Design Speeds and associated Sight Distance requirements on the minor road.

Additional Information

Single Point Urban Intersection – Ramp Throat at Surface Road
At single point urban diamond intersections, the length and geometry of the right turn moves to the entry ramps are such that positive guidance is required to prevent turning vehicles from veering from the correct path. A driver at the stop line of the intersection should have sufficient sight distance to the pavement within the ramp throat to enable the turning manoeuvre to be made with confidence. The turning path should be defined with suitable turn lines and a raised central island should also be provided for separation and guidance.

7.3 Exit Ramp Nose

Additional Information
On the approach to an exit ramp, it is most desirable that the required sight line should lie above a sealed surface to ensure that it is not obstructed by vegetation. Alternatively, the batter surface should be at least 0.3 metres below the line of sight and clear of shrubs or other obstructions.

Sight distance to the ramp surface is desirable on ramps located on the outer side of curves, which means that the ramp crossfall should not differ significantly from the crossfall of the freeway on the approach to the nose.

The line of sight along an exit ramp preferably should be above a sealed pavement in order to ensure that visibility is not blocked by high grass or road furniture. In urban locations, in addition to meeting this
requirement, it may be necessary to provide for tail light stopping distance for trucks to the back of the 95th percentile queue. This is the same as the truck stopping sight distance with an eye height of 2.4 metres and an object height of 0.6 metre (the height of the tail light). On steep downgrades, allowance should be made for the effect of the grade on vehicle speeds and stopping distances.

Exit ramp noses on the inside of curves are less conspicuous than exit ramps on straight sections of freeway, so the limiting radii (1500 m rural, 900 m urban) should be used for ramps regardless of the direction of the curve. Refer to text preceding AGRD Part 4C, Figure 7.2.

AGRD Part 4C, Figure 7.1: Sight distance requirements at exit ramps and AGRD Part 4C, Figure 7.2: Parallel lane at an exit on right hand curves

Additional Information
Step out line marking details are referred to in Section 11.1 of this Supplement.

7.4 Entry Ramp Nose

Substitute Information
(a) Desirably the sight distance on the freeway approach to an entry ramp nose should be 300 metres. This sight distance is measured from the centre of the outside freeway lane at an eye height of 1.1 metres to an object height of 0.1 metres at the nose.

(b) In addition, 240 metres of sight distance should be available from a vehicle on the ramp 60 metres prior to the nose to driver’s eye height of 1.1 metres in an upstream vehicle in the left lane of the freeway.

AGRD Part 4C, Table 7.2: Visibility requirements at entry ramp merge and merges of major roads

Clarification Information
The criteria in the two columns with the headings “Approach to nose” and “Mutual visibility between carriageways” shall not be used. The criteria provided in Figure V7.1 shall be used. The criteria in the column with heading “Terminal visibility” may be used.

Commentary 3 is not considered to add any relevant information.

Figure V7.1: Entry Ramp Sight Distance (from RDG Figure 5.7.2.2)

7.5 Safe Intersection Sight Distances

Note: Heading should be just “Sight Distance

Additional Information
Secondary Road over the Freeway
At rural spread diamond interchanges, the vertical curve across the structure may be marginally below the ruling stopping sight distance standard in order to provide straight grades on the fills and to achieve safe intersection sight distance at ramp terminals economically, see Section 9.2.2 of this Supplement.

At urban diamond interchanges, the safe intersection sight distance (SISD) maybe restricted by bridge barriers and therefore the ramp terminals are usually signalised.

Safe Intersection Sight Distance

Clarification Information
The SISD values in AGRD Part 4A, Section 3 are to be used on interchanges in urban and rural environments. They are not to be reduced to absolute minimum. \( R_T = 1.5s \) shall not be used for interchanges.

The following clause:

“A characteristic of closed diamond interchanges is that the ramp terminals are relatively close to the bridge abutments and hence the SISD may be restricted by bridge barriers (minor road over) or the abutments (minor road under).”

…… should read as follows:

“A characteristic of closed diamond interchanges is that the ramp terminals are relatively close to the bridge abutments and hence the barrier location should be placed for the required SISD to be met where practicable.”
8.0 Horizontal Alignment

8.1 Major Road
VicRoads has no supplementary comments for this section.

8.2 Minor Road
VicRoads has no supplementary comments for this section.

8.2.1 Curvature
Additional Information
Tapers should only be used when lanes are added and, as a consequence, a visible kink in the alignment is needed to mark the presence of features such as deceleration lanes or the commencement of an additional lane. If a taper is essential, the maximum permissible lateral velocity is one m/sec. Otherwise, such as in the situation described in AGRD Part 4C, Section 8.2.2, it is preferable to develop alignment shifts using curves with radii which are consistent with the operating speed of the road, see Table V8.1. The critical factor in all cases is the radius, not the taper angle. Adverse crossfall on these curves should be avoided. On low and intermediate speed roads where adverse crossfall is unavoidable, the desirable minimum adverse crossfall shall be 0.025 m/m.

Table V8.1: Radii at Tapers
(from RDG Table 5.7.5.3)

<table>
<thead>
<tr>
<th>SPEED</th>
<th>RADIUS R (m)</th>
</tr>
</thead>
<tbody>
<tr>
<td>120</td>
<td>3000</td>
</tr>
<tr>
<td>100</td>
<td>2400</td>
</tr>
<tr>
<td>80</td>
<td>1800</td>
</tr>
<tr>
<td>60</td>
<td>1000</td>
</tr>
</tbody>
</table>

Note: See Figure V8.1.

8.3 Ramps

8.3.2 Geometric Requirements and Table 8.1: Geometric Requirements
Clarification Information
It is undesirable to use 7% superelevation.
Requirements for the tangent and curve after a left-hand side exit nose are set out in Table V8.2 of this Supplement.

8.3.3 System Interchanges – Direct Ramps
Clarification Information
Speed reductions of greater than 20 km/h are generally not supported in Victoria.
The method outlined in AGRD Part 4C, Appendix A – Reverse curves to reduce speeds, should be avoided on direct ramps.

Table V8.2: First Curve Past Exit Nose
(from RDG Table 5.7.4.4)

<table>
<thead>
<tr>
<th>INTERMEDIATE SPEED (URBAN)</th>
<th>HIGH SPEED</th>
</tr>
</thead>
<tbody>
<tr>
<td>R min</td>
<td>250 m</td>
</tr>
<tr>
<td>30 m</td>
<td>40 m</td>
</tr>
<tr>
<td>Freeway straight or on left curve</td>
<td>70 m</td>
</tr>
<tr>
<td>Freeway on right hand curve</td>
<td>70 m</td>
</tr>
</tbody>
</table>

8.3.4 Service Interchanges
Additional Information
In urban areas it is important to have adequate vehicle storage within exit ramps so that queues do not extend into the freeway and obstruct traffic flow.

Where ramp metering may be required in the future, consideration should be given to providing ramps with adequate storage capacity (length and width) to suit future volumes. Refer to VicRoads Managed Freeways – Freeway Ramp Signals Handbook (VicRoads, 2010).

8.3.4 Service Interchanges – Entry Loop Ramps
Additional Information
Generally, entry ramp loops should be designed for one lane of traffic. Allowance shall be made for the tracking of the 25 metres semi-trailer by widening of sealed shoulders where required.

Where two lanes are necessary, lane widths shall allow for a semi-trailer and car turning side by side.

If a complex loop alignment is required, any curve placed after a tangent shall suit the estimated operating speed at the end of the straight, and the radius should increase on successive curves.
On the approach to the freeway nose it is desirable to provide a 40-metre tangent or an 80-metre long spiral or large radius curve to assist drivers to accelerate to a speed at which the vehicle can merge readily. Where it is not possible to provide this alignment, the 80-metre parallel section of the standard entry ramp (refer Figures V11.6 to V11.8) should be increased in length by 40 metres because of the lower approach speed coming out of the loop.

To facilitate acceleration and merging of trucks, the 3-metre left shoulder should extend from 40 metres before the freeway nose to a point at least 100 metres beyond the end of the taper on the freeway. Where tight constraints exist, the shoulder shall not be less than 1 metre wide at any point and the sum of the taper width and the shoulder width shall be not less than 4.5 metres. This criterion allows trucks to continue safely next to the traffic lane without being forced into the lane at a low speed, and provides a refuge for drivers who have to abort the merge.

The minimum crest vertical curve has a $K$ value of 24 based on a design speed of 80 km/h. This was developed as a compromise from past experience to balance construction cost and accident risk. The short vertical curve enables maximum sight distance to be provided to the ramp terminal areas where the accident risk is highest. This outweighs the slightly increased risk on the crest due to reduced stopping sight distance, i.e. the sight distance to an object on the road. Use of the short crest vertical curve also results in earthwork savings and reduced right of way requirements, see Figure V9.1.

As long as there are no horizontal restrictions to sight distance (such as bridge barriers) the $K = 24$ value will usually meet the specified sight distance requirements on straight alignments, provided ramp terminals are properly located according to the guidelines in Section V10.1.

### 9.3 Ramps

VicRoads has no supplementary comments for this section.
10.0 Ramp Terminals at Minor Roads

10.1 Ramp Terminal Locations

Substitute Information (from RDG 5.7.7.2)

- the grade of the secondary road must not exceed 2% to ensure that turning trucks remain stable. This involves providing positive effective crossfall where possible. Where effective adverse crossfall must be provided, it should be minimised and ideally positive effective crossfall should not decrease in the direction of travel around the swept path, however with any reduction in cross fall through the swept path, the change shall be provided through a uniform rate of change. Refer also to VicRoads Supplement to AGRD Part 4A, Section 2.2.

- the spacing between ramp terminals should be at least 100 to 120 m to provide for deceleration and storage between ramps. This minimum distance has been used historically in Victoria and has provided adequate performance.

10.2 Ramp Alignment at Minor Road Terminals

10.2.1 Exit Ramp Alignment at Minor Road Terminals

Intersection angle and curve radius

Additional Information

The appropriate radius, R₁, depends on the angle between the ramp and the secondary road, angle \( \phi \) as shown on Figure V10.1. Radius R₁ is obtained from Table V10.1.

Table V10.1: Right Turn Radius R₁
(from RDG Table 5.7.10.1)

<table>
<thead>
<tr>
<th>Angle ( \phi ) degrees between the ramp and cross road</th>
<th>Right turn radius R₁</th>
</tr>
</thead>
<tbody>
<tr>
<td>30</td>
<td>20</td>
</tr>
<tr>
<td>40</td>
<td>25</td>
</tr>
<tr>
<td>50</td>
<td>30</td>
</tr>
<tr>
<td>60</td>
<td>40</td>
</tr>
<tr>
<td>70</td>
<td>45</td>
</tr>
<tr>
<td>80</td>
<td>45</td>
</tr>
</tbody>
</table>

Exit Ramp Splitter Island

Clarification Information

The reference to AGRD Part 4 is incorrect. The reference should be to AGRD Part 4A.

10.2.2 Entry Ramp Alignment at Minor Road Terminals

The right-turn roadway

Additional Information to AGRD Table 10.2

Table V10.2(a): Radius of Turning Template (Right Turn)
(Refer to AGRD Part 4C, Figure 10.2)
(from RDG Table 5.7.10.3 (a))

<table>
<thead>
<tr>
<th>ENTRY RAMP TEMPLATE RADIUS</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ramp Angle ( \theta ) (Degrees)</td>
</tr>
<tr>
<td>---------------------------------</td>
</tr>
<tr>
<td>25(^{\circ}) - 50</td>
</tr>
<tr>
<td>51 - 69</td>
</tr>
<tr>
<td>70 - 80</td>
</tr>
</tbody>
</table>
Notes:
1 The angle $\theta$ in Table V10.2 is the angle shown in AGRD Part 4C, Figure 10.2. To obtain an estimate of this angle the ramp can be sketched in using a preliminary ramp length of 300 metres.
2 Radii specified on turning templates are outside radii.
3 As an approximate estimate of maximum truck speeds on curves, the speed can be assumed to be numerically equal to the radius of the curve. More accurate estimates can be obtained from AGRD Part 3.

Left-turn into entry ramp

Additional Information
In urban areas, high angle stand-up, left-turn slip lanes are preferred to free-flow slip lanes due to pedestrian safety.

Where free flow left-turn slip lanes are appropriate, the following radii are recommended.

Table V10.2(b): Radius of Left Turn Roadway
(Refer to AGRD Part 4C, Figures 10.2 and 10.6) (from RDG Table 5.7.10.3 (b))

<table>
<thead>
<tr>
<th>Ramp Angle $\theta^1$ (Degrees)</th>
<th>Left Turn Radius$^2$ – R (m)</th>
</tr>
</thead>
<tbody>
<tr>
<td>25 -50</td>
<td>175 m</td>
</tr>
<tr>
<td>50 - 69</td>
<td>120 m</td>
</tr>
<tr>
<td>70 - 80</td>
<td>80 m</td>
</tr>
<tr>
<td>Oblique$^3$</td>
<td>20 m</td>
</tr>
</tbody>
</table>

Notes:
1 The minimum angle is 25 degrees.
2 Radii specified are approximate.
3 For oblique angle, use deceleration lane and smaller radius.

10.3 Ramp Terminal at Minor Road

Additional Information
The arrangement in AGRD Part 4C, Figure 10.3 would normally accommodate a car which needs to cross from the exit ramp to the entry ramp. In special circumstances there could be a demand for buses, the 25-metre restricted-access semi-trailer or over-dimensional vehicles to cross the median at a site. In this case, the surfaces under the template should be made driveable. Colour and texture should be used to define the original shape of the median and islands.
V10.4 Accident Patterns at Diamond Interchanges

The majority of reported single vehicle and two-vehicle accidents at unsignalised diamond interchanges involve right-turns from the exit ramp terminals.

The frequency of single vehicle accidents may be reduced by ensuring that the alignment of both the right and left turn lanes at the terminal are visible in accordance with intersection requirements.

Attention to detail is required in order to avoid obstruction of the required Safe Intersection Sight Distance at the ramp terminal by bridge handrails, high kerbs and safety barriers. In some cases widening of the footway may be justified in order to improve sight distance.

The typical right-turn radii at urban diamond interchanges may encourage trucks to turn at speeds which are near their limit of stability. The designer should avoid reduction of the turning radius at the entry to the ramp, and should avoid an increase of adverse crossfall along the turn path.

V10.5 Restricted-Access Vehicle

As a minimum, the intersection area should be checked using turning templates for the 25 metre restricted-access semi-trailer to ensure that the swept path of this vehicle is clear of obstructions such as signs and guard fencing. Where appropriate (i.e. major freight route), intersections may need to be designed to fully cater for restricted access vehicles (or larger).

Depending on the traffic flow and characteristics of the secondary road, the restricted turn vehicle template may be placed in a favourable position outside the marked turn lane, and may encroach into other traffic lanes, islands or verge areas where this is acceptable. The area affected by this vehicle template must be paved and appropriately surfaced to carry the required loads. Refer to AGRD Part 4C, Figures 10.4 and 10.5 (refer to Austroads Design Vehicles and Turning Path Templates (1995)).
- relatively large radius right turn lanes from the exit ramp and into the entry ramp, which require care in design to ensure safe operation;
- the advantage that land acquisition is less along the secondary road;
- higher capacity relative to closed diamonds.

It should be noted that high capacities are not necessarily desirable as high volume entry ramps can create operational problems on the freeway. This is a factor which should be considered as congestion on the freeway is more difficult to manage than congestion on the surface road system. If the high capacity ramp does create a problem then it may be necessary to provide ramp metering, see Section 11.4 of this Supplement, as this can often conflict with the purpose of constructing a costly high capacity interchange.

**V10.6.2 Number of Lanes (from RDG 5.7.13.2)**

The number of lanes required at opening of the freeway and in the design year shall be determined by thorough traffic analysis.

Generally provision should be made for three through lanes in each direction and two right turn lanes in each direction. If all of these lanes are not provided, the first stage works should be sufficient to enable the ultimate development to be constructed without costly additional structural work. The minimum number of through lanes in the first stage shall be two lanes in each direction.

**V10.6.3 Stop Line Separation (from RDG 5.7.13.3)**

As safety and efficiency increase with closer spacing between stop lines, the spacing should be minimised and would generally be within the range of 60 metres to 80 metres.

The need to minimise the length of the median opening is particularly important where the secondary road is on a horizontal curve in order to meet the sight distance requirements, see Section V10.6.8.

**V10.6.4 Median Island (from RDG 5.7.13.4)**

An island should be provided at the centre of the interchange to improve delineation and to accommodate road furniture. It should have a minimum width of 1.8 metres between the right turn lanes to provide a vehicle body clearance of 3 metres between opposing right turn vehicles. The island must have an area of at least 10 square metres to ensure that it is visible to approaching vehicles and for fitting in signs. Note that increases in island size have the effect of reducing the efficiency of the interchange.

**V10.6.5 Right Turn Entry (from RDG 5.7.13.5)**

Two long approach right-turn lanes should be provided on the secondary road to ensure that the interchange operates efficiently.

The minimum width of the approach lanes for trucks should not be less than 3.5 metres, and 3.7 metres is preferable, where significant volumes of trucks use the interchange.

The width of the turn lanes within the interchange shall be based on turning templates for the design vehicle or vehicles. The clearance between turning template wheel paths and lip of channel should be increased to 0.5 metres because kerbs can trip and overturn trucks. A check should be made that the 25-metres restricted-access semi-trailer can negotiate the intersection from the right turn lanes but without necessarily observing lane discipline.

Radii for right turn movements from the secondary road to the entry ramp may be in the range 60 metres to 120 metres with the larger radius preferred.

To avoid instability of trucks, standards should not reduce along the right turn path in the direction of travel, that is,
- a spiral should not be provided on the approach end of the curve;
- the gradient should either remain constant or increase positively;
- superelevation should increase from the crossroad to the desirable value;
- advisory speed signs should be provided for turning trucks;
- truck stopping sight distance shall be available at all points around the right turn.
- throat width of the entry ramp should be according to requirements in AGRD Part 4C, Section 10.3 and in this Supplement.

**V10.6.6 Right Turn Exit (from RDG 5.7.13.6)**

Radii for right turn movements from the exit ramp should be in the range 60 metres to 120 metres, similar to the right turn into the entry ramp.

The geometry of the right turn and location of islands within the intersection should discourage the through movement from the
exit ramp onto the entry ramp to restrict the return movement to the major road.

**V10.6.7 Left Turns onto Entry Ramp and from Exit Ramp (from RDG 5.7.13.7)**

Early designs have an accident history of conflicts between left turning traffic and oncoming right turning traffic, and rear end accidents on exit ramps. These can be remedied by:

- providing a single lane left turn from the exit ramp, with long storage length, turning into an exclusive lane on the secondary road;
- use generous left turn radii, in the range 20 metres to 60 metres;
- use large islands at the ends of exit ramps, in the range 220 m² to 300 m².
- Left turns onto entry ramp should be designed as Give Way situation with superelevation favouring rightturners.

**V10.6.8 Sight Line Boundaries (from RDG 5.7.13.8)**

A sight line boundary drawing should be prepared using sight lines as shown on Figure V10.3, and sight distances as listed in Table V10.3.

On the cross road overpasses, the sight line boundary is used to locate the limit of the bridge structures and the bridge railing. Under the freeway overpasses the sight line boundary is used to locate obstructions to sight distance such as bridge piers.

The sight distances on Table V10.3 are approach sight distances. The eye position is assumed to be at the centre of the right-most lane of the right-turning roadway and the object is deemed to be at the centre of the lane.

<table>
<thead>
<tr>
<th>RADIUS (m)</th>
<th>CAR SPEED (km/h (Approx.))</th>
<th>SIGHT DISTANCE (m)</th>
</tr>
</thead>
<tbody>
<tr>
<td>60</td>
<td>50</td>
<td>48</td>
</tr>
<tr>
<td>70</td>
<td>53</td>
<td>54</td>
</tr>
<tr>
<td>80</td>
<td>56</td>
<td>60</td>
</tr>
<tr>
<td>90</td>
<td>60</td>
<td>67</td>
</tr>
</tbody>
</table>

**V10.6.9 Pedestrians and Cyclists (from RDG 5.7.13.9)**

Crossing locations for pedestrians are shown on Figure V10.3. Provision of signalisation for pedestrians and cyclists seriously affects the operation of this type of interchange. In areas with high pedestrian cross traffic, special structures may have to be constructed for pedestrians and cyclists. This interchange type is not appropriate in areas with heavy pedestrian movements along the secondary road.

---

**Figure V10.2: Exit Ramp Terminal Layout (from RDG Figure 5.7.13.7)**
11.0 Ramp Terminals at Major Road

The information provided for the design of ramp terminals at the major road differs from historical practice. To maintain consistency across the Victorian freeway network, the design of exit and entry ramps shall generally continue to be based on the guidance previously provided in VicRoads Road Design Guidelines.

The principles outlined in the text of AGRD Part 4C, Section 11 are generally applicable to Victorian conditions; however, many of the example ramp layouts are not to be used. The sections that follow specify any differing principle and layouts to be adopted.

11.1 General

Substitute Information

Exit and Entry Ramp – Nose Details
The relevant ramp nose layouts are listed on Table V11.1. A brief explanation of the situations in which each ramp type is used is given in AGRD Part 4C, Sections 11.1.1 and V11.1.2 below.

V11.1.1 Exit Ramp Types
(from RDG 5.7.9.1)
The selection of exit ramp types for use depends on the number of lanes on the ramp and the ramp length.

(a) As indicated in AGTM Part 6, Section 6.6.3, a one lane ramp with one lane at the nose is used on low volume rural roads where the ramp length is less than 300 m. The combined width of traffic lane plus shoulders is 7.5 metres to provide for overtaking, see Figure V11.1.

(b) Two lane ramps with a single lane at the nose are basically single lane ramps with an additional lane provided to allow for overtaking. This design is used when the length of the single lane ramp exceeds 300 m. A 1 metre shoulder is provided on both sides as lateral support to the pavement and for control of moisture. If the ramp is in cut, SM type of kerb and channel may be used to reduce the width of cut. The treatment in Figure V11.2 is usually used in rural area, whereas the treatment in Figure V11.3 is usually used in urban area.

(c) Two lane ramps with two lanes at the nose are required when traffic volumes in the design year warrants two lanes, see Section V11.4. A three metre shoulder is required on the left hand side to provide for parking of stalled vehicles and emergency vehicles. The use of 1 metre shoulders or kerbs and channels on a one lane ramp is explained in item (b) above Figure V11.4.

V11.1.2 Entry Ramp Types
(from RDG 5.7.9.2)

(a) One lane entry ramp with one lane at the nose is used on low volume rural roads where the ramp length is less than 300 m. The use of shoulders is explained in Section V11.1.1(a) above Figure V11.6.

(b) Where traffic volumes warrant two lanes, there are two options in terms of selection of entry ramp types:
• to provide a two lane ramp with a single lane at the nose using the ramp capacity to control the volume of traffic entering the freeway, see Figure V11.7 and V11.8. The treatment in Figure V11.7 is usually used in rural area, whereas the treatment in Figure V11.8 is usually used in urban area.

• to provide a full two lane ramp with the left hand lane running into an exclusive lane on the freeway, Figure V11.9 and V11.10.

The use of 1 metre shoulders or kerbs and channels is explained in Section V11.1.1(b) and the use of 3 metre shoulders is explained in Section V11.1.1(c) above.

The markings associated with the various exit and entry ramp details shall be in accordance with VicRoads TEM, Volume 2, Chapter 12.

### Table V11.1: Exit and Entry Ramp Nose Details
(from RDG Table 5.7.9.1)

<table>
<thead>
<tr>
<th>EXIT RAMP TYPE ¹</th>
<th>No. of Lanes at Nose</th>
<th>No. of Lanes on Ramp</th>
<th>Shoulder (S) or Kerb (K) on Ramp Proper</th>
<th>Figure Number</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td>LHS</td>
<td>RHS</td>
</tr>
<tr>
<td></td>
<td>1</td>
<td>1</td>
<td>S (3 m)</td>
<td>S (1 m)</td>
</tr>
<tr>
<td></td>
<td>1</td>
<td>2</td>
<td>S (1 m)</td>
<td>S (1 m)</td>
</tr>
<tr>
<td></td>
<td>1</td>
<td>2</td>
<td>K</td>
<td>K</td>
</tr>
<tr>
<td></td>
<td>2</td>
<td>2</td>
<td>S (3 m)</td>
<td>S (1 m)</td>
</tr>
</tbody>
</table>

Exit Ramp - Step Out Markings at Exit Ramp Tapers²

<table>
<thead>
<tr>
<th>ENTRY RAMP TYPE ¹,³,⁴</th>
<th>No. of Lanes at Nose</th>
<th>No. of Lanes on Ramp</th>
<th>Shoulder (S) or Kerb (K) on Ramp Proper</th>
<th>Figure Number</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>1</td>
<td>1</td>
<td>S (3 m)</td>
<td>S (1 m)</td>
</tr>
<tr>
<td></td>
<td>1</td>
<td>2</td>
<td>S (1 m)</td>
<td>S (1 m)</td>
</tr>
<tr>
<td></td>
<td>1</td>
<td>2</td>
<td>K</td>
<td>K</td>
</tr>
<tr>
<td></td>
<td>2</td>
<td>2</td>
<td>S (3 m)</td>
<td>S (1 m)</td>
</tr>
<tr>
<td></td>
<td>2</td>
<td>2</td>
<td>S (3 m)</td>
<td>K</td>
</tr>
</tbody>
</table>

Notes:

1. Traffic volume warrants for the selection of the number of lanes on ramps are set out in Table V5.1 in this Supplement and AGTM Part 6, Section 6.6.3.

2. Step out linemarking should be provided at the exit ramp taper of all rural freeways and those urban freeways where the exit ramp is located on the outside a freeway curve with radius less than 900m, see detail in Figure V11.5.

3. When an entry ramp is laid out to the standard dimensions on a curved freeway alignment, the taper may have visible kinks, which should be smoothed by adjusting to a suitable radius for the edge of the taper.

4. Full width shoulders downstream of the entry ramp nose should be provided as shown on Figures V11.6 to V11.10. Where tight constraints exist, subject to approval by the Principal Road Design Engineer, narrower shoulders may be used subject to the following constraints:
   - the shoulder shall not be less than 1 metre wide at any point, and
   - the sum of the taper width and the shoulder width shall not be less than 4.5 metres. The 4.5 metre width allows for a 3.5 metre lane plus a 1 metre clearance to a barrier. This is sufficient to prevent forced merges. It also provides a refuge for drivers who find that they have to abort the merge.
Figure V11.1: Exit Ramp – Single Lane
(from RDG Figure 5.7.1)

RAMP TAMPER
TABLE OF OFFSETS

<table>
<thead>
<tr>
<th>DISTANCE (metres)</th>
<th>OFFSETS (metres)</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>11.2</td>
</tr>
<tr>
<td>10</td>
<td>10.6</td>
</tr>
<tr>
<td>20</td>
<td>9.8</td>
</tr>
<tr>
<td>40</td>
<td>8.4</td>
</tr>
<tr>
<td>60</td>
<td>7.0</td>
</tr>
<tr>
<td>80</td>
<td>5.6</td>
</tr>
<tr>
<td>100</td>
<td>4.2</td>
</tr>
<tr>
<td>120</td>
<td>2.8</td>
</tr>
<tr>
<td>140</td>
<td>1.4</td>
</tr>
<tr>
<td>160</td>
<td>0.0</td>
</tr>
</tbody>
</table>

NOTES

[1] DIMENSIONS ARE SHOWN TO LINE OF KERB

[2] STEP OUT LINEMARKING SHOULD BE PROVIDED AT THE EXIT RAMP TAMPER OF ALL RURAL FREEWAYS AND THOSE URBAN FREEWAYS WHERE THE EXIT RAMP IS LOCATED ON THE OUTSIDE OF A FREEWAY CURVE WITH RADIUS LESS THAN 900m REFER TO FIG 5.7.5 FOR DETAILS.

[3] WIDTH OF FREEWAY SHOULDER IS 3.5m, WHERE KERB AND CHANNEL ARE PROVIDED THE WIDTH IS 3.8m TO LINE OF KERB
Figure V11.2: Exit Ramp - Single Lane At Nose, Two Lane Ramp
(from RDG Figure 5.7.2)

RAMP TAPER

<table>
<thead>
<tr>
<th>OFFSETS FROM EDGE OF THROUGH TRAFFIC LANE TO EDGE OF DIVERGE TAPER</th>
<th>(metres)</th>
<th>(metres)</th>
</tr>
</thead>
<tbody>
<tr>
<td>DISTANCE</td>
<td>OFFSETS</td>
<td></td>
</tr>
<tr>
<td>NOSE 0</td>
<td>11.2</td>
<td></td>
</tr>
<tr>
<td>20</td>
<td>9.8</td>
<td></td>
</tr>
<tr>
<td>40</td>
<td>8.4</td>
<td></td>
</tr>
<tr>
<td>60</td>
<td>7.0</td>
<td></td>
</tr>
<tr>
<td>80</td>
<td>5.5</td>
<td></td>
</tr>
<tr>
<td>100</td>
<td>4.2</td>
<td></td>
</tr>
<tr>
<td>120</td>
<td>2.8</td>
<td></td>
</tr>
<tr>
<td>140</td>
<td>1.4</td>
<td></td>
</tr>
<tr>
<td>160</td>
<td>0.0</td>
<td></td>
</tr>
</tbody>
</table>

NOTES

1) DIMENSIONS ARE SHOWN TO LINE OF KERB

2) STEP OUT LINEMARKING SHOULD BE PROVIDED AT THE EXIT RAMP TAPER OF ALL RURAL FREEWAYS AND THOSE URBAN FREEWAYS WHERE THE EXIT RAMP IS LOCATED ON THE OUTSIDE OF A FREEWAY CURVE WITH RADIUS LESS THAN 300m. REFER TO FIG 5.7.5 FOR DETAILS.

3) WIDTH OF FREEWAY SHOULDER IS 3.0m, WHERE KERB AND CHANNEL ARE PROVIDED THE WIDTH IS 3.0m TO LINE OF KERB.
Figure V11.3: Exit Ramp – Single Lane at Nose, Kerbed Two Lane Ramp

RAMP TAPER TABLE OF OFFSETS

<table>
<thead>
<tr>
<th>OFFSETS FROM EDGE OF THROUGH TRAFFIC LANES TO EDGE OF DIVERGE TAPER</th>
<th>DISTANCE (metres)</th>
<th>OFFSETS (metres)</th>
</tr>
</thead>
<tbody>
<tr>
<td>SHOULDER 3m (3)</td>
<td>80 m</td>
<td>11.2</td>
</tr>
<tr>
<td>NOSE</td>
<td>20</td>
<td>9.8</td>
</tr>
<tr>
<td></td>
<td>40</td>
<td>6.6</td>
</tr>
<tr>
<td></td>
<td>60</td>
<td>4.4</td>
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<tr>
<td></td>
<td>80</td>
<td>2.8</td>
</tr>
<tr>
<td></td>
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<td>1.4</td>
</tr>
<tr>
<td></td>
<td>120</td>
<td>0.6</td>
</tr>
<tr>
<td></td>
<td>140</td>
<td>0.0</td>
</tr>
</tbody>
</table>

NOTES

11. DIMENSIONS ARE SHOWN TO LINE OF KERB

12. STEP OUT LIMING SHOULD BE PROVIDED AT THE EXIT RAMP TAPER OF ALL RURAL FREEWAYS AND THOSE URBAN FREEWAYS WHERE THE EXIT RAMP IS LOCATED ON THE OUTSIDE OF A FREEWAY CURVE WITH RADIUS LESS THAN 900m, REFER TO FIG 5.7.5 FOR DETAILS.

13. WIDTH OF FREEWAY SHOULDER IS 3.0m, WHERE KERB AND CHANNEL ARE PROVIDED, THE WIDTH IS 3.0m TO LINE OF KERB.
Figure V11.4: Exit Ramp - Two Lanes
(from RDG Figure 5.7.4)

**NOTES**
1. On busy freeways with 3.0m shoulder, the auxiliary lane length is 750m, on low volume freeways which will never reach capacity, the length of auxiliary lane can be reduced to 350m. In urban area, due regard should be given for the spacing of adjacent interchanges in determining the length of an auxiliary lane.

2. Radius of lip of kerb at the nose is 1.5m.
3. Width of freeway shoulder is 3.0m, where kerb and channel are provided, the width is 3.0m to line of kerb.

4. Dimensions are shown to line of kerb.

5. Step out line marking should be provided at the exit ramp taper of all rural freeways and those urban freeways where the exit ramp is located on the outside of a freeway curve with radius less than 900m, refer to Fig 5.7.5 for details.

<table>
<thead>
<tr>
<th>DISTANCE FROM NOSE (m)</th>
<th>OFFSET (m)</th>
<th>DISTANCE FROM NOSE (m)</th>
<th>OFFSET (m)</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>14.71</td>
<td>180</td>
<td>3.5</td>
</tr>
<tr>
<td>20</td>
<td>13.31</td>
<td></td>
<td></td>
</tr>
<tr>
<td>40</td>
<td>11.91</td>
<td>930</td>
<td>3.5</td>
</tr>
<tr>
<td>60</td>
<td>10.51</td>
<td>940</td>
<td>3.0</td>
</tr>
<tr>
<td>80</td>
<td>9.11</td>
<td>950</td>
<td>2.5</td>
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<td>100</td>
<td>7.71</td>
<td>980</td>
<td>2.0</td>
</tr>
<tr>
<td>120</td>
<td>6.31</td>
<td>970</td>
<td>1.5</td>
</tr>
<tr>
<td>140</td>
<td>4.91</td>
<td>980</td>
<td>1.0</td>
</tr>
<tr>
<td>160</td>
<td>4.29</td>
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</tr>
<tr>
<td>180</td>
<td>3.85</td>
<td>1000</td>
<td>0.0</td>
</tr>
</tbody>
</table>

**OFFSETs SHOWN IN TABLE**

**Exit Ramp Taper**

**Distance from Design Line**

**RAISED CONCRETE SURFACE**

**Inlet**

**Start of Ramp**

**Ramp Design Line**

**Shoulder 3m (3)**

**Ramp Design Line**

**Start of Ramp**

**Shoulder 1m**

**Offset 70m**

**Offset 3.5m auxiliary lane**

**Offset 1000m**
Figure V11.5: Exit Ramp - Step Out Markings At Exit Ramp Tapers (from RDG Figure 5.7.5)
Figure V11.6: Entry Ramp - Single Lane
(from RDG Figure 5.7.6)

**Entry Ramp Taper Offsets**

<table>
<thead>
<tr>
<th>Distance from Nose (m)</th>
<th>Offset (m)</th>
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</thead>
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<td>70</td>
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<tr>
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**NOTES**

1. Dimensions are shown to line of kerb.
2. Width of freeway shoulder is 3.0m, where kerb and channel are provided, the width is 3.0m to line of kerb.
3. The ramp design line is set out with an offset of 8.115m at the nose and a taper angle of 4 degrees 30 minutes.
4. The nose is offset 4.5m from the design line to the line of kerb.
Figure V11.7: Entry Ramp – Two Lanes, Single Lane At Nose
(From RDG Figure 5.7.7)
Figure V11.8: Entry Ramp – Two Kerbed Lanes, Single Lane at Nose
(from RDG Figure 5.7.8)
Figure V1.9: Entry Ramp – Two Lanes with Shoulders
(from RDG Figure 5.7.9)

**Notes:**

1) Dimensions are shown to line of kerb.

2) Width of Freeway shoulder is 3.0m where kerb and channel are provided. The width is 3.0m to line of kerb.

3) The ramp design line is set out with an offset of 0.15m at the nose and a RAP of angle of 4 degrees 30 minutes.

4) The nose is offset 4.5m from the design line to the line of kerb.

5) The standard length of auxiliary lane is 800m. On low volume freeways which will never regain capacity, the length of auxiliary lane can be reduced to 350m min.

6) In an urban area, due regard should be given for the spacing of adjacent interchanges in determining the length of an auxiliary lane.

### Table: Entry Ramp Taper

<table>
<thead>
<tr>
<th>Distance from Nose (m)</th>
<th>Offset (m)</th>
<th>Distance from Nose (m)</th>
<th>Offset (m)</th>
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Figure V11.10: Entry Ramp – Two Lanes with Kerbs
(from RDG Figure 5.7.10)

NOTES

11) DIMENSIONS ARE SHOWN TO LINE OF KERB

12) WIDTH OF FREEWAY SHOULDER IS 3.0m, WHERE KERB AND CHANNEL ARE PROVIDED, THE WIDTH IS 3.8m TO LINE OF KERB

13) THE RAMP DESIGN LINE IS SET OUT WITH AN OFFSET OF 0.115m AT THE NOSE AND A TAPER ANGLE OF 4 DEGREES 30 MINUTES

14) THE NOSE IS OFFSET 4.5m FROM THE DESIGN LINE TO THE LINE OF KERB

15) THE LINE OF KERB FROM THE NOSE TO POINT "A" IS STRAIGHT Apart FROM Rounding OF A Kink IN THE KERB ALIGNMENT AT POINT "A"

16) THE STANDARD LENGTH OF AUXILIARY LANE IS 800m ON LOW VOLUME FREEWAYS WHICH WILL NEVER REACH CAPACITY. THE LENGTH OF AUXILIARY LANE CAN BE REDUCED TO 350m MIN. IN AN URBAN AREA, DUE REGARD SHOULD BE GIVEN FOR THE SPACING OF ADJACENT INTERCHANGE LINES IN DETERMINING THE LENGTH OF AN AUXILIARY LANE

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<th>OFFSET (m)</th>
<th>DISTANCE FROM NOSE (m)</th>
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</tbody>
</table>
11.2 Exit Ramps

Substitute Information
Refer to Section 11.1 of this Supplement for information on ramp terminal layout references.

Additional Information

Exit Nose Location
Factors affecting selection of the location of the exit ramp nose include:

- appropriate alignment and grading of the freeway, and especially the availability of the required sight distance to the start of the taper and to the ramp nose, refer to AGRD Part 4C, Section 7.3);
- providing adequate weaving distances between entry and exit ramp noses on the freeway, see AGRD Part 4C, Section 2.4.2 and in this Supplement);
- siting exit ramps to allow adequate space for signing;
- avoiding superelevation development areas in order to limit water flow depth across the widest section of pavement within the taper area;
- achieving at least the minimum length of the ramp to satisfy grading requirement and to provide for the deceleration and queuing of traffic.

11.2.1 Single-lane Exits

Clarification Information
A simple diverge, Figure V11.1, is the preferred treatment on Victorian freeways. The diverge and nose details in the layouts shown in AGRD Part 4C, Figure 11.1 shall not be used.

In order to improve the visibility of the exit locations, step-out line markings in accordance with AS 1742.8 (1990) and Figure V11.5 should be provided at the start of all rural freeway exit ramps. The same step-out treatments should be provided on urban freeway exit ramps where the limiting radius control cannot be met (i.e. 900 m min radius), see also VicRoads TEM Volume 2, Figure 12.21.

A parallel lane treatment may be considered where the exit is on the outside of right-hand curve and drivers may inadvertently enter the ramp or where constrained conditions result in a curve downstream of the exit nose that requires early vehicle deceleration.

Where a parallel lane treatment is adopted due to a curve downstream of the exit ramp nose, the length of the parallel lane shall be based on the deceleration distances provided in Table 11.1 to enable a vehicle to slow to the appropriate speed to navigate the curve. Exiting vehicles should not be required to decelerate in a continuing through lane of the main carriageway in order to navigate a downstream curve on an exit ramp.

Substitute Figure Reference(s)
For reference AGRD Part 4C, Figure 11.1 refer also to Figure V11.1.

For reference AGRD Part 4C, Figure 11.2 refer to Figures V11.2 and V11.

11.2.2 Two-lane Exits

Clarification Information
Refer to comments for Section 5.2.1 of this Supplement for additional information on when two lanes are required.

The layout in AGRD Part 4C, Figure 11.3 shall not be used. The linemarking shown in Figure 11.3 is inappropriate for Victorian conditions and shall not be used.

Generally, the minimum length of auxiliary lane associated with two-lane exits on busy freeways shall be 750m from the end of taper to the diverge at the exit. Refer to Figure V11.4 for further information on layout details and lane lengths. Also refer to VicRoads TEM Volume 2, Figure 12.4 for linemarking and signing details associated with two-lane exits.

Substitute Figure Reference(s)
For reference AGRD Part 4C, Figure 11.3 refer to Figure V11.4 and the included notes.

11.2.3 Exits to two High-Speed Roadways

Additional and Clarification Information
A major fork is defined as the bifurcation of a directional roadway, of a terminating freeway route into two directional multilane ramps that connect to another freeway, or as the diverging area created by the separation of a freeway route into two separate freeway routes of about equal importance.

Major forks often occur in freeway to freeway interchanges, such as Y- and T-interchanges, see Sections 6.5.2 in Appendix VB.

Nose Design
Two design options are available at the diverge area depending on the ramp layout.

According to Appendix VB, Section 6.5.2.2 of this Supplement, if right turning traffic is less than 30% of the total and the layout on Figure VB6.5(e) is adopted, then a normal ramp diverge nose (Figure V11.4) can be used.
If the right turning traffic is more than 50% of the total and the layout on Figure VB6.5(d) is adopted, then the diverge should be designed as a major fork. The major fork design recommended by AASHTO (1994) is shown on Figure V11.11 (a) to (c). If the right turning volume is between 30% and 50%, traffic analyses, site constraints and economic impacts should be considered to ensure the most appropriate layout is utilised. Note the lane balance i.e. one additional lane downstream of the nose in Figures V11.11 (a) and (b). The turning roadways downstream of the nose diverge in the ultimate direction of travel. Deviations from this layout are not recommended unless specifically approved by the Principal Road Design Engineer because AASHTO states that “operational difficulties invariably develop unless traffic in one of the interior lanes has an option of taking either of the diverging roadways”.

As the radii at major forks are large, the gore on the approach to the nose is long and narrow. The provision of gantry signs on the approaches to major forks is considered essential to avoid driver confusion.

Figure V11.12 shows the transition from a two lane carriageway to a major fork.

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**Figure V11.11: (a), (b) and (c) Major Forks**  
*from RDG Figure 5.7.14.1*
Freeway Design on the Approach to the Diverge Nose

In view of the non-standard conditions at freeway terminals, the following controls should be followed:

- the approach to the nose should be either straight or relatively straight
- long sight distances should be provided both on the approach to the gore area and to all signs to ensure that drivers have ample time in which to evaluate the situation and move into the appropriate traffic lane. Sight distance to the nose in the gore area should be at least 400 m measured from an eye height of 1.1 m to an object height of 0.1 m.
- gantry signs should be used to ensure that drivers know which lane to enter.

Freeway Design Downstream of the Diverge Nose

The appropriate treatment depends on whether the diverge is a major fork, Figure VB6.5(d), or a normal exit ramp Figure VB6.5(e).

- where a major fork is used, speeds on both diverging legs should be consistent with operating speeds on the freeway. This does not mean that they must match freeway speeds. Speed drops of 10 km/h are acceptable as long as the diverging roadways are clearly visible to approaching drivers. Further speed reductions can then be made with grades and curves.
- where right turn traffic is less than 30% of the total traffic and a normal semi direct turn is used, then speeds for the right turn movement would be similar to speeds on a normal ramp i.e. 90 km/h for cars at the nose. The major movement in this case would appear as a continuation of the freeway and freeway speeds would be maintained. In this case the design speed should not be less than 10 km/h below the operating speed on the approach.

In both cases the turning roadways downstream of the nose must have at least two lanes.

11.2.4 Lane Drop at an Exit

Clarification Information

AGRD Part 4C, Figure 11.5 shall not be used. Refer to VicRoads TEM Volume 2, Figure 12.9 for layout details for a lane drop in the vicinity of an exit ramp.

The taper merge length should be based on a rate of lateral shift of 0.6 m/s with a minimum length of 140m for a 100km/h operating speed. A 3 m shoulder should be maintained adjacent to the merge taper and downstream of the merge location.

11.3 Entry Ramps

Clarification Information

In Victoria, the merges at entry ramps are generally marked with a continuity line. Refer to VicRoads TEM Volume 2, Chapter 12 for guidance on marking various entry ramp layouts. The provision of a continuity line indicates that merging vehicles are changing lanes and do not have priority over vehicles in the left lane of the freeway.

11.3.1 General

Clarification Information

References to simple merges at entry ramps should be disregarded. In general, simple merges should not be implemented in Victoria. Refer to Figures V11.6 to V11.8 for appropriate merge layouts.

11.3.2 Entry Ramps – Single-lane entry

Clarification Information

AGRD Part 4C, Figure 11.6 shall not be used. References to simple merges at entry ramps
should be disregarded. In general, simple merges should not be implemented in Victoria. Refer to Figures V11.6 to V11.8 for appropriate merge layouts.

### 11.3.3 Entry with Auxiliary Lanes

**Clarification and Substitute Information**

_AGRD Part 4C, Figure 11.7_ shall not be used. Refer to Figures V11.6 to V11.10.

In general, the length and geometry of an entry ramp should allow for vehicles to be doing at least 80 km/h at the nose where the operating speed of the main freeway carriageway is 100 km/h or greater.

Where the design speed of the main carriageway is greater than 80 km/h, the minimum length of the auxiliary lane at an entry ramp shall be in accordance with Figures V11.6 to V11.10. Where the design speed of the main carriageway is less than or equal to 80 km/h, the length of the parallel lane may be based on 4 sec of travel time. An absolute minimum of 0 m for the parallel lane should not be used.

The taper length at the end of an auxiliary lane shall be in accordance with the Figures V11.6 to V11.10.

_**AGRD Part 4C, Table 11.4**_ should not be used for determining lengths of parallel lanes.

**Substitute Figure Reference(s)**

In reference to _AGRD Part 4C, Figure 11.7(a), (c) and (d)_ refer to Figures V11.6 to V11.8 of this Supplement.

### 11.3.4 Two-lane Entry

**Clarification and Substitute Information**

_The information provided in this section of the AGRD shall not be used in Victoria._

In general, the length and geometry of an entry ramp should allow for vehicles to be doing at least 80 km/h at the nose where the operating speed of the main freeway carriageway is 100 km/h or greater.

Layout details and lane lengths shall be provided in accordance with Figures V11.9 and V11.10 and _VicRoads TEM Volume 2, Figure 12.4._

The key feature with this arrangement is that the right lane of the entry ramp merges with the left lane of the main carriageway and the left lane is directed into an added lane on the freeway downstream of the interchange.

**Substitute Figure Reference(s)**

For _AGRD Part 4C Figure 11.7(b)_ refer to Figures V11.9 and V11.10.

### 11.3.5 Loop Ramps

**Clarification Information**

Reference shall also be made to comments in this Supplement as appropriate in relation the various exit and entry types.

### 11.3.6 Merging of High-Speed Major Roads

**Additional Information**

A _branch connection_ is defined as the beginning of a directional roadway of a freeway formed by the convergence of two directional multilane ramps from another freeway or by the convergence of two freeway routes to form a single freeway route.

Similar to major forks, branch connections occur often with freeway to freeway interchanges. Two possible merge options are shown on Figures V11.13(a) and (b). Of the two, the layout shown as Figure V11.13(a) is generally preferred. The layout in Figure V11.13(b) would only be used to avoid a forced right hand merge such as the one shown on Figure V11.13(e). As long as exclusive lanes can be provided for the right hand carriageway, the design shown at point "A" in Figure V11.13(a) is the most appropriate.

Designs for the branch connection shown in Figure V11.13(a) must provide continuous high speed alignments for each carriageway in the vicinity of the nose.

The essential difference between branch connections and normal two lane ramp merges is in the location of the taper, see Figures V11.9 and V11.10. The standard two lane merge drops one lane immediately downstream of the nose. In the case of branch connections, the taper, if one exists (Figure V11.13(d)), is located at least 400 m downstream of the nose. An absolute minimum length of 300 m may be used in constrained locations.

Lane arrangements for branch connections are shown on Figures V11.13(c), (d) and (e). The layout on Figure V11.13(c) is appropriate for use when both roadways are close to capacity. The layout on Figure V11.13(d) is appropriate when either the volume in the left hand ramp or both ramps have low volumes. When the left hand roadway is close to capacity and the right hand ramp traffic volume is low, i.e. just above the warrant for a single lane ramp, it is not practical to provide exclusive lanes for the right hand
carriageway. In this case it is necessary to adopt the layout in Figure V11.13(b).

Forced right hand merges such as the one shown on Figure V11.13(e) are not favoured because merges from the right hand side can be hazardous for drivers of vehicles with poor left hand visibility (e.g. vans and trucks).

**Figure 11.8: Major Branch Connections**

**Substitute Information**

**Use Figure V11.13 below in place of AGRD Part 4C, Figure 11.8.**

Figure 11.14 shows a branch connection with a two lane carriageway. It is noted that the lane arrangement shown does not meet lane balance requirements, refer to AGTM Part 6. The layout shown is primarily for interim arrangements where it is desirable to fully construct system interchanges prior to the provision of ultimate capacity along a corridor.

*Figure V11.13(a) to (e) Branch Connections (from RDG Figure 5.7.15.1)*
11.4 Ramp Traffic Signals


11.4.3 Geometric and layout design – Ramp Width

Clarification Information
The shoulder width which develops adjacent to a merge length shall widen to no less than 3m at the end of the taper.

The appropriate Supplement figures as referenced shall be used for the nose details associated with the various entry ramp lane arrangements.

11.4.3 Geometric and layout design – Example Designs

Clarification Information
Figure V6.9 and Figure V6.11 provide limited examples of ramp and merge layouts for freeway ramp signals. Refer to *VicRoads Managed Freeways – Freeway Ramp Signal Handbook* (*VicRoads, 2010*) for additional layout variations and up-to-date versions of the available layouts.

12.0 Ramps on Two-Lane Freeways

Clarification Information
General practice in Victoria is to not adopt this cross-section for freeway facilities.

13.0 Pedestrians

13.1 General

Additional Information
Where pedestrian demand across the freeway is high but not located at an interchange, such as near a school, consideration may be given to provision of a bridge for pedestrians only.

13.2 Bus Passengers

Additional Information
Bus stops adjacent to the freeway main carriageway shall be avoided. Steps and ramps from freeway level to the local street level shall be avoided.

Planning of the freeway may include provision of medians of sufficient width to carry exclusive bus ways, light rail or even heavy rail passenger systems. The transport provider should be consulted for detailed requirements. Guidelines for light rail and tramway cross sections are shown in AGRD Part 3.

Passenger access to or from light rail stops in the median must be grade-separated, and the facility must be maintained from within its own right of way.

14.0 Cyclists

14.1 General

Additional Information
Cyclists are generally permitted to use rural freeways in Victoria, but are prohibited from using urban freeways because of concern for their safety. Refer to *VicRoads TEM Volume 1*, Section 5.4.7.

For rural freeways, refer to *VicRoads TEM Volume 2, Figure 12.8* for treating bicycles at freeway interchanges.

The treatment shown in *AGRD Part 4C, Figure 14.2* is generally not used in Victoria.

14.2 Treatment at Interchanges

VicRoads has no supplementary comments for this section.
15.0 Pavement Markings, Signs and Lighting

15.1 General

Additional Information

A freeway driver should not be required to make a sudden decision and signs should be located well in advance of the decision point. Freeway signs are of a higher standard than those provided on other roads, and signs should conform to VicRoads TEM Volume 2, in particular Chapter 12 and AS 1742.8 - 1990 Manual of Uniform Traffic Control Devices - Part 8, Freeways.

Information on service and tourist facilities should be provided as well as advanced direction signing. Additional design information is given in VicRoads TEM Volume 2, in particular Chapter 12.

Where manual tolling is carried out, adequate advance warning of toll facilities is required so that motorists understand that they are liable to pay a toll.

The minimum distances between ramp noses are dependent on whether or not effective signing can be provided to inform, warn and control drivers. On rural freeways, advance exit direction signs should be placed 2 km and 1 km from the exit. On urban freeways, this spacing may be reduced to 1 km and 500 metres. Where the spacing between exits is less than 1.2 km, special gantry-mounted lane direction signs will be necessary.

Functional designs which require complicated signing are to be avoided if possible. Freeway interchange layouts which are difficult to sign and mark include:

- closely spaced ramps combined with multi-lane ramps;
- right-hand entry or exit ramps;
- closely spaced entry and exit ramps with auxiliary lanes;
- trap lanes; and
- separate sequential ramps leading to opposite directions on the one intersecting road.

Pavement striping, delineators, and other markings are important parts of driver communication at interchanges. These should be uniform and consistent, following AS 1742 and VicRoads TEM Volume 2.

In relation to markings and signs associated with freeway ramp signals, refer to VicRoads Managed Freeways – Freeway Ramp Signals Handbook (VicRoads, 2010).

15.2 Key Considerations

VicRoads has no supplementary comments for this section.

15.3 Lighting of Interchanges

Refer to VicRoads TEM Volume 1, Chapter 6 – Lighting of Roads and VicRoads Guideline for Road Lighting Design for VicRoads’ policy on Freeway Lighting requirements.

16.0 Landscaping and Street Furniture

16.1 General

Additional Information

The landscape design for interchanges should aim to integrate the road with the surrounding landscape and minimise adverse visual, environmental and social impacts. The aesthetic quality of the driving experience along the road should also be considered. The scale of the design should correspond to the vehicle speed at which the landscape and road environment will be viewed.

Landscape design of interchanges should relate to the landscape through which the road traverses, not only through planting design, but also through the design of hard structural elements such as bridges and walls and in the design of land forming. Interchanges should make a positive visual contribution to the road and complement the surrounding landscape. Bridges should appear as a single sculptural element, with consideration given to the whole composition of the bridge and its relationship to adjacent ramps and other constructed elements.

Bridges and other hard landscape elements such as retaining walls should be designed in a coordinated process in conjunction with similar stages of road design and be integrated with the overall landscape design. These hard elements may require specific treatments to enhance their visual quality through the use of architectural forms and finishes.

Planting should be established to screen interchanges from surrounding land users. This planting should also be effectively utilised to improve the motorist’s experience of the road. The design intent may continue proposed planting themes for the entire road corridor or take the opportunity to signify a particular location as in a town entry.
However, it is important that substantial trees should not be planted within the clear zones, and that shrubs when fully grown should not obscure the sight lines to ramp noses, see AGRD Part 4C, Sections 7.3 and 7.4 and VicRoads Supplement, or sight distances at ramp terminals.

Planting should be developed in consultation with qualified specialists and take into account local conditions, safety requirements and long term maintenance.

16.2 Landscape Development
VicRoads has no supplementary comments for this section.

16.3 Road Safety
VicRoads has no supplementary comments for this section.

17.0 Other Considerations

17.1 Access in the Vicinity of Interchanges
VicRoads has no supplementary comments for this section.

17.2 Service Centres

Additional Information
Where a freeway service centre is provided, there should be no access provided to/from the local road system. All access should be via the freeway main carriageway or interchange ramps.

Clause 52.30 of the Victoria Planning Provisions outlines minimum requirements for Freeway Service Centers.

References
VicRoads has no supplementary comments for this section.

Appendices

Appendix C
AGRD Part 4C, Appendix C provides limited examples of ramp and merge layouts for freeway ramp signals. Refer to VicRoads Managed Freeways – Freeway Ramp Signal Handbook (VicRoads, 2010) for additional layout variations and up-to-date versions of the available layouts.

Commentaries
VicRoads has no supplementary comments for this section.

Tables
VicRoads has no supplementary comments for this section.

Figures
VicRoads has no supplementary comments for this section.
Appendix VA

Freeway Planning Considerations and Interchange Planning and Design Considerations (from VicRoads RDG Part 5: Interchanges)

This section should be considered in conjunction with information in AGTM Part 6: Intersections, Interchanges and Crossings, Section 6.2 and 6.3.

A1.0 GENERAL (from RDG 5.2.1)

A1.1 Strategic Planning (from RDG 5.2.1.1)

Planning of freeways at a project level should always be preceded by strategic planning of the road network, to optimise the spacings of freeways and interchanges, and to provide estimates of traffic volumes for road design purposes.

The function of the existing road network may be altered by addition of a freeway. The planning should consider the present and future land development and the resulting demand for transport, and also must provide alternative routes for those road users and vehicles that are prohibited from using the freeway. It is important that the whole road network be integrated and appropriately interconnected through interchanges and intersections.

The justification for any interchange should be established from a comprehensive traffic study of the proposed road network, aiming to optimise traffic service and community interests.

The primary purpose of any interchange is to distribute conflicting traffic safely and effectively. The appropriate form of interchange is that which maintains the operational capacity under the predicted demand conditions.

A1.2 Project Planning (from RDG 5.2.1.2)

The planning aspects of interchanges include:

(d) Provision of high speed flows uninterrupted by access to private properties, parking, and cross traffic, where appropriate.

(e) Reduction of travel time and cost by selection of the minimum length route consistent with community and environmental values.

(f) Restriction of access to the freeway to interchanges at selected locations.

(g) Achievement of acceptable levels of service by provision of appropriate numbers of lanes and maintaining lane balance.

(h) Retention of the use of the local road system by provision of grade separations across a freeway at selected locations.

(i) Consideration of pedestrian needs on secondary roads connecting with a freeway.

(j) Consideration of the needs of cyclists along secondary roads which connect to the freeway, along those rural freeways where cyclists are permitted, and where a bicycle path passes through an interchange.

(k) Provision of rest areas and Service Centres at appropriate intervals.

(l) Consideration of environmental issues and preparing a landscape concept proposal;

(m) Consideration of political and legal requirements.

A2.0 WARRANTS (from RDG 5.2.2)

A2.1 Interchange Warrants (from RDG 5.2.2.1)

Refer also to AGTM Part 6, Section 6.2.2.

An interchange should be provided where:

(a) an economical analysis demonstrates that it is justified;

(b) all forms of possible at-grade treatments are likely to be unsafe or would not meet objectives with respect to mobility of major traffic flows;

(c) National Highways guidelines require an interchange;
(d) a combination of at-grade intersection and interchanges would not be expected by motorists and hence could lead to unsafe situations.

**Table VA2.1: Economic Warrants (from RDG 5.2.2.1)**

<table>
<thead>
<tr>
<th>BASIC INTERCHANGE WARRANT</th>
<th>Expressway volume (vpd)</th>
<th>Cross Road Volume (vpd)</th>
</tr>
</thead>
<tbody>
<tr>
<td>7500</td>
<td>3600</td>
<td></td>
</tr>
<tr>
<td>10000</td>
<td>3300</td>
<td></td>
</tr>
<tr>
<td>12500</td>
<td>3000</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>BASIC OVERPASS WARRANT</th>
<th>Expressway volume (vpd)</th>
<th>Cross Road Volume (vpd)</th>
</tr>
</thead>
<tbody>
<tr>
<td>7500</td>
<td>1800</td>
<td></td>
</tr>
<tr>
<td>10000</td>
<td>1650</td>
<td></td>
</tr>
<tr>
<td>12500</td>
<td>1500</td>
<td></td>
</tr>
</tbody>
</table>

**NOTE**
- (1) Assumed traffic growth rate was 3% p.a.
- (2) Target Benefit Cost Ratio was 1.0
- (3) Assumed diamond interchange used

An analysis of the economic justification of interchanges and overpasses for rural expressways with traffic in the range 7,500 to 12,500 AADT was carried out by van Every (1982) and summarised in Table VA2.1.

These warrants are for guidance only, and an individual case, for example where accident rates are higher than average, may be justified by a specific economic analysis, or by the factors set out in (b), (c) and (d) above. Cost of accidents may justify grade separation where the sum of the crossing volumes is about 1000 v.p.d.

**A2.2 At-grade Intersection Treatments (from RDG 5.2.2.2)**

Where a rural expressway is crossed by a local road with average daily traffic less than 50 vehicles per day (v.p.d), the cross road should be closed or relocated.

Roundabouts are generally not favoured as at-grade treatments on rural expressways, as they have a significant effect on the mobility of drivers using the major road. Where crossing traffic on a rural facility is greater than 50 v.p.d., the choice of treatment is usually either a staggered T intersection or a wide median treatment, see AGRD Part 4A, Sections 4.11 and 4.13.

Wide median treatments should be limited to:
- (a) T intersections where the entering side road traffic is less than 1000 v.p.d;
- (b) Cross intersections where the sum of the volumes entering from both side roads is less than 1000 v.p.d;
- (c) Sites where the accident exposure (E) is less than 6000 v.p.d. expressed by:

\[ E = 2 \sqrt{V_1 V_2} \]

Where:
- V1 is the sum of traffic volumes entering from the major route (v.p.d.), and
- V2 is the sum of the traffic volumes entering from the minor legs

**Note:** The exposure formula is also included in AGRD Part 4A, Section 4.4.2, however it is currently incorrect and the formula above should be used. See also VicRoads Supplement to AGRD Part 4A.

**A2.2.3 Grade Separation Requirements (from RDG 5.2.5)**

It is desirable that the secondary roads carrying traffic across a freeway should continue without interruption or deviation. Grade separations should be of sufficient number and capacity to handle adequately not only the normal traffic, but the traffic diverted to the cross street from the other streets terminated by the freeway and traffic generated by connections to the freeway. Determination of the number and location of cross streets to be grade-separated requires extensive community consultation and a thorough analysis of traffic on the local network in addition to that on the freeway and interchanges.

Terminated and through streets may connect to frontage roads on either side of the freeway. Locations of intersections between frontage roads and major cross roads need to be chosen with care, as safety, operational or capacity problems arise if they are placed too close to freeway ramp terminal intersections.

**A2.2.4 Right Of Way (from RDG 5.2.12)**

The process of acquiring right of way is complex and may take years. It is therefore preferable that the road reservation is defined fairly generously at the planning stage, especially at interchanges, so that small additional parcels of land are not required later. In complex interchanges carrying high...
volumes, some flexibility should be allowed for possible future change of interchange form when selecting boundaries.

Detailed boundaries should allow space for features such as catch drains, noise attenuation mounds, stockpiles during construction, sedimentation basins, and ancillary works areas. Additional allowance for landscaping may be required at interchanges.

Minimum right of way clearances from batter points are set out in AGRD Part 3, Section 4. Further to AGRD Part 3, Table 4.30, the minimum clearance adopted between batters and right of way should be 10m during the planning phase of a project.

A2.3 Design Procedure (System Interchanges) (from RDG 5.4.2)

A2.3.1 Define planning goals (from RDG 5.4.2.1)

The roles and functions of freeways within the road network need to be defined, together with the relative priorities of local political, social and environmental factors. It is preferable that controls, criteria and community expectations are written down, so that later design reviews can assess to what degree each interchange option satisfies the requirements.

Examples of planning objectives are set out in Section VA1.2 Planning Considerations above.

Should the objective be reservation of land in a planning scheme, boundaries should be set so as to allow flexibility for future interchange options.

A2.3.2 Traffic Network Predictions (from RDG 5.4.2.2)

Proposed interchange locations should be shown on the road network prior to traffic assignment and predictions. The omission of an interchange would generally result in higher traffic volumes on arterial roads and greater circuitry of travel. However, too close spacing of interchanges can result in operational inefficiency in weaving areas and higher accident rates as more local trips are attracted to the freeway. For advice on interchange spacing, see AGTM Part 6, Section 6.3.1 and AGRD Part 4C, Section 2.4.2.

Traffic predictions for urban networks should be carried out using computer modelling, but the results should be reviewed for practicality by comparing them to existing traffic patterns and assessing whether the results can be used to identify major turning movements and to determine the basic number of lanes for through carriageways and ramps.

A2.3.3 Obtain Site Details (from RDG 5.4.2.3)

Reliable contoured mapping is required for an interchange layout, together with cadastral, planning scheme and major utility services information. Photogrammetric mapping may have to be supplemented by engineering survey where clearances are small or existing features are to be matched.

A2.3.4 Controls and Criteria (from RDG 5.4.2.4)

The features which are to be regarded as controls on each design must be identified and further classified into mandatory and discretionary controls. Mandatory control must be met, whereas other controls may be allowed some degree of compromise.

Common criteria include the design principles listed in AGTM Part 6, Section 6.3 and others such as:

(a) all movements to be provided at an interchange;
(b) all access to and from the freeway to be on the left-hand side;
(c) avoid use of reversed small radius curves;
(d) avoid use of curves and loops with radii less than 55 metres.

Variations from the desirable criteria may be warranted in some circumstances such as:

- at major forks a right-hand diverge and merge might be appropriate, see Section VB6.5.2.2;
- in rural areas with low traffic volumes, a cloverleaf may be considered appropriate although weaving is involved;
- rural cross roads which have very low volumes may be provided with at-grade intersections as an interim treatment, see Section VA2.2 for warrants.
A2.3.5 Evaluate Options (from RDG 5.4.2.5)

The interchange options should be compared against the selected controls and criteria, and the economic, environmental and operational factors set out in AGTM Part 6, Section 6.5.5. It is quite usual for some controls and criteria to be in conflict, and the most suitable interchange is that which achieves an optimal balance of the desired characteristics.

A2.3.6 Design Review (from RDG 5.4.2.6)

The planning concepts of an interchange should be reviewed before detailed design to determine whether the original controls are still relevant. Changes in land use, traffic patterns or design standards over time may necessitate corresponding changes in interchange design. In urban areas, community expectations about environmental issues such as noise and air pollution, conservation of vegetation and fauna habitats are becoming higher.

A2.4 General (Service Interchanges) (from RDG 5.5.1)

Also to be considered in conjunction with information in AGTM Part 6, Section 6.5.3.

(In this section, “secondary” describes any road of lesser classification than a freeway. In many cases this will be an arterial road, but in rural areas it is common for interchanges to be placed at intervals on roads which serve local and municipal traffic circulation.)

Freeway to secondary road interchange types usually include a stop condition on the turning movements associated with the secondary road. Capacity of the interchange is restricted by the conflicting traffic movements on the secondary road, and can be improved by provision of additional lanes at the ramp terminal and on the secondary road approaches.

An interchange desirably should provide for all traffic movements because operational problems may result if any movements cannot be performed. Generally, where an exit or entry movement is provided, the reverse movement should be provided as well. Exceptions may only occur in inner city areas, perhaps in conjunction with a one-way street system.

The design procedure is similar to that set out in the Design Procedure for System Interchanges in Section VA2.3.

Common criteria include the design principles listed in AGTM Part 6, Section 6.3, Section VA2.3.4 and others such as:

(a) use single lane exits where traffic volumes permit because they are simpler for drivers to comprehend and therefore easier to sign;

(b) avoid use of at grade intersections along freeway main carriageways, see Section VA2.0, Warrants.
Appendix VB

Additional information to Austroads Guide to Traffic Management (AGTM) Part 6: Intersections, Interchanges and Crossings, Section 6: Interchanges

B6.3.1 Spacing of Interchanges – Urban freeways/motorways

Weaving sections generate considerable turbulence in traffic flow, so interchange forms which eliminate weaving from the main carriageways are desirable. Any entry ramp located within about 3 km of a freeway to freeway interchange and aligned towards that interchange is likely to create weaving problems. Where provision of freeway access is unavoidable and the weaving volumes would be high, one solution to be considered is braiding of the entry and exit ramps (AGTM Part 6, Figure 6.1).

Braiding in this sense refers to the grade separation between ramps intersecting at a low angle on one side of the freeway. By this means, weaving is avoided.

Good signing is essential for such interchanges to operate satisfactorily.

B6.3.3 Route Continuity and Consistency

Separate Link (from RDG 5.4.7.2)

Access between freeways can be provided using a separate link as shown on Figure VB6.1. Connections of this type can be useful in highly developed urban areas. The disadvantages are the additional travel distances, and possible driver disorientation.

B6.5.2 System Interchanges

B6.5.2.1 Y Interchanges (from RDG 5.4.3)

The simplest interchange form for a three-way junction is the Y interchange in which the angle of intersection is acute. The basic Y interchange does not cater for all movements, but is oriented to serve major traffic demand in one quadrant. The omitted movements must be provided elsewhere.

If future traffic patterns and demands are uncertain, it is prudent to reserve land for the ultimate provision of all movements.

"Y" shaped interchanges which have no connection between the arms of the "Y" are shown on Figure VB6.2.

The interchanges operate as "major forks", see also, AGRD Part 4C, Section 11.2.3 and Section VB6.5.2.2. Where circumstances permit, access between the spread legs of these interchanges may be provided from a surface road which crosses the two arms.

"Y" interchanges with direct connections between the arms of the "Y" as shown on Figure VB6.3 are similar to the directional "T" layouts except that priority is given to the major legs of the Y, which are designed as freeway carriageways.
In the examples shown, major forks and branch connections have been provided for the minor movements between the upper arms of the "Y", see AGRD Part 4C, Sections 11.2.3 and 11.3.6 and VicRoads Supplement. These may be acceptable provided that right turns on the major fork are less than 30 per cent of the total traffic. In the case of the branch connection merges, it must be possible to provide exclusive lanes for the right-hand carriageway to avoid a right-hand merge. Refer to AGTM Part 6, Section 6.6.7 and 6.6.8 for additional information regarding major forks and branch connections.

Another option is the Trumpet interchange, which may also be used for a T-interchange. The trumpet interchange is not favoured for

freeway to freeway interchanges because a high speed carriageway ends in a low speed loop without passing through an obvious speed change area (discussed in Section B6.5.2.2). Where used, the option of "Type A" or "Type B" trumpet interchange (see Figure VB6.4) is chosen by assigning the loop to the lower turning volume. The "Type B" trumpet interchange is an appropriate application where the more direct alignment favours the major right turn and the loop provides for a volume less than 1000 v.p.h. Then the skewed crossing has a shorter travel distance and flatter turning radius for the heavier right-turning volume, and the turning angles for both right-turns are less.
B6.5.2.2 T Interchanges (from RDG 5.4.4)

The T interchange is the special case of a three-way junction where the legs intersect at or close to right angles.

There are three basic options for directional T interchanges as shown on Figure VB6.5 (a), (b) and (c).

In three-level option shown on Figure VB6.5(b) the connecting roadways cross over the centre of the interchange as with “the stack”, see Section B6.5.2.3.

The layouts on Figure VB6.5 (b) and (c) have outer ramp crossings. The location of the ramp intersection and the ramp grading are interdependent, and must satisfy the vertical clearance and maximum grade controls as well as providing a satisfactory horizontal alignment.

The feature of concern with all T interchanges is the design of the diverge in the carriageway at the end of the terminating freeway, called a major fork, see also AGRD Part 4C, Section 11.2.3 and VicRoads Supplement. At major forks, the horizontal geometry of each carriageway should continue past the gore without any kinks or tapers, as shown on Figure VB6.5(d).

When traffic volumes on the right turn are more than 30 per cent of the total, the lanes should be arranged as shown on Figure VB6.5(d). Where right turn traffic is equal to, or less than 30 per cent of the total, the crossover ramp shown on Figure VB6.5(e) may be considered. Refer to AGTM Part 6, Section 6.6.7 for additional information regarding the alignment of major forks.

Where slow moving trucks delay other traffic at a major fork or where the distance available between a previous interchange and the major fork is insufficient for entering trucks to weave safely across the high speed freeway lane, a separate ramp as shown on Figure VB6.5(f) may be justified.
B6.5.2.3 The Stack (from RDG 5.4.5)
The Basic Stack (from RDG 5.4.5.1)
The Basic Stack is among the most effective four-leg freeway-to-freeway interchanges which provide direct connections for all movements. Other four leg freeway-to-freeway interchanges can be considered as variations to the basic stack. The name "stack" relates to the arrangement of the ramps, which are stacked in pairs at different levels at the centre of the interchange.

Because of the high cost of four leg interchanges, several options should be considered, as even minor adjustments may significantly affect the construction cost or traffic operation.
Economic Factors (from RDG 5.4.5.2)
The cost of a stack depends on a number of factors including the ramp arrangement, the depth of cut and the curve radii used on the ramps.

(a) Ramp arrangements
The options available are shown in Table VB6.1.

(b) Design Speed
Although significant savings can be made by reducing ramp design speeds, safety is paramount, and the design speeds for ramp curves must correspond to the estimated operating speeds, see AGRD Part 3, Section 3 and associated VicRoads supplement.

(c) Earthworks Balance
Generally, construction costs decrease with cut depths relative to the cost of constructing from ground level upwards. Earthwork balance is required for maximum savings of up to 40 per cent, and this could require a cut approximately 10 metres deep. However, if pumped drainage is required, savings may not be realised.

(d) Angle between Freeways
Costs increase with skew and become significant when the skew angle exceeds 15 to 20 degrees.

(e) Structural Controls
Significant savings in structure costs can be made by standardizing the spans on as many structures as possible. The example below shows typical pier locations for an S1 stack.

Note the spacing between the upper ramps which has been designed to enable the ramp to be supported on single piers. Note also the use of equal spans on the upper structure.

Table VB6.1: Ramp Arrangement Options for the Stack
(from RDG Figure 5.4.5.2)

<table>
<thead>
<tr>
<th>Roadway Level</th>
<th>Type of Stack</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>S1</td>
</tr>
<tr>
<td>Highest</td>
<td>Ramp</td>
</tr>
<tr>
<td>Lowest</td>
<td>Freeway Ramp</td>
</tr>
</tbody>
</table>

NOTES:
1. Stack S1 has ramps at upper and lower levels with the two freeway carriageways in between. For cuts in excess of 8 metres deep, interchange S1 is the cheapest with the cost of the other interchanges increasing in order from S1 to S6.
2. For cuts less than 8 metres in areas with relatively low land values, interchange S2 can be cheaper than S1. The cost of the other stacks increase in the order shown. A disadvantage of S2 is the high rise and falls required for each ramp. For this reason S1 is considered to be preferable to S2.
3. Stack S4 has the best ramp geometry overall with minimum rise and fall.
4. Stack S5 does not appear to have any particular merit although S5 type interchanges have been constructed in the USA. The Hollywood Pasadena / Santa Anna Freeway interchange in Los Angeles is an example of this interchange. This layout should only be considered where local controls have a major influence on the ramp arrangement.
5. Stack S6 would only be considered if both freeways were elevated on the approaches.
(f) Interchange Height

Where an interchange is mainly on filling, there is a loss of capacity with increasing ramp height arising from reduction of truck speeds. This effect can be significant when the proportion of trucks exceed 10 per cent and where there are high rises and falls on the ramps.

Options available to the designer include:

- lower the interchange;
- choose a different ramp arrangement with less rise and fall;
- permit trucks to use the left shoulder;
- provide an additional lane for trucks;
- adopt a different interchange layout with less rise and fall on the ramps.

**Variants of the Stack (from RDG 5.4.5.3)**

The Open Stack is a variant in which all the centrally located ramps are replaced by inner ramps, see Figure VB6.8(a). Variants of the Open Stack with the inner ramps moved out further from the centre are shown on Figure VB6.8(b) to VB6.8(e). These layouts are usually not favoured because they require more land than other options.

Open stacks may be considered for use where:

- land is cheap, usually in rural areas, or
- the basic stack is considered to be unacceptably high because of noise or visual intrusion effects, and
- the slight savings in travel distance are considered to be worthwhile.

There are many other variants of the stack, replacing centrally located ramps with combinations of inner and outer ramps, as shown in Figure VB6.9.
Figure VB6.8(a) to (e): Open Stacks and Variants
(from RDG Figure 5.4.5.3(a) to (e))

(a) Basic open stack

(b) Open stack
(1 inner ramp)

(c) Open stack
(2 inner ramps)

(d) Open stack
(3 inner ramps)

(e) Open stack
(4 inner ramps)
Figure VB6.9: Variants of Stack Interchanges
(from RDG Figure 5.4.A.1)
The Turbine is a stack with outside turns as shown on Figure VB6.10. Some variants of The Turbine include loops. The variants are shown in Figure VC6.11.

The Turbine could be considered for use where:

- the height of a stack is considered visually intrusive in urban areas;
- the use of simple single level structures is desirable, such as in areas with poor foundation conditions.

A disadvantage of The Turbine is the low radius curve either at the start or end of each turbine ramp.

Figure VB6.10 The Turbine Interchange (from RDG Figure 5.4.5.3 (f))
B6.5.2.4 Interchanges with Loops (from RDG 5.4.6)
Loops (from RDG 5.4.6.1)
Loops are ramps which provide indirect right turn movements. They are usually circular. A single lane loop should only be considered for a quadrant with traffic volumes less than 900 pcu/h in the design year.

Loops have been incorporated into many interchanges overseas because they are cheaper than semi-direct turning roadways and require less land acquisition. However, accident rates are higher than comparable rates on turning roadways, see Appendix VC.

A number of interchanges in the USA which were originally constructed with loops have subsequently had turning roadways constructed to replace the loops in order to increase capacity.

A cloverleaf interchange may be considered at the intersection of two freeways in a rural environment where right-turns at-grade are to be avoided, demand for weaving is minimal, and the cost of right-of-way is
relatively low. This interchange form has the safety disadvantage of low speed loops exiting from high speed lanes.

Partial cloverleaf designs may be used where land is not available in one or two quadrants, or where one or two movements in the interchange are large compared to the others and grade separation of the movement would provide superior operation. Cloverleaf interchanges with or without collector distributor roads are usually not economical for urban construction because of the large area required.

**The Cloverleaf (from RDG 5.4.6.2)**

The Cloverleaf Interchange has a loop in each of the four quadrants. However, only the cloverleaf with two sets of collector distributor roads is suitable for use as a freeway to freeway interchange, see Figure VB6.12. The topic of collector-distributor roads is covered in Section B6.5.2.5. The safety benefits of collector distributor roads are reflected in the lower accident rates evident in Appendix VC. The interchange is better suited to a semi-rural or rural area, due to the large area it occupies.

The disadvantages compared with direct or semi-direct interchanges are the extra travel distance required for right turning traffic, and the weaving manoeuvres generated between adjacent entry and exit noses.

Collector-distributor roads should be used in order to avoid:

- two closely spaced exits on the main carriageway,
- problems associated with signing for the second exit, and
- weaving on the main carriageway.

An analysis should be undertaken on weaving between the two adjoining loops, as at certain volumes interference increases rapidly and causes a reduction of through traffic speed.

Two lane loops would require widening of the grade separation structure by two lanes, larger radii and greater separation of the terminals of adjacent ramps. Usually two lane loops are not economical on account of construction cost, land acquisition, and additional travel distance. Therefore, two lane loops are rare.

Economic evaluations comparing loops with directional ramps should take into account the additional costs of the collector distributor roads required.

**Other Interchanges with Loops (from RDG 5.4.6.3)**

Semi-directional interchanges with loops but no weaving are shown on Figure VB6.13. Spread of through lanes is not required for these schemes. However, four or more structures are required. Single exits and entrances on the left enhance operational characteristics of these layouts.
The purpose of a collector-distributor road is to accommodate weaving clear of the through carriageway, and to provide adequate capacity while minimising the number of entry and exit points, see Figure VB6.14. Collector-distributor roads are one-way roads which traverse a single interchange, or pass through two interchanges, or which pass continuously through several interchanges rather like a continuous frontage road except that access to abutting property is prohibited. In addition to removing weaving from the through carriageways, collector-distributor roads allow single entrances and exits to be developed, allow exits from the through carriageway to occur in advance of the structure, and allow a uniform pattern of exits to be maintained.

The minimum number of lanes on a collector distributor road is two. Continuous collector-distributor roads should be integrated into the basic lane design, and capacity analysis and basic lane determination should be performed for the overall system rather than for the separate carriageways. The operating speed of collector distributor roads is usually slower than the main carriageway because of the interference caused by weaving.

The shoulders on a collector distributor road should at least equal the widths of those on the adjacent main carriageway, and in weaving sections it is desirable to have a 3-metre right shoulder so that trapped or broken-down vehicles do not disrupt traffic flow.

The collector-distributor road should be separated from the main carriageway by the required minimum width of clear zone, or by a safety barrier.

Operational problems will occur if collector-distributor roads are not properly signed, and those servicing more than one interchange will require special consideration.
Transfer Roads (from RDG 5.4.9.2)
Connections between the main carriageways and collector distributor roads are called transfer roads, which may be either one or two lanes. The principle of lane balance applies to design of transfer roads at both ends. The left-hand shoulder of the transfer road should be equal in width with that on the main carriageway. The terminals of the transfer roads should be designed as entry or exit ramps, see AGRD Part 4C, Sections 11.2 and 11.3 and VicRoads Supplement.

B6.5.3 Service Interchanges

Additional Information

Buttonhook Ramps (from RDG 5.2.4.1)
Unusual configurations where ramp connections are made to roads remote from the secondary road over the freeway, such as so-called “buttonhook” ramps, should be avoided, as they confuse many drivers.

B6.5.4 Characteristics of Service Interchange Types (shown in AGTM Part 6, Table 6.1)

Figure 6.7: Conventional Diamond Interchange

Additional Information

Reasons for the preference given to diamond interchanges include:

(a) they are readily recognised from the freeway, and consistently present the simple driving tasks of exiting from the left, decelerating on the ramp, and turning at the terminal;

(b) diamond type ramps are about 30 per cent safer than loop ramps, see accident rates for different ramp types tabulated in Appendix VC;

(c) the right of way requirements are lower than Parclo's A and B;

(d) all exits precede the bridge, a desirable operational feature;

(e) ramp terminals can be signalised when warranted;

(f) where other roads intersect near the ramp terminal, a roundabout may be an appropriate ramp terminal treatment.

Figure 6.11: Split Diamond Consideration

Additional Information

Performance is improved if the split diamonds are placed on pairs of one way roads as shown on Figure VB6.11a. One advantage is that storage on the structure for right turning vehicles is not required.

Figure 6.13: Grade Separated Roundabout

Additional Information

Traffic volumes of 30,000 to 35,000 pcu’s/day can be handled on the roundabout although delays to lower volume movements occur if the traffic movements are not balanced. In this circumstance, performance can be improved by signalising the entries to the roundabout.

As an ultimate development, the cross road can be grade separated over the roundabout to create a three level roundabout interchange, see Figure VB6.13a.
Additional Information
The minor (secondary) road grade should be less than 2%.

Single point urban diamonds cost 50% to 100% more to construct than conventional diamonds, due mainly to the structures. In the secondary-road-over case, complex shaped structures are required. Wider structures are often required so that the bridge railing is offset sufficiently to meet sight distance requirements.

Additional Interchange Types, Elements and Consideration not covered in AGTM

BV6.5.6 Trumpet Interchanges

Trumpet Type A

Additional Information
The Trumpet caters for all movements at a three-legged intersection. Care must be taken with signing on the secondary road, because right turns and left turns to the freeway both exit to the left.

When viewing the Trumpet Type A in the direction of freeway traffic, the loop appears before the bridge, see Figure VB6.4.

The main hazard with the Type A layout is that approach speeds on the secondary road exceed the safe speed on the loop, and the loop is obscured from view by the bridge parapet. For these reasons, this layout should not be used unless:

(a) traffic volumes in the quadrant served by the loop are low, and
(b) loop approach speeds can be controlled.

BV6.5.7 Trumpet Type B

In the Trumpet Type B, when viewed from the direction of through traffic the loop appears on the far side of the structure, see Figure VB6.4.

Generous radii should be used for the right turn ramp from the secondary road to the freeway in order to prevent truck instability.

Where the exit nose from the freeway to the loop would lie in the shadow of the structure, drivers may have difficulty in identifying the exit; preferably, the exit nose should be moved in advance of the structure.

BV6.5.8 Cloverleaf Interchanges

Cloverleaf interchanges can be used either as freeway to freeway interchanges, see The Cloverleaf in Section VB6.5.2.4, or as surface road interchanges. As they are more expensive than conventional diamonds, cloverleafs would only be considered for use for connections between major arterials and freeways.

The principal deficiency of the layout is the limited capacity within the weaving sections between the loops. As a guide, cloverleafs without collector distributor roads have weaving capacities of only 500 to 1000 veh/h. The lower value applies when traffic volumes between a loop pair are unbalanced. Cloverleafs with collector distributor roads have greater weaving capacities which should be determined by analysis, with expected values between 1000 and 1500 veh/h, see Figure VB6.15.

Factors to be considered with cloverleaf interchanges include:

- the capacity of the weaving section between loops depends on the distance between the noses. This can be maximised by using either loops with radii greater than the 55 metres minimum specified in ”Exit Loop Ramps” and ”Entry Loop Ramps” in AGRD Part 4C, Section 8.3.4 and VicRoads Supplement, or using elongated loops. Loops for cloverleaf interchanges should have radii in the order of 60 metres to 80 metres. At some locations elongated loops may be required although these are not favoured because of their increased accident rates.
the larger the loop radius, the larger the area of the interchange and the longer is the travel distance. However, typical cloverleafs require areas comparable to other types of freeway to freeway interchanges.

- generous sight distance must be provided to exit ramp noses on downhill loops. This can only be achieved when the approach road is either relatively flat or on a sag vertical curve.
- collector distributor roads should be used, and should be provided with full width shoulders on both sides of the carriageway adjacent to the weaving area as a refuge for trapped or disabled vehicles.

**BV6.5.9 Parclo Interchanges**

**General**

The partial cloverleaf interchange, or Parclo, has loops usually in two quadrants and at-grade junctions where the ramps meet the secondary road. The determination of which quadrant is to be without ramps is usually dependent on availability of right of way, or the predominant turning movements to be handled. This type of interchange may be adopted where design controls such as industrial development or protected environmental features in one or more quadrants preclude use of a diamond interchange. It can be used to great advantage for grade separating major turning movements. When evaluating interchange options, one factor is that accident rates are higher on loop ramps than on diamond ramps, see Appendix VC.

Parclo interchanges can be used to increase the effective weaving length between closely spaced interchanges. However, the Parclo's will generally not permit passage of abnormally high loads due to bridge clearance restrictions except in the case of A4 and B4 type interchanges which have similar ramps to diamonds, see Figures 6.16 and 6.18 shown in AGTM Part 6, Table 6.1 and VicRoads Supplement.

Guidelines for Parclo Interchanges include:

- the ramp arrangement should enable major turning movements to be made by left-turn exits and entrances;
- where the through traffic volume is significantly greater than on the secondary road, preference should be given to an arrangement placing the left-turns, either exit or entry, on the freeway, even although it results in a direct right turn from the secondary road.

Other factors to be taken into account when considering the use of a Parclo include:

(a) clear advance direction signs are essential, as drivers on the secondary road may be confused by the need to turn in the opposite direction to their intended direction of travel;

(b) an auxiliary acceleration lane will be required beyond the entry nose, as truck speeds at the end of loop entry ramps will be less than the acceptable minimum merge speed;

(c) wherever a loop is proposed in order to increase weaving distances between closely spaced interchanges, a weaving analysis is required to ensure that truck numbers and speeds will not create a bottleneck within the weaving section;

(d) loops shall not be designed entirely with spirals, that is, without any circular curve;
(e) loops with compound curves or straights have higher accident rates than circular loops.

In determining whether the freeway goes under or over at a Parclo interchange, it is desirable that traffic slowing (uphill) approaching the minor road and accelerating (downhill) approaching the freeway.

When viewing a Parclo A interchange in the direction of freeway traffic, the loop appears before the bridge. In the Parclo B, the loop

**AGTM Figure 6.15: Parclo A**

Substitute information

Figure in AGTM is incorrect. Use the Figure VB6.15a shown below.

---

**Figure VB6.15a: Parclo A**

(from RDG 5.5.6.2)

![Figure VB6.15a](from RDG 5.5.6.2)

**AGTM Figure 6.16: Parclo A4**

Substitute information

Figure in AGTM is incorrect. Use the Figure VB6.16a shown below.

**Figure VB6.16a: Parclo A4**

(from RDG 5.5.6.3)

![Figure VB6.16a](from RDG 5.5.6.3)
**AGTM Figure 6.17: Parclo B**

Substitute information
Figure in AGTM is incorrect. Use the Figure VB6.17a shown below.

If the right turn from the secondary road is on the bridge, storage length may be restricted unless increased by additional structural width.

![Figure VB6.17a: Parclo B](from RDG Figure 5.5.6.4)

**Figure 6.18: Parclo B4**

Substitute information
Figure in AGTM is incorrect. Use the Figure VB6.18a shown below.

If the right turn from the secondary road is on the bridge, storage length may be restricted unless increased by additional structural width.

![Figure VB6.18a: Parclo B4](from RDG Figure 5.5.6.5)
Figure 6.19: Parclo AB

Clarification information
Figure VB6.19a below clarifies the movements at the minor road terminals. The loop exit ramp nose is located in the preferred position, in advance of the structure.

Figure VB6.19a: Parclo AB  
(from RDG Figure 5.5.6.6)

B6.7.1 Basic Lane Numbers
Localised volume decreases are ignored, while increases on short sections may be accommodated by auxiliary lanes.

An increase in the basic number of lanes is required where traffic builds up sufficiently to warrant an extra lane in each direction over a substantial length of the route.

Figure VB6.16: Basic Number of Lanes  
(from Figure 5.2.7.1)

B6.8.2 Traffic Data Requirements
Estimation of traffic volumes may be based on either:

(a) transport planning studies in urban areas involving the estimation of future network volumes using computer modelling techniques, together with a detailed assessment of localised influences; or

(b) in rural areas, estimated volume based on growth trends within corridors.

In urban areas capacity is normally important, and designs are based on predicted peak hour volumes for the design year. However, the traffic demand on a new freeway may result in it operating at capacity a relatively short time after opening. In this situation the design should aim to provide reasonable capacity, but more importantly to achieve a balanced level of service throughout the freeway.

B6.8.4 Level of Service
Refer to AGTM Part 3: Traffic Studies and Analysis for Level of Service definitions and methods of analysis.

The most critical points for analysis are usually just upstream of a diverge or just downstream of a ramp merge. Traffic using the interchange elements should be able to
operate at a satisfactory level of service without reducing the design level of service on the freeway.

Calculations should be carried out in accordance with the *Highway Capacity Manual* (Transportation Research Board 2000).

Target levels of service in the design year will be influenced by economic and political criteria, and the designer should aim to achieve the highest practicable levels. Suggested guidelines are set out in Table VB6.2.

The appropriate measure for signalised ramp terminals is degree of saturation rather than level of service. Closely spaced ramp terminals where signals will be required should be designed as complex signalised intersections. Four phase systems with phase overlap are more efficient than three phase systems. The target sum of the critical ratios of flow to saturation flow in the design year should not exceed 0.9.

### Table VB6.2: Target Levels of Service in Design Year (from RDG Figure 5.3.4.2)

<table>
<thead>
<tr>
<th>Road Type</th>
<th>Environmental and Terrain</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Rural Level</td>
</tr>
<tr>
<td>Freeway</td>
<td>B</td>
</tr>
<tr>
<td>Arterial</td>
<td>B</td>
</tr>
<tr>
<td>Collector</td>
<td>C</td>
</tr>
<tr>
<td>Local</td>
<td>D</td>
</tr>
</tbody>
</table>
Appendix VC

Interchange Forms
(from VicRoads RDG Part 5: Interchanges Appendix 5.2.A.1)

Appendix to AGTM - Part 6, Section 6.5: Interchange Forms

Interchange Layouts by Kenichi Takebe
Interchange Layouts by Kenichi Takebe (continued)
Interchange Layouts by Kenichi Takebe (continued)
Interchange Layouts by Kenichi Takebe (Continued)
Interchange Layouts by Kenichi Takebe (Continued)
Appendix VD

Ramp Accident Rates

(from VicRoads RDG Part 5: Interchanges Appendix 5.4.B)

The accident rates in Table VC1.1 were extracted from a paper by R A Lundy entitled, "The effect of ramp types and geometry on accidents". The main conclusions which can be reached from the figures are:

- diamond type ramps are significantly safer than other ramp types.
- cloverleaf loops on collector distributors are significantly safer than loops which connect directly to the freeway.
- ramps which diverge from the right hand side of the freeway have more than three times the number of accidents than ramps with left hand exits.

More detailed information on accident rates can be obtained from "Accidents and safety associated with interchanges" in TRR1385.

Table VC1.1: Accident Rates on Ramps
(In Accidents per Million Vehicles)
(from RDG Figure 5.4.B.1)

<table>
<thead>
<tr>
<th>TYPE OF RAMP</th>
<th>ROAD OVER FREEWAY</th>
<th>ROAD UNDER FREEWAY</th>
<th>TOTALS FOR EACH RAMP TYPE</th>
<th>TOTALS FOR ALL RAMPS</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Entry</td>
<td>Exit</td>
<td>Entry</td>
<td>Exit</td>
</tr>
<tr>
<td>Diamond Ramps</td>
<td>0.35</td>
<td>0.67</td>
<td>0.46</td>
<td>0.66</td>
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<tr>
<td>Loops without CD road</td>
<td>0.76</td>
<td>0.83</td>
<td>0.82</td>
<td>0.94</td>
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<tr>
<td>Cloverleaf loops with CD road</td>
<td>0.39</td>
<td>0.52</td>
<td>0.38</td>
<td>0.08$^1$</td>
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<tr>
<td>Right hand exit ramps</td>
<td>0.74</td>
<td>1.74</td>
<td>1.38</td>
<td>2.64</td>
</tr>
<tr>
<td>Buttonhook ramps</td>
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<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Scissor ramps</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Averages$^2$</td>
<td>0.59</td>
<td>0.89</td>
<td>0.6</td>
<td>1.07</td>
</tr>
</tbody>
</table>

Notes:
1. Only 5 cases were included in the study
2. Averages are based on the number of ramps included in the original study.