Road and Traffic Engineering

Supplement to Austroads Guide to Road Design (AGRD)

Part 4C: Interchanges (2015)

Version 3.0, April 2020

VICTORIA State Government | Department of Transport

Supplement to Austroads Guide to Road Design Part 4C: Interchanges (2015)

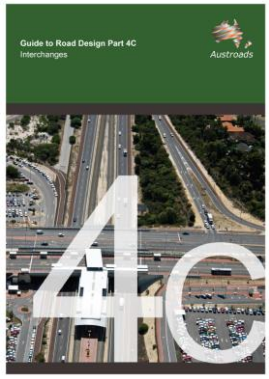
This Supplement must be read in conjunction with the Austroads Guide to Road Design.

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

Document Purpose

This Supplement is to provide corrections, clarifications and additional information to the *Austroads Guide to Road Design Part 4C: Interchanges* Second Edition published in December 2015. This Supplement refers to the content published in the Second Edition of this part to the guide.

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



Document Revision History

Version	Date	Type of Change	Description of Change
1.0	July 2010		Development of Supplement
1.1	Sept 2010		Minor changes to text, references and layouts.
2.0	July 2011		Rural left turn treatment
3.0	April 2020		Changes to format, updating references, removing duplicate information

Additional Notes on Current Version

Section 6.4.1. Ramp Design Speed: Updated information about Exit Ramp Design Speed

Section 7.4. Entry Ramp Nose: Updated information for Entry Ramp Nose Sight Distance calculation

CONTENTS

1.0. Introduction

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 A of the Supplement has been included to provide some additional planning and design consideration guidance in a single location.

This Supplement should be read in conjunction with *VicRoads TEM Volume 1 Part 2.06: Supplement to Austroads Guide to Traffic Management Part 6: Intersections, Interchanges and Crossings*.

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 A, 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

2.2. Design Considerations

2.2.3. Design Considerations Process and Principles – Stormwater Drainage

Additional Information

Refer to *VicRoads Supplement to AGRD Part 5 – Drainage Design*.

2.2.5. Public Transport – *Freeway access ramps for Buses*

Additional Information

Refer to *VicRoads Managed Motorway Design Guide* for additional information regarding provision of bus only lanes on metered entry ramps.

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 *VicRoads TEM Volume 1 Part 2.06: Supplement to Austroads Guide to Traffic Management Part 6: Intersections, Interchanges and Crossings* .

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 Part 2.15: Supplement to AS 1742.15*.

3.0. Forms of Interchange

3.1. Traffic Considerations

Departure

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.

4.3. 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.

5.0. Cross-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*.

Refer to *VicRoads Managed Motorways Design Guide Volume 2 Part 3 Section 3.7.2* and *Section 3.7.3* for warrants for lanes on ramps.

Exit Ramps

Departure

Single-lane (at the nose) exit ramps should be widened to two lanes on the ramp when the ramp is longer then **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 of this Supplement.

Departure

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 11 ((a)-(c)) and Figure V11.12 of this Supplement.

Entry Ramps

Departure

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

Departure

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

Departure

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.

Departure

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 5.1: Ramps

Departure

AGRD Part 4C, Table 5.1 shall not be used. Use the Figures V11.1 to V11.10 and Table V5.2 of this Supplement. Refer also to Figures V5.1(a) and V5.1(b).

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

Number Of Lanes (One Way)	**Left Shoulder** (m)	**Right Shoulder** (m)
Single	3.0	1.0
Two ADT<2000	1.0	1.0
Two ADT>2000	3.0	1.0
Three	3.0	3.0

Kerbs

Departure

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.

Figure V5.1(a): Typical Freeway Ramp Cross Sections Ramps at System (Freeway to Freeway) Interchanges (from RDG Figure 3.14.2(a))

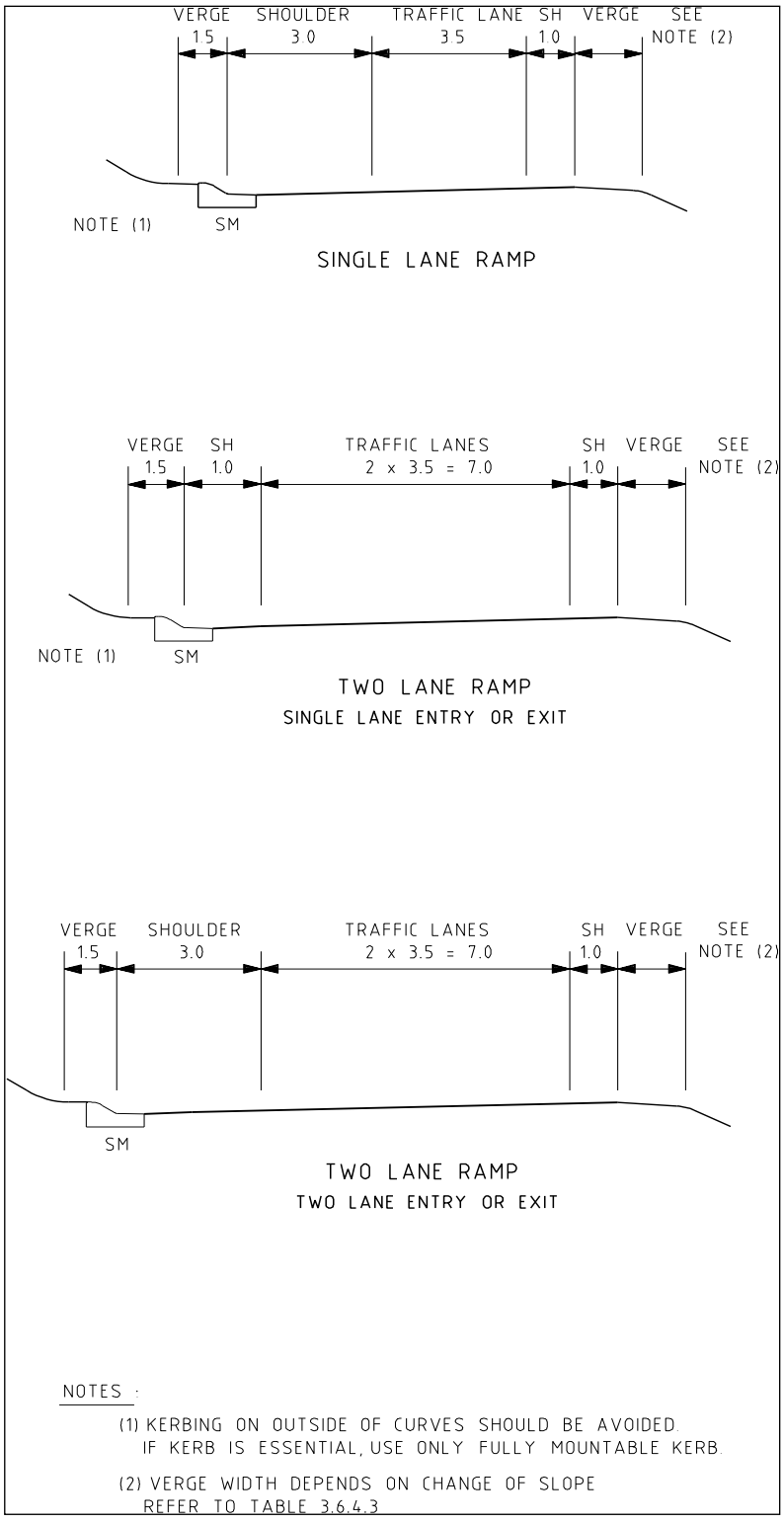
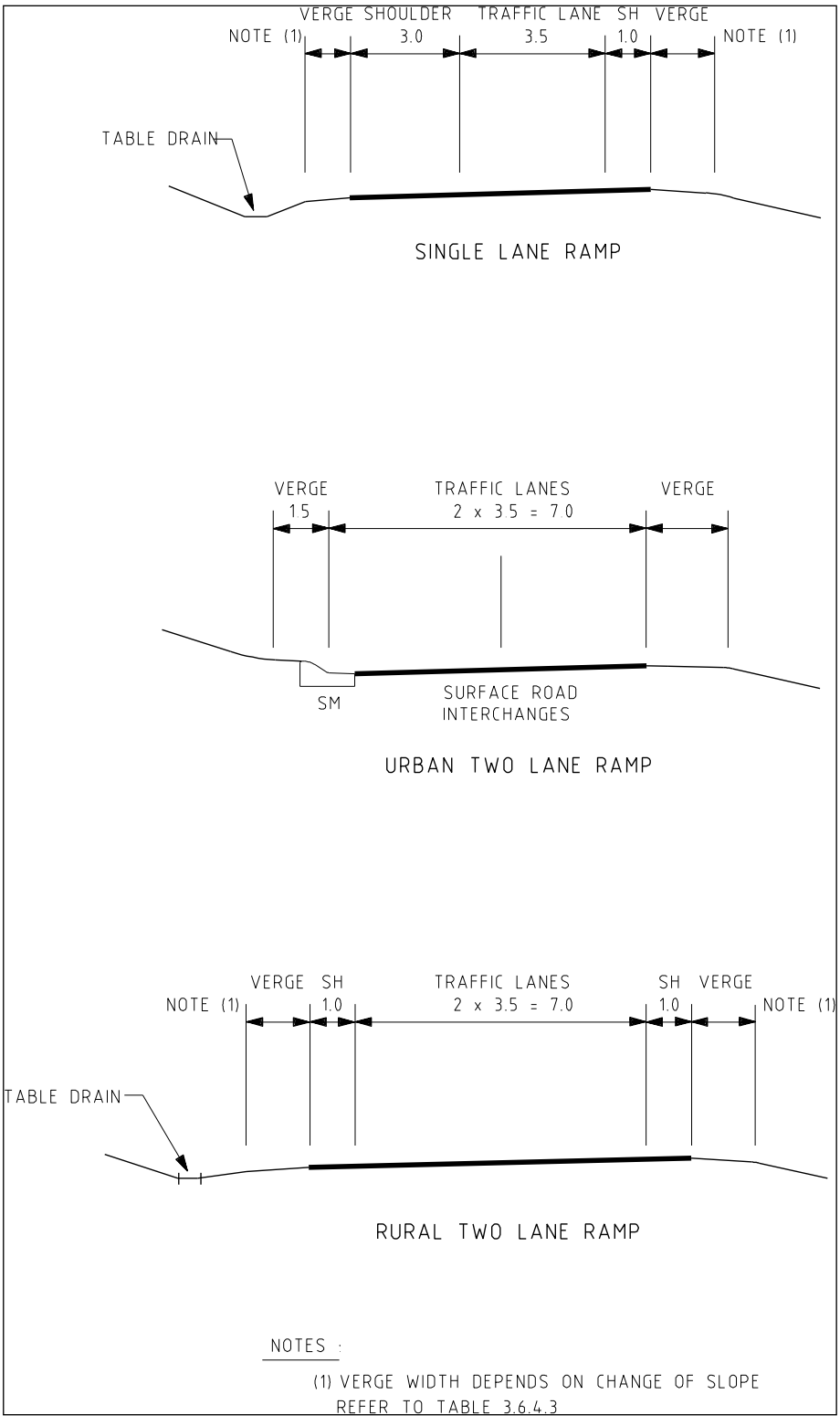


Figure V5.1(b): Typical Freeway Ramp Cross Sections Ramps and Loops at Service (Freeway to Surface Road) Interchanges (from RDG Figure 3.14.2(b))



6.0. Design Speed

6.3. Minor Road

Additional 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.

Departure

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

Entry Ramps

Departure

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.

Exit Ramps

Additional Information

Ramps should be designed to provide safe sight distance for cars and trucks at all locations using estimates of vehicle operating speeds. The assumed operating speed of 80 km/h should be adopted as the design speed at the exit ramp nose. The design speed for the rest of the ramp should desirably be 80 km/h but may be reduced where warranted along the ramp length. The design speed adopted along a ramp shall be based on measured operating speed where available or based on use of an appropriate rate of deceleration for the context being addressed. Where a reduction in design speed is considered along a ramp, a design speed of 80km/h shall be provided from the nose and along the ramp length until the location where the vehicle will need to commence to decelerate to an appropriate speed at the ramp terminal location (i.e. either a stop condition or relevant exit speed).

For the purpose of determining the extent of the ramp where consideration can be given to reducing design speed, a coefficient of deceleration (d) no greater than 0.36 shall be adopted - refer AGRD Part 3 and/or AGRD Part 4A for further information regarding rates/coefficient of deceleration. On steep downgrades, allowance should be made for the effect of the grade on vehicle speeds and stopping distances.

6.4.2. Other Considerations

Additional 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

7.2. Stopping Sight Distance on the Major and Minor Road

Departure

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

Single Point Urban Intersection – Ramp Throat at Surface Road

Additional Information

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

Additional Information

Desirable minimum sight distances at entry ramp noses shall be provided in accordance with *AGRD Part 4C, Section 7.4*. The speed used for sight distance calculations shall be the greater of the Design Speed or, where applicable, the highest speed limit proposed to be displayed where Variable Speed Limits (VSL) are deployed.

7.5. Safe Intersection Sight Distances

Note: Heading should be just “Sight Distance”

Secondary Road over the Freeway

Additional Information

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

Departure

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. RT = 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

8.2. Minor Road

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 1.0 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)

SPEED	RADIUS R (m)
120	3000
100	2400
80	1800
60	1000

1. See Figure V8.1.

8.3. Ramps

8.3.2. Geometric Requirements and Table 8.1: Geometric Requirements

Departure

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

Departure

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)

	INTERMEDIATE SPEED (URBAN)	HIGH SPEED
R min	250 m	300 m
Minimum Tangent after Nose:		
Freeway straight or on left curve	30 m	40 m
Freeway on right hand curve	70 m	70 m

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*

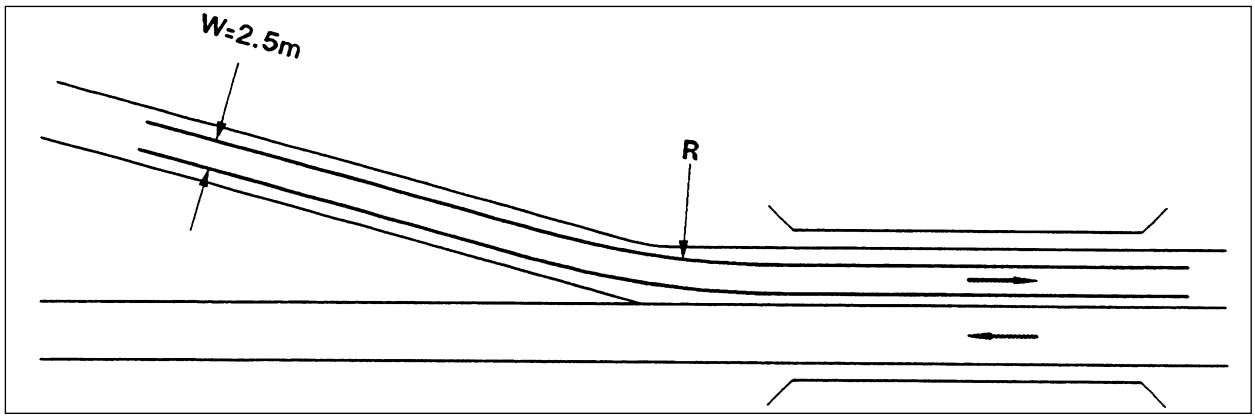
Additional Information

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.

Figure V8.1: Development of Alignment Shifts (from RDG Figure 5.7.5.3)



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.

9.0. Vertical Alignment

9.2. Minor Road

9.2.2. Spread Diamond

Departure

Refer to Section 6.3 of this Supplement for clarification of Design Speeds on the minor road.

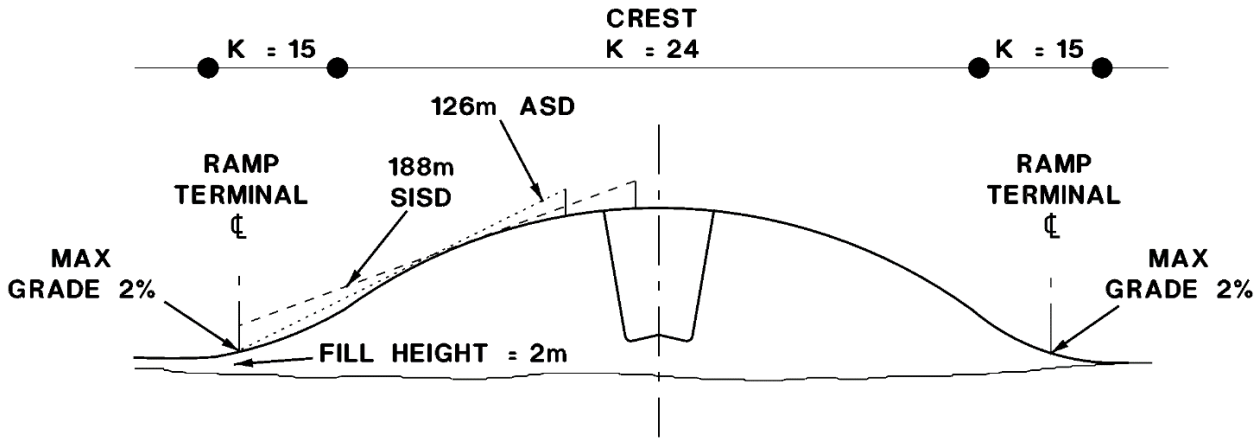
A minimum reaction time, RT, of 2.0 sec shall be used for the design elements around an interchange.

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.

Figure V9.1: Spread Diamond – Secondary Road Grading (refer to AGRD Part 4C Figure 9.1(c) and (d))

(from RDG 5.7.8.1)



10.0. Ramp Terminals at Minor Road

10.1. Ramp Terminal Locations

Departure

(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, R_1, depends on the angle between the ramp and the secondary road, angle ϕ as shown on Figure V10.1. Radius R_1 is obtained from Table V10.1.

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

Angle ϕ degrees between the ramp and cross road	Right turn radius R_1
30	20
40	25
50	30
60	40
70	45
80	45

Exit Ramp Splitter Island

Departure

The reference to Part 4 is incorrect, the reference should be to Part 4A.

10.2.2. Entry Ramp Alignment at Minor Road Terminals

The right-turn roadway

Additional Information

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))

ENTRY RAMP TEMPLATE RADIUS	
Ramp Angle θ [1] (Degrees)	Right Turn Radius[2] (m)
25[3] - 50	20
51 - 69	25
70 - 80	30

1. ***The angle θ 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(a): Radius of Turning Template (Right Turn) (Refer to AGRD Part 4C, Figure 10.2)

(from RDG Table 5.7.10.3 (a))

Ramp Angle θ[1] (Degrees)	Left Turn Radius[2] – R (m)
25 -50	175 m
50 - 69	120 m
70 - 80	80 m
Oblique[3]	20 m

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

Rural Channelised Left-turn (CHL) Treatment with Acceleration Lane at Freeway Entry Ramp

Additional Information

Where a Channelised Left-turn (CHL) Treatment with an acceleration lane in a rural location is proposed at a Freeway entry ramp terminal to cater for the movement from the minor road on to the entry ramp, the performance of design vehicle that will be using the route needs to be considered. Where truck volumes warrant (i.e. where this intersection form is catering for a recognised or likely truck route), a truck turning speed of 15km/h to 20km/h (or greater) shall be adopted for the determination of appropriate swept path for the left turn configuration.

It is also important that the trailing nose of the island be extended to minimise the risk of trucks encountering adverse superelevation at the exit to the left turn movement.

It should be noted that this type of left turn treatment may not be desirable if pedestrian and bicycle volumes are significant.

Selection of an appropriate truck turning speed at an entry ramp terminal should consider the overall entry ramp geometry and provide for appropriate truck merging speeds to be achieved at the freeway entry ramp nose.

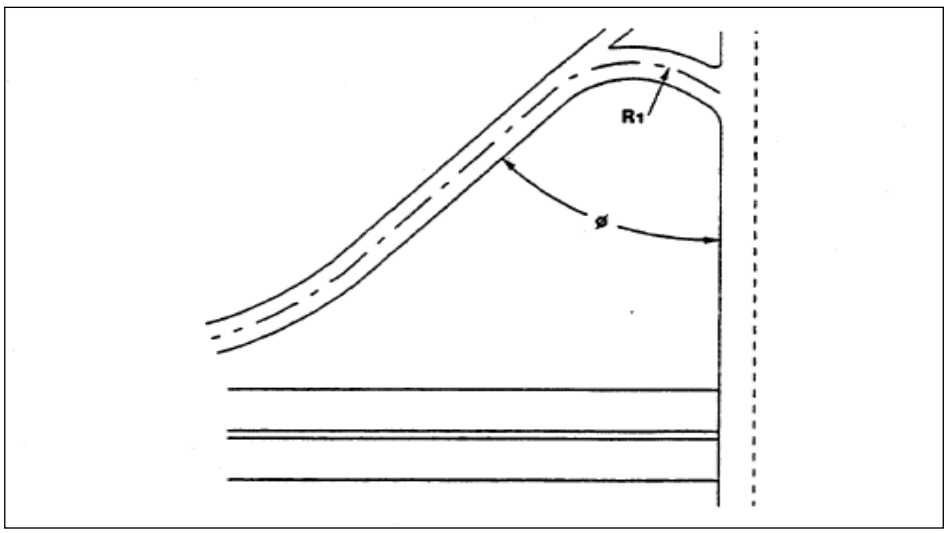
10.3. Ramp Terminal at Minor Road

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.

Figure 10.1 – Example of an exit ramp terminal - Substitute Information

Figure V10.1: Definition of Angle ϕ (from RDG Figure 5.7.10.1)



V10.4. Accident Patterns at Diamond Interchanges

Additional Information

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

Additional Information

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)*).

For turning path requirements for Heavy Vehicles refer to *VicRoads Road Design Note 0401 Heavy Vehicle Access Requirements*.

V10.6. Single Point Diamond Interchange

V10.6.1. Features (from RDG 5.7.13.1)

Additional Information

Refer to Figure 6.14 shown in *AGTM Part 6, Table 6.1* or Figure V10.2 of this Supplement.

The main features of the layout are:

- the use of a single intersection at the centre of the interchange in place of the two intersections on normal diamond layouts;
- at the centre of the interchange, right turning vehicles have opposing vehicles passing on the left side, which is unusual for an interchange but identical to at-grade cross intersections;
- 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)

Additional Information

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)

Additional Information

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)

Additional Information

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)

Additional Information

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)

Additional Information

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)

Additional Information

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 right turners.

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

Additional Information

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 V10.3: Sight Distances on Single Point Diamond RT Lanes (from RDG Table 5.7.13.8)

RADIUS (m)	CAR SPEED km/h (Approx.)	SIGHT DISTANCE (m)
60	50	48
70	53	54
80	56	60
90	60	67

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)

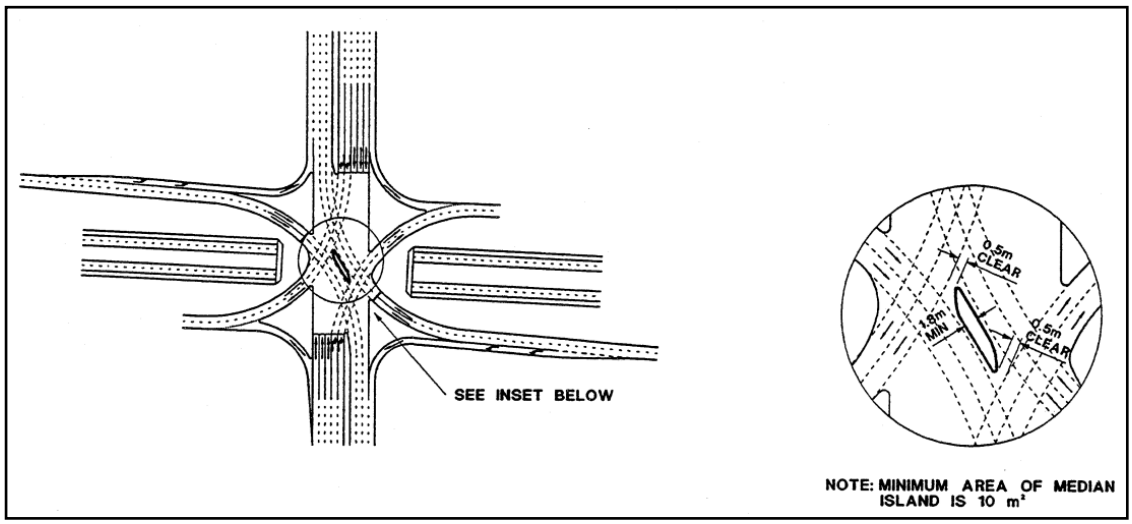
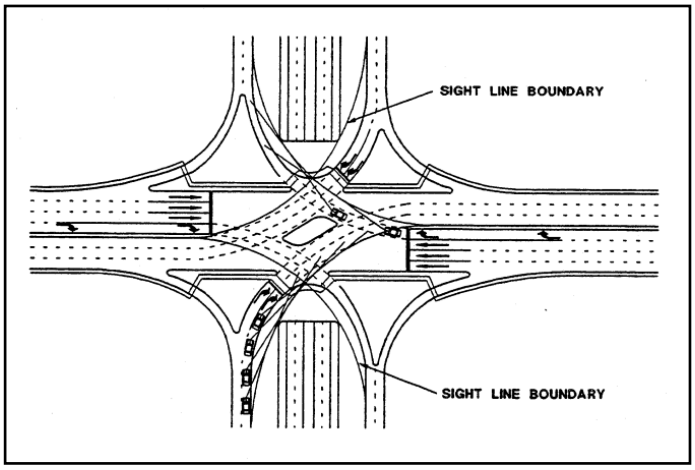


Figure V10.3: Sight Distance Diagram (from RDG Figure 5.7.13.8)



11.0. Ramp Terminals at Major Road

Additional Information

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

Exit and Entry Ramp – Nose Details

Departure

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)

Additional Information

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)

Additional Information

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.

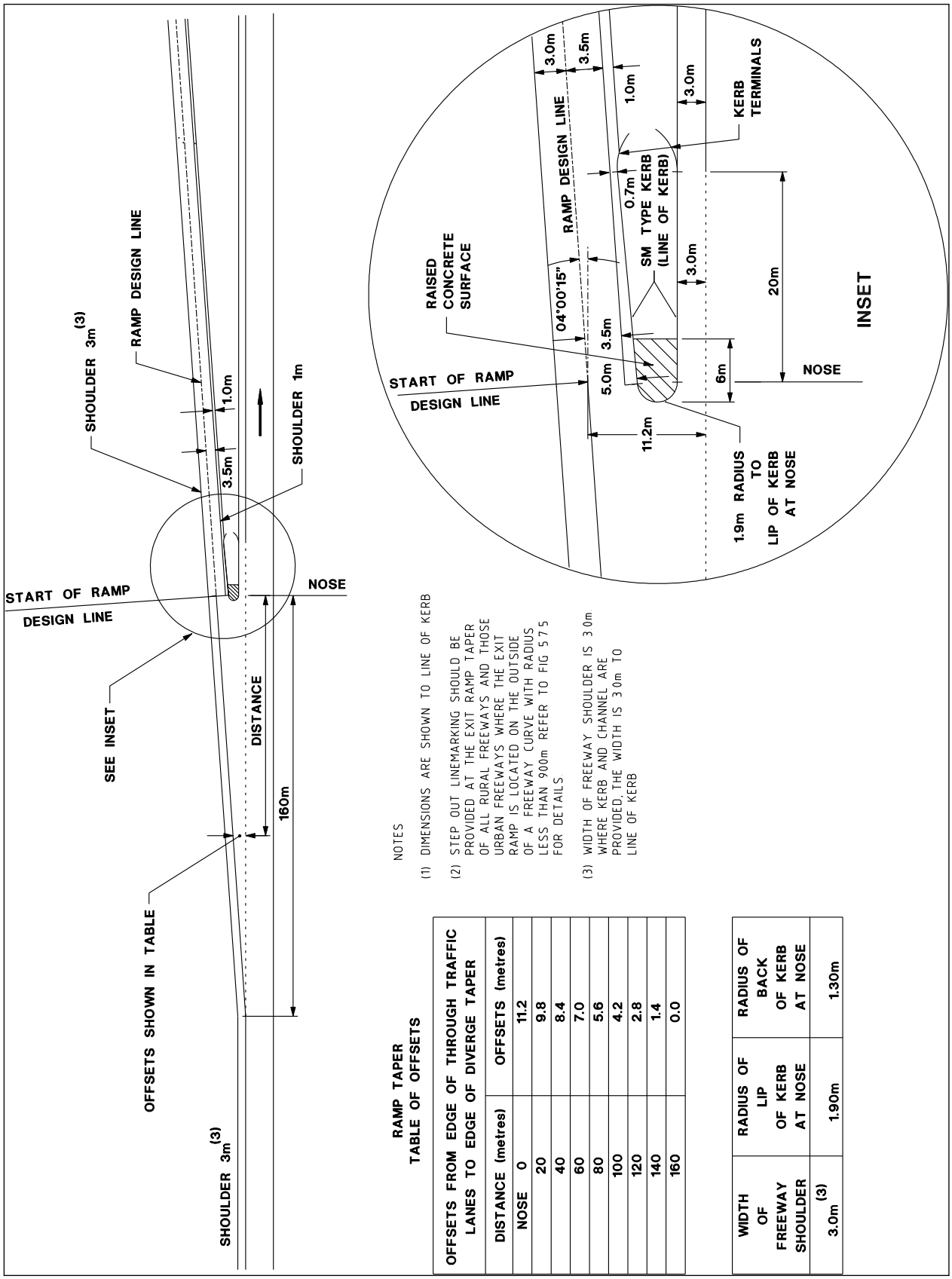
The markings associated with the various exit and entry ramp details shall be in accordance with *VicRoads Traffic Engineering Manual*.

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

EXIT RAMP TYPE [1]				
No. of Lanes at Nose	No. of Lanes on Ramp	Shoulder (S) or Kerb (K) on Ramp Proper		Figure Number
		LHS	RHS	
1	1	S (3 m)	S (1 m)	V11.1
1	2	S (1 m)	S (1 m)	V11.2
1	2	K	K	V11.3
2	2	S (3 m)	S (1 m)	V11.4
Exit Ramp - Step Out Markings at Exit Ramp Tapers[2]				V11.5
ENTRY RAMP TYPE [1,3,4]				
1	1	S (3 m)	S (1 m)	V11.6
1	2	S (1 m)	S (1 m)	V11.7
1	2	K	K	V11.8
2	2	S (3 m)	S (1 m)	V11.9
2	2	S (3 m)	K	V11.10

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:***
    a. ***the shoulder shall not be less than 1 metre wide at any point, and***
    b. ***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 TAPER
TABLE OF OFFSETS

OFFSETS FROM EDGE OF THROUGH TRAFFIC LANES TO EDGE OF DIVERGE TAPER	
DISTANCE (metres)	OFFSETS (metres)
NOSE 0	11.2
20	9.8
40	8.4
60	7.0
80	5.6
100	4.2
120	2.8
140	1.4
160	0.0

WIDTH OF FREEWAY SHOULDER	RADIUS OF LIP OF KERB AT NOSE	RADIUS OF BACK OF KERB AT NOSE
3.0m (3)	1.90m	1.30m

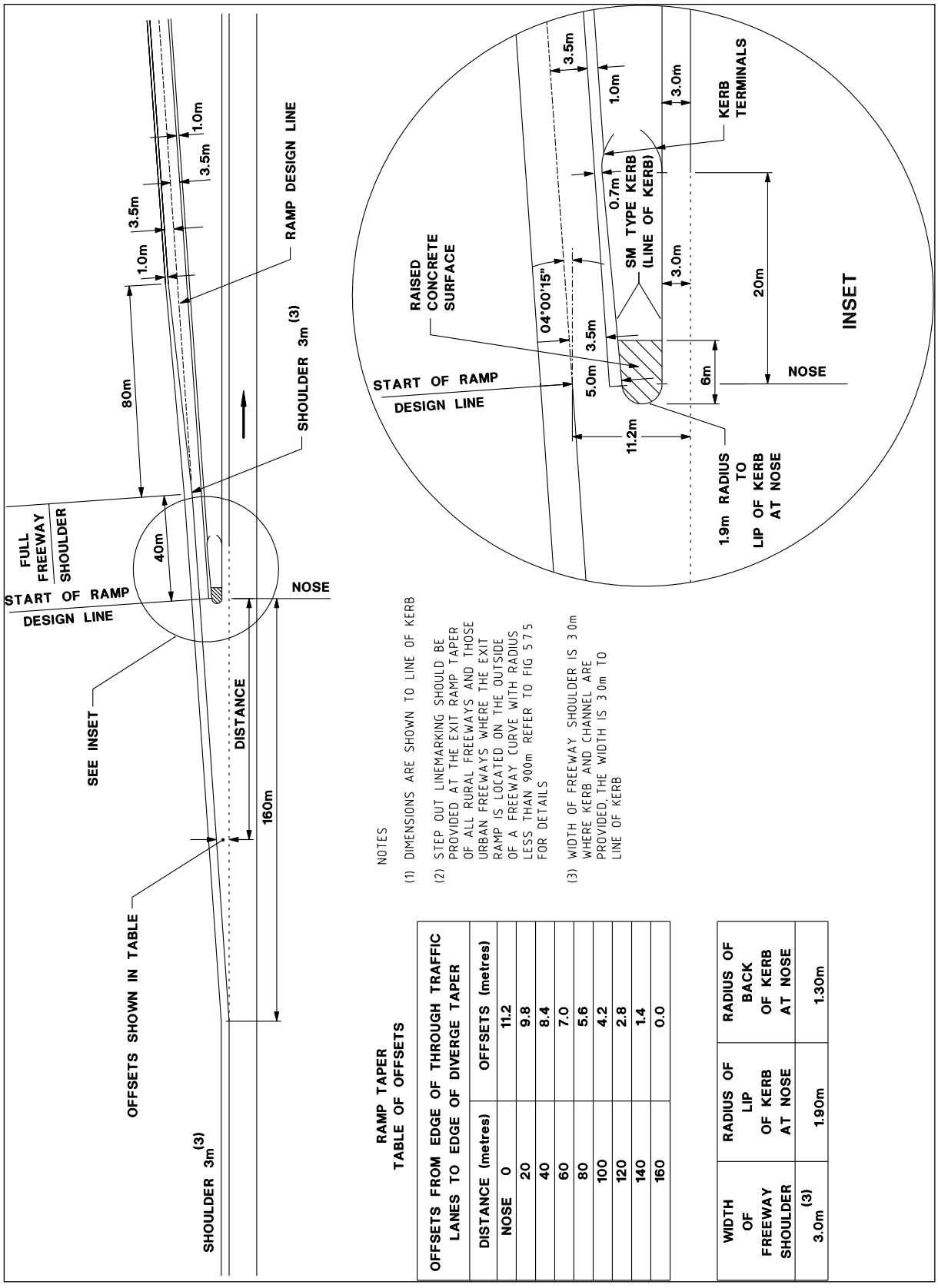
NOTES

(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 900m 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 V11.2: Exit Ramp – Single Lane At Nose, Two Lane Ramp (from RDG Figure 5.7.2)



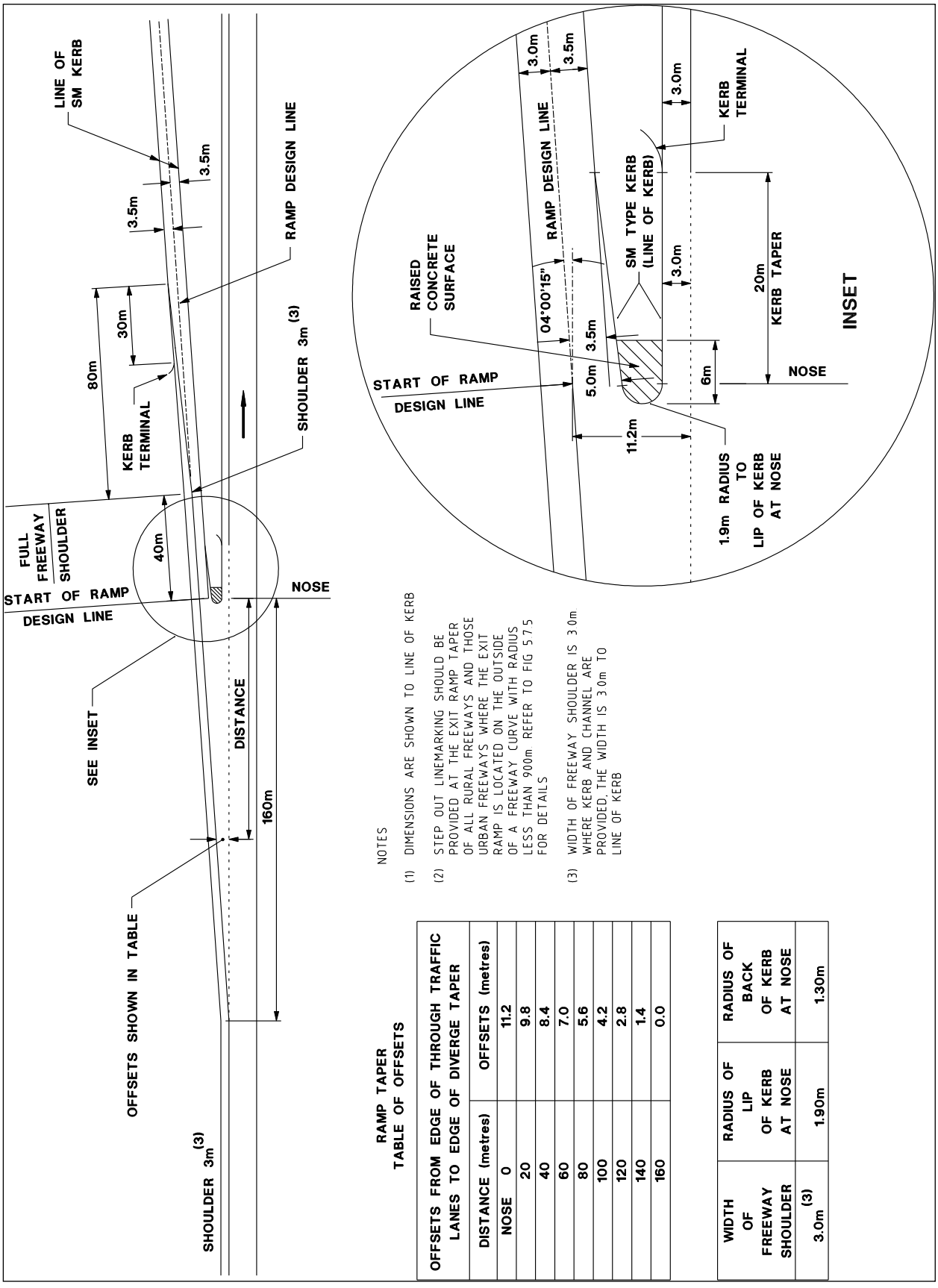
RAMP TAPER
TABLE OF OFFSETS

OFFSETS FROM EDGE OF THROUGH TRAFFIC LANES TO EDGE OF DIVERGE TAPER	
DISTANCE (metres)	OFFSETS (metres)
NOSE 0	11.2
20	9.8
40	8.4
60	7.0
80	5.6
100	4.2
120	2.8
140	1.4
160	0.0

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 900m 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

WIDTH OF FREEWAY SHOULDER (3)	RADIUS OF LIP OF KERB AT NOSE	RADIUS OF BACK OF KERB AT NOSE
3.0m	1.90m	1.30m

Figure V11.3: Exit Ramp – Single Lane at Nose, Kerbed Two Lane Ramp (from RDG Figure 5.7.3)



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 900m REFER TO FIG 5.7.5 FOR DETAILS

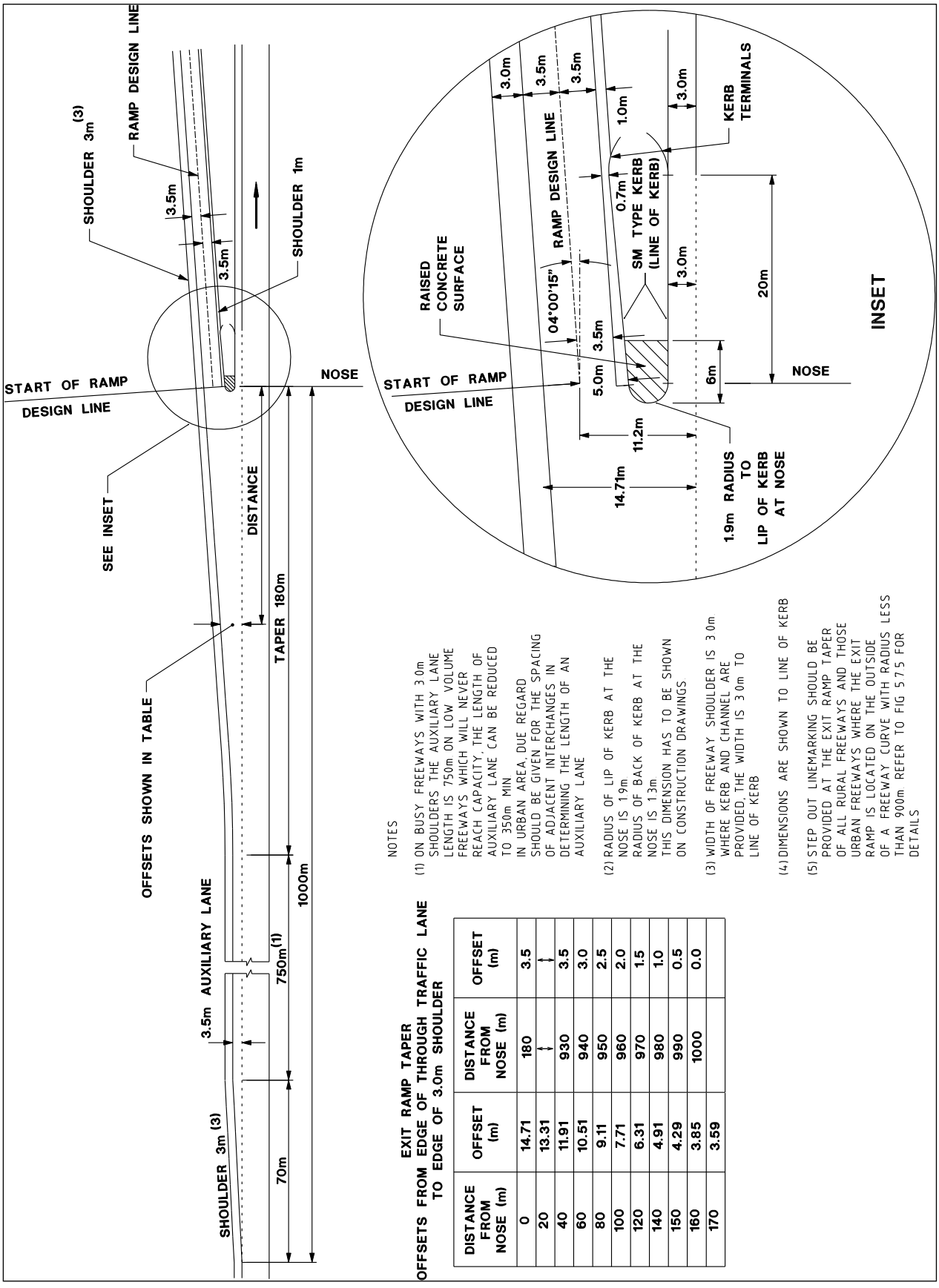
(3) WIDTH OF FREEWAY SHOULDER IS 3.0m WHERE KERB AND CHANNEL ARE PROVIDED, THE WIDTH IS 3.0m TO LINE OF KERB

RAMP TAPER
TABLE OF OFFSETS

OFFSETS FROM EDGE OF THROUGH TRAFFIC LANES TO EDGE OF DIVERGE TAPER	
DISTANCE (metres)	OFFSETS (metres)
NOSE 0	11.2
20	9.8
40	8.4
60	7.0
80	5.6
100	4.2
120	2.8
140	1.4
160	0.0

WIDTH OF FREEWAY SHOULDER	RADIUS OF LIP OF KERB AT NOSE	RADIUS OF BACK OF KERB AT NOSE
3.0m (3)	1.90m	1.30m

Figure V11.4: Exit Ramp – Two Lanes (from RDG Figure 5.7.4)



EXIT RAMP TAPER
OFFSETS FROM EDGE OF THROUGH TRAFFIC LANE TO EDGE OF 3.0m SHOULDER

DISTANCE FROM NOSE (m)	OFFSET (m)	DISTANCE FROM NOSE (m)	OFFSET (m)
0	14.71	180	3.5
20	13.31	↓	↓
40	11.91	930	3.5
60	10.51	940	3.0
80	9.11	950	2.5
100	7.71	960	2.0
120	6.31	970	1.5
140	4.91	980	1.0
150	4.29	990	0.5
160	3.85	1000	0.0
170	3.59		

NOTES

(1) ON BUSY FREEWAYS WITH 3.0m SHOULDERS 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 MIN 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 1.9m
RADIUS OF BACK OF KERB AT THE NOSE IS 1.3m
THIS DIMENSION HAS TO BE SHOWN ON 'CONSTRUCTION DRAWINGS'

(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 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 900m REFER TO FIG 5.7.5 FOR DETAILS

Figure V11.5: Exit Ramp – Step Out Markings At Exit Ramp Tapers (from RDG Figure 5.7.5)

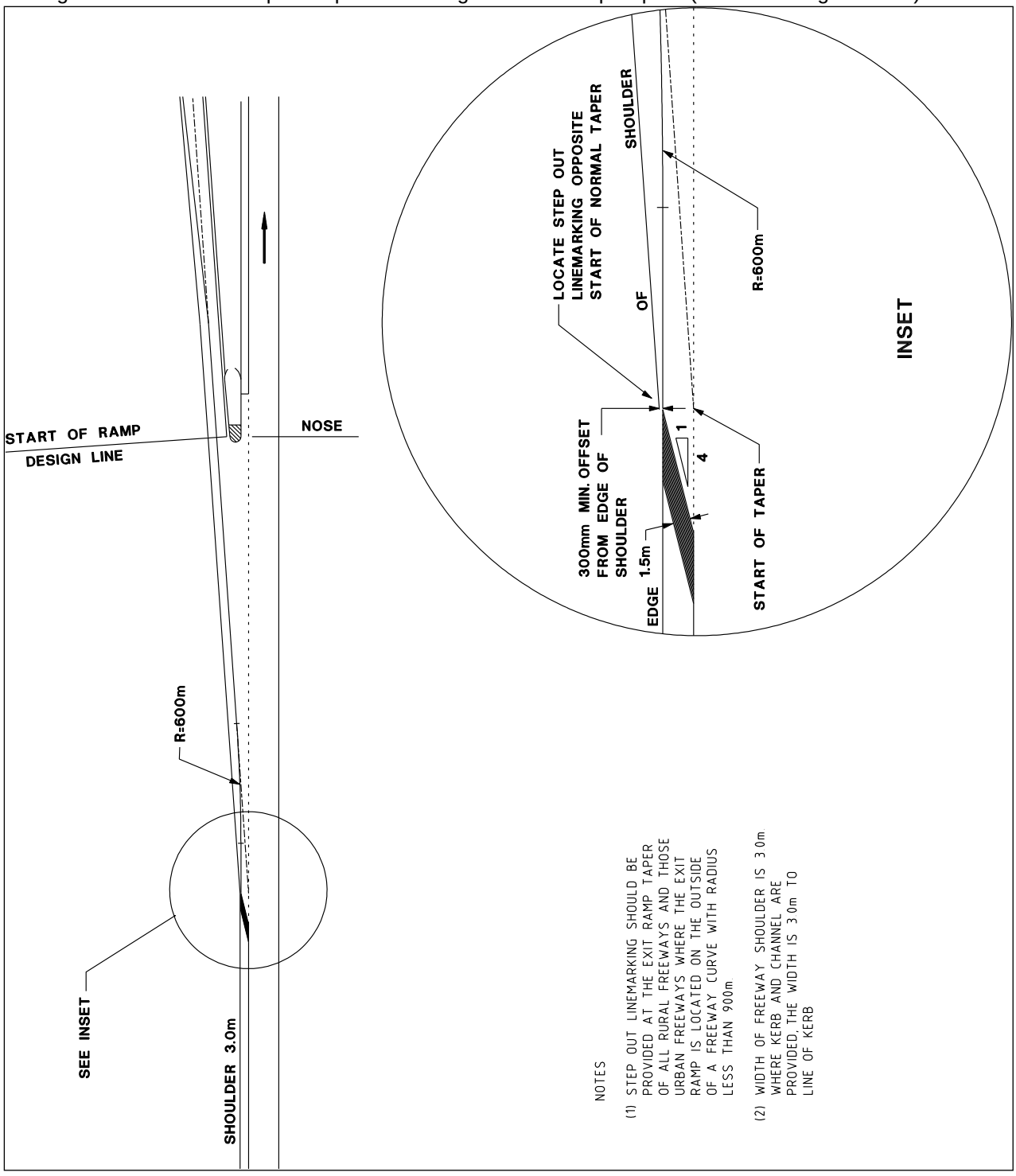
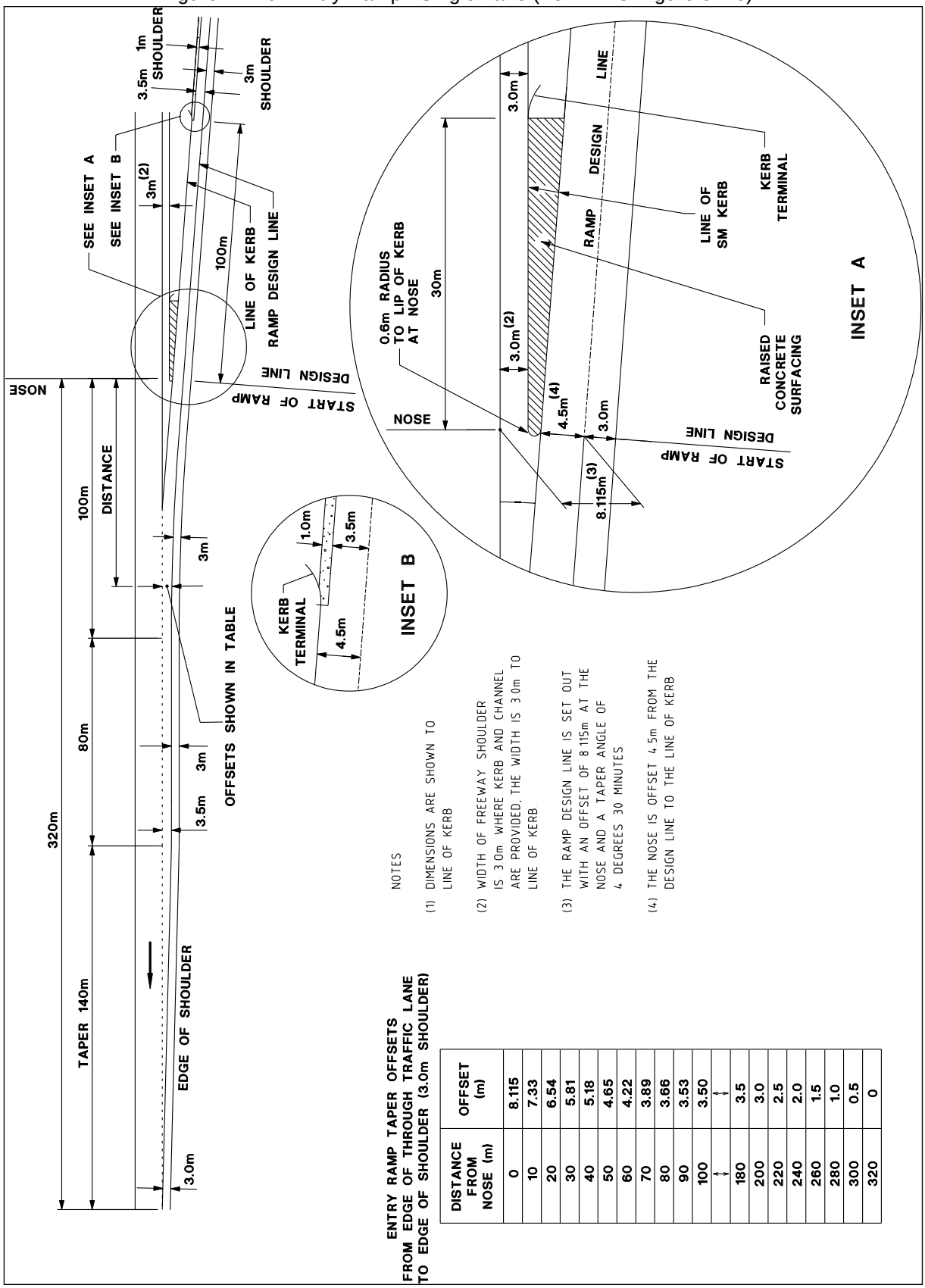


Figure V11.6: Entry Ramp –Single Lane (from RDG Figure 5.7.6)



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

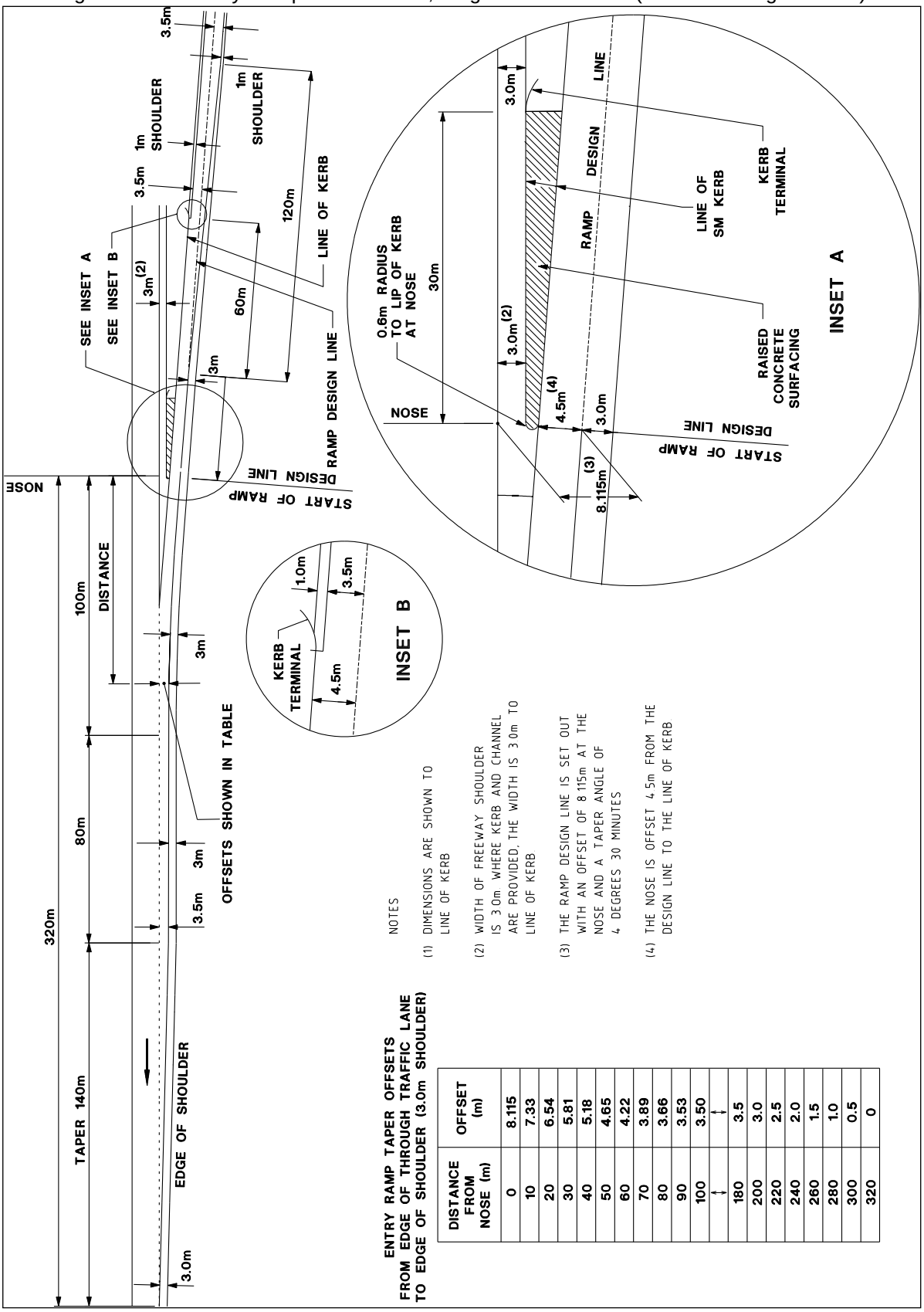
(3) THE RAMP DESIGN LINE IS SET OUT WITH AN OFFSET OF 8.115m AT THE NOSE AND A TAPER ANGLE OF 4 DEGREES 30 MINUTES

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

ENTRY RAMP TAPER OFFSETS FROM EDGE OF THROUGH TRAFFIC LANE TO EDGE OF SHOULDER (3.0m SHOULDER)

DISTANCE FROM NOSE (m)	OFFSET (m)
0	8.115
10	7.33
20	6.54
30	5.81
40	5.18
50	4.65
60	4.22
70	3.89
80	3.66
90	3.53
100	3.50
↓	↓
180	3.5
200	3.0
220	2.5
240	2.0
260	1.5
280	1.0
300	0.5
320	0

Figure V11.7: Entry Ramp – Two Lanes, Single Lane At Nose (From RDG Figure 5.7.7)



ENTRY RAMP TAPER OFFSETS
FROM EDGE OF THROUGH TRAFFIC LANE
TO EDGE OF SHOULDER (3.0m SHOULDER)

DISTANCE FROM NOSE (m)	OFFSET (m)
0	8.115
10	7.33
20	6.54
30	5.81
40	5.18
50	4.65
60	4.22
70	3.89
80	3.66
90	3.53
100	3.50
↓	↓
180	3.5
200	3.0
220	2.5
240	2.0
260	1.5
280	1.0
300	0.5
320	0

NOTES

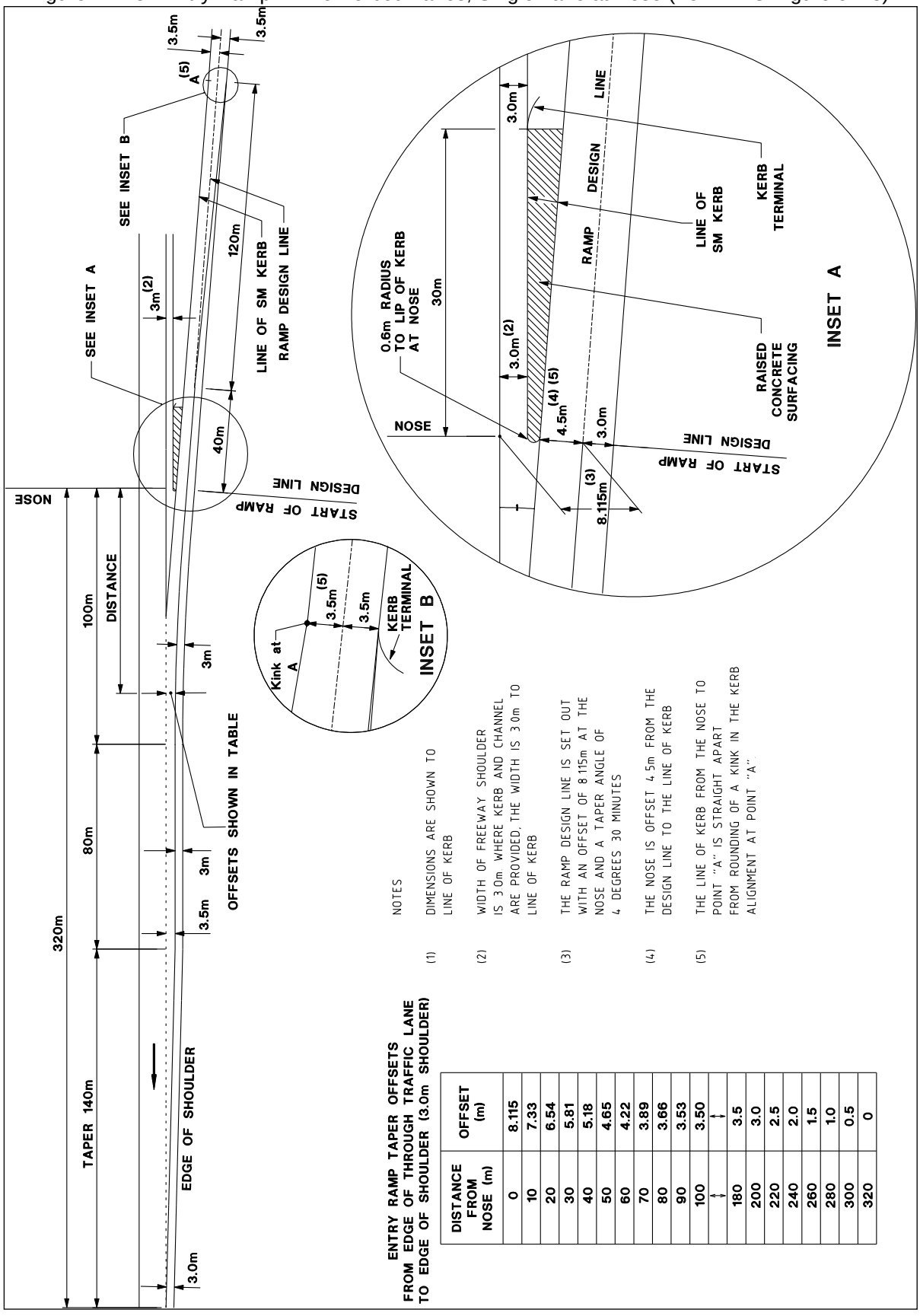
(1) DIMENSIONS ARE SHOWN TO LINE OF KERB

(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 V11.8: Entry Ramp – Two Kerbed Lanes, Single Lane at Nose (from RDG Figure 5.7.8)



ENTRY RAMP TAPER OFFSETS FROM EDGE OF THROUGH TRAFFIC LANE TO EDGE OF SHOULDER (3.0m SHOULDER)

DISTANCE FROM NOSE (m)	OFFSET (m)
0	8.115
10	7.33
20	6.54
30	5.81
40	5.18
50	4.65
60	4.22
70	3.89
80	3.66
90	3.53
100	3.50
↔	↔
180	3.5
200	3.0
220	2.5
240	2.0
260	1.5
280	1.0
300	0.5
320	0

NOTES

(1) DIMENSIONS ARE SHOWN TO LINE OF KERB

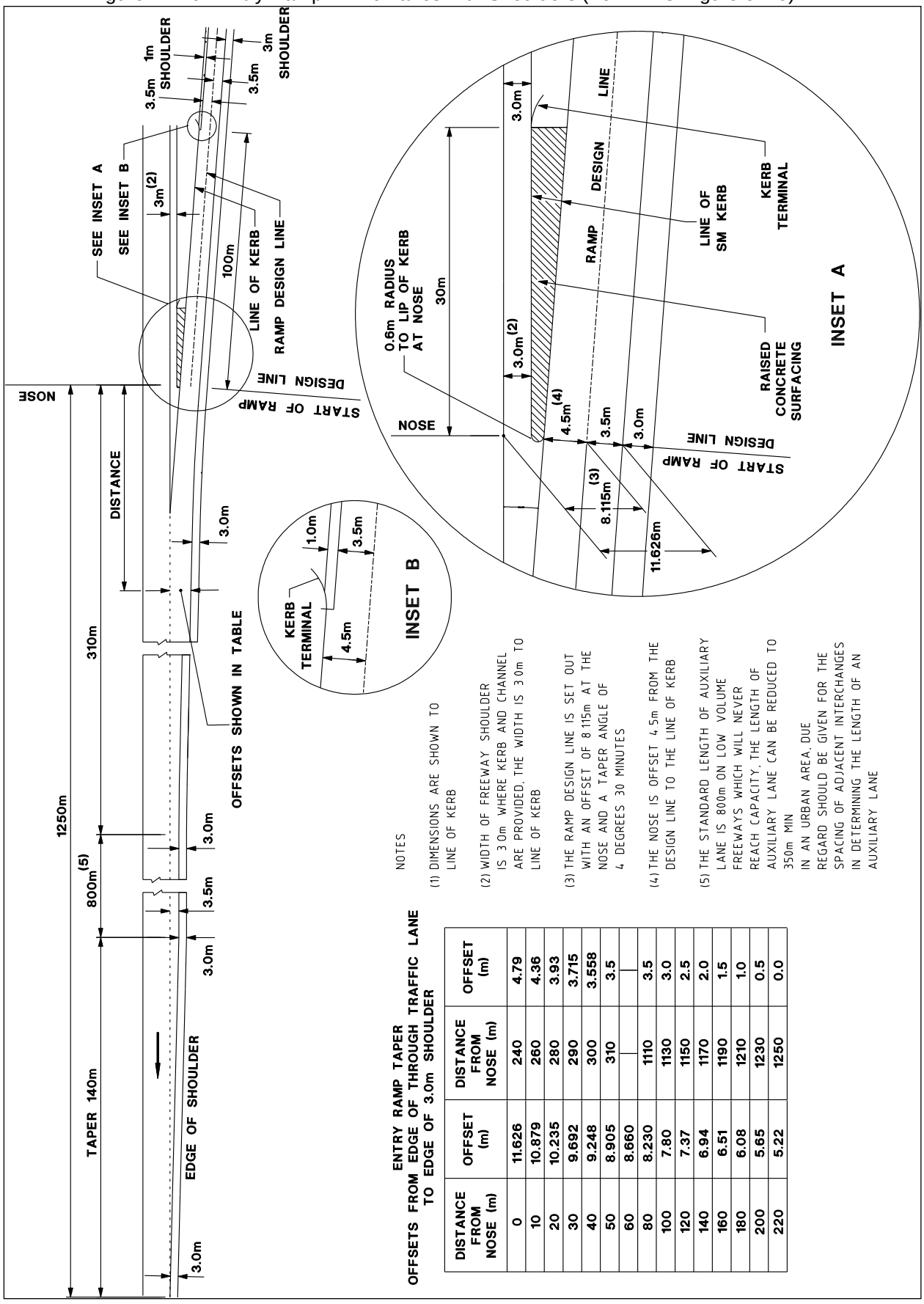
(2) WIDTH OF FREEWAY SHOULDER IS 3.0m WHERE KERB AND CHANNEL ARE PROVIDED. THE WIDTH IS 3.0m TO LINE OF KERB

(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

(5) 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".

Figure V11.9: Entry Ramp – Two Lanes with Shoulders (from RDG Figure 5.7.9)



ENTRY RAMP TAPER
OFFSETS FROM EDGE OF THROUGH TRAFFIC LANE TO EDGE OF 3.0m SHOULDER

DISTANCE FROM NOSE (m)	OFFSET (m)	DISTANCE FROM NOSE (m)	OFFSET (m)
0	11.626	240	4.79
10	10.879	260	4.36
20	10.235	280	3.93
30	9.692	290	3.715
40	9.248	300	3.558
50	8.905	310	3.5
60	8.660		
80	8.230	1110	3.5
100	7.80	1130	3.0
120	7.37	1150	2.5
140	6.94	1170	2.0
160	6.51	1190	1.5
180	6.08	1210	1.0
200	5.65	1230	0.5
220	5.22	1250	0.0

NOTES

(1) DIMENSIONS ARE SHOWN TO LINE OF KERB

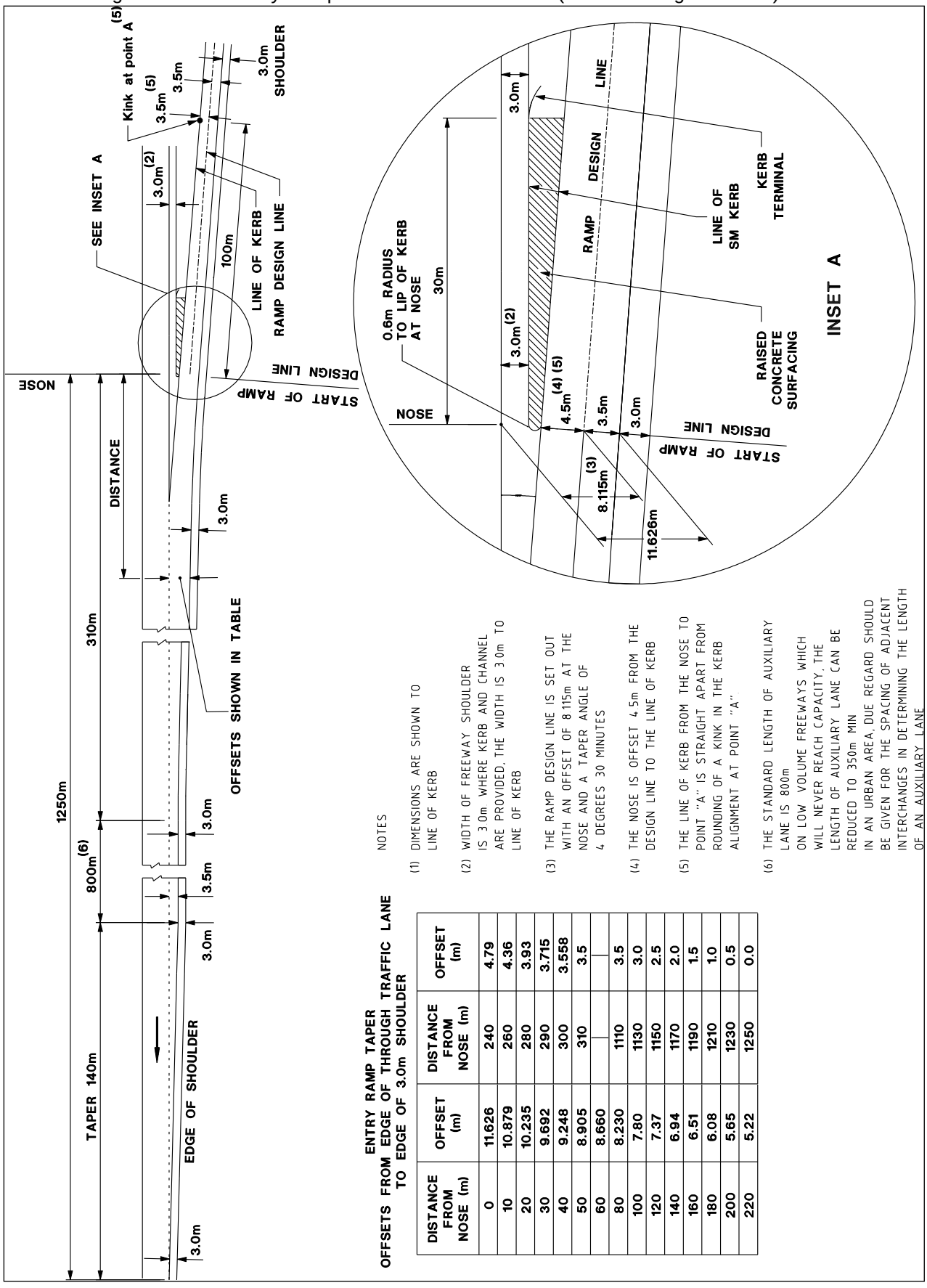
(2) WIDTH OF FREEWAY SHOULDER IS 3.0m WHERE KERB AND CHANNEL ARE PROVIDED. THE WIDTH IS 3.0m TO LINE OF KERB.

(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

(5) 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 INTERCHANGES IN DETERMINING THE LENGTH OF AN AUXILIARY LANE

Figure V11.10: Entry Ramp – Two Lanes with Kerbs (from RDG Figure 5.7.10)



ENTRY RAMP TAPER
OFFSETS FROM EDGE OF THROUGH TRAFFIC LANE TO EDGE OF 3.0m SHOULDER

DISTANCE FROM NOSE (m)	OFFSET (m)	DISTANCE FROM NOSE (m)	OFFSET (m)
0	11.626	240	4.79
10	10.879	260	4.36
20	10.235	280	3.93
30	9.692	290	3.715
40	9.248	300	3.558
50	8.905	310	3.5
60	8.660	—	—
80	8.230	1110	3.5
100	7.80	1130	3.0
120	7.37	1150	2.5
140	6.94	1170	2.0
160	6.51	1190	1.5
180	6.08	1210	1.0
200	5.65	1230	0.5
220	5.22	1250	0.0

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

(5) 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".

(6) 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 INTERCHANGES IN DETERMINING THE LENGTH OF AN AUXILIARY LANE

11.2. Exit Ramps

Departure

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

Exit Nose Location

Additional Information

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

Departure

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 1742.2* 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*.

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.

Departure

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

Departure

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* for linemarking and signing details associated with two-lane exits.

Departure

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 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 *VicRoads TEM Vol 1 Part 2.06 Sections 6.5.2*.

Nose Design

Additional Information

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

According to *VicRoads TEM Vol 1 Part 2.06 Section 6.5.2 (b) T Interchanges*, if right turning traffic is less than 30% of the total and the layout on Part 2.06 Section 6.5.2. Figure 7(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 Part 2.06 Section 6.5.2. Figure 7(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 Engineer Road Design and Traffic (Roads) 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.

Freeway Design on the Approach to the Diverge Nose

Additional Information

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

Additional Information

The appropriate treatment depends on whether the diverge is a major fork, *VicRoads TEM Vol 1 Part 2.06 Section 6.5.2(b) Figure 7(d)*, or a normal exit ramp *VicRoads TEM Vol 1 Part 2.06 Section 6.5.2(b) Figure 7(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.

Figure V11.11: (a), (b) and (c) Major Forks (from RDG Figure 5.7.14.1)

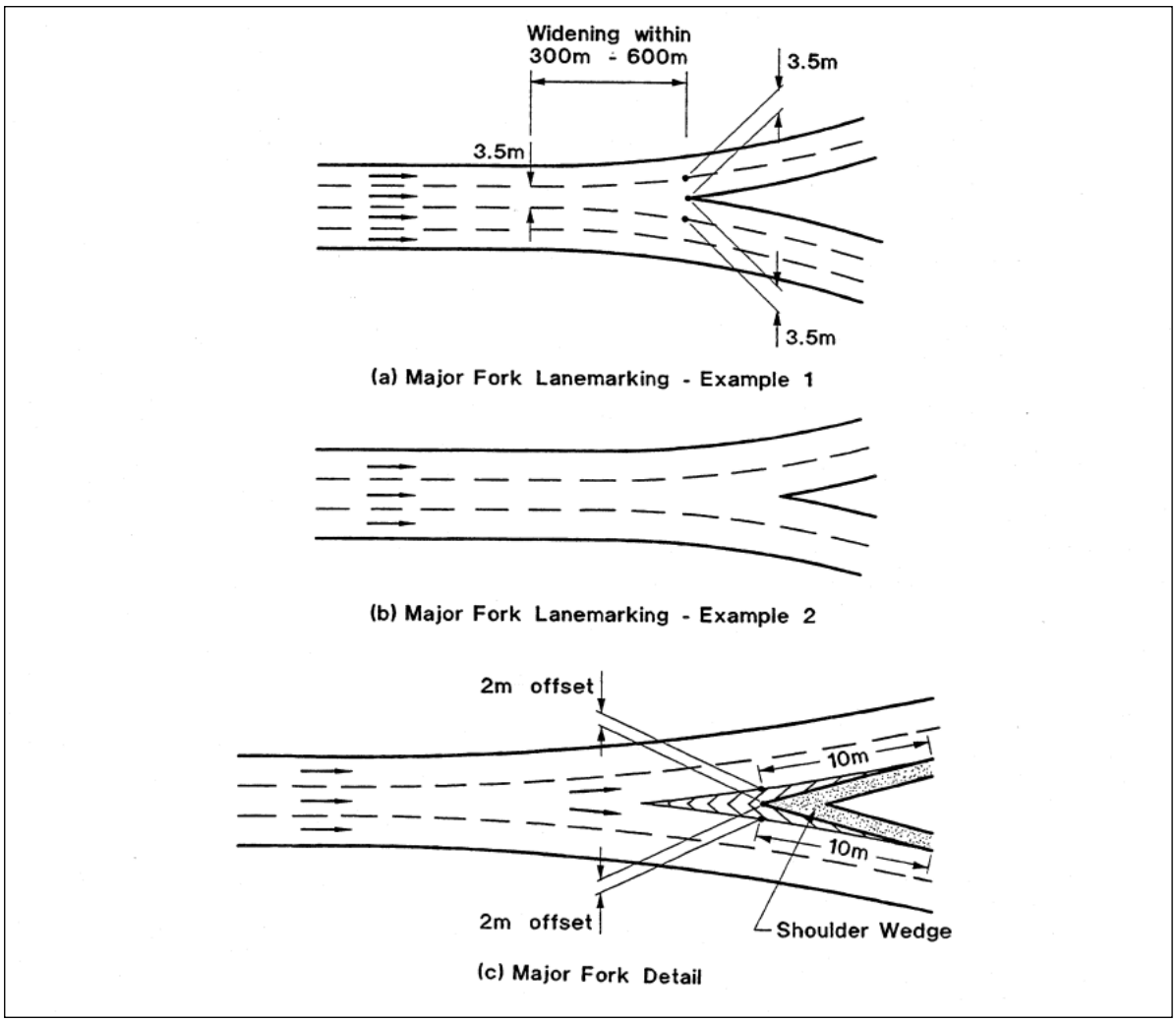
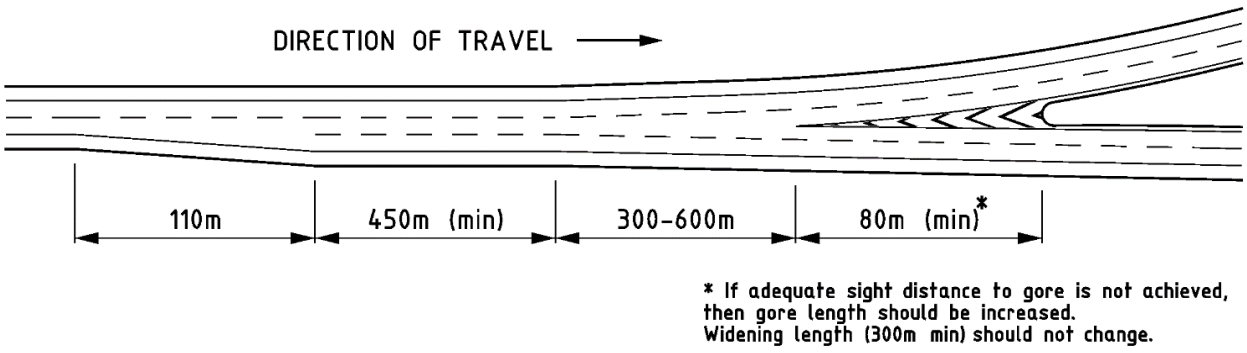


Figure V11.12: Transition from a two lane carriageway to a major fork.



11.2.4. Lane Drop at an Exit

Departure

AGRD Part 4C, Figure 11.5 shall not be used. Refer to *VicRoads TEM* 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

Additional Information

In Victoria, the merges at entry ramps are generally marked with a continuity line. Refer to *VicRoads TEM Volume 2* 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

Departure

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

Departure

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

Departure

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 that 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.

Departure

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. Entry with Auxiliary Lanes

Departure

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*.

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.

Departure

For *AGRD Part 4C Figure 11.7(b)*, refer to Figures V11.9 and V11.10.

11.3.5. Loop Ramps

Departure

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

Departure

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)

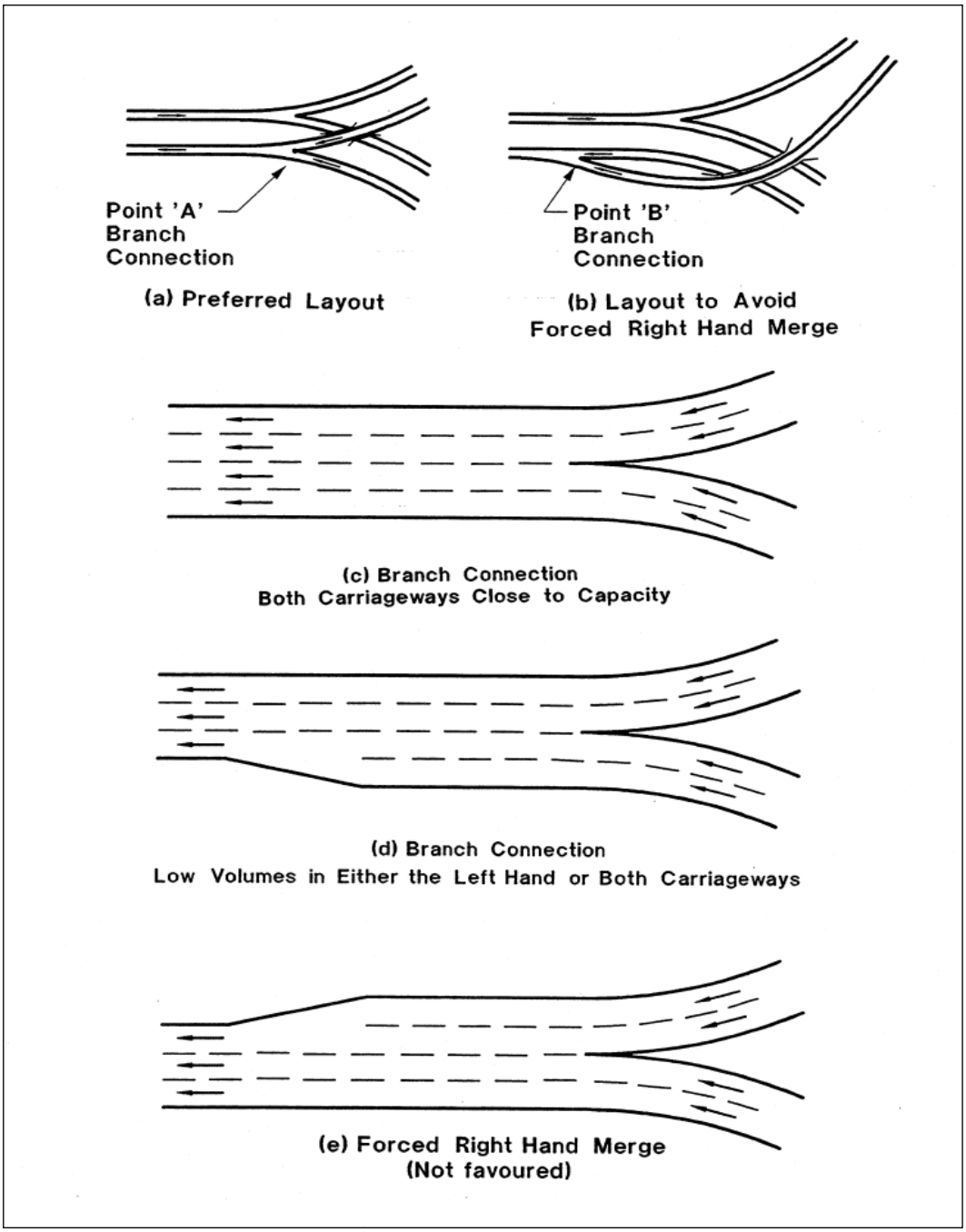
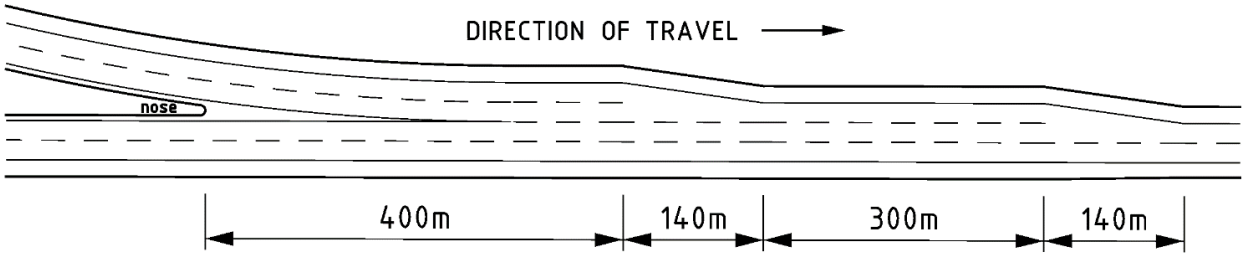


Figure V11.14: Branch connection with reduction to a two lane carriageway.



11.4. Ramp Traffic Signals

Additional Information

Refer to *VicRoads Managed Motorway Design Guide* for guidance and requirements when implementing Freeway Ramp signals on Victorian freeways.

11.4.3. Geometric and layout design – Ramp Width

Departure

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

Departure

Figure V6.9 and Figure V6.11 provide limited examples of ramp and merge layouts for freeway ramp signals. Refer to *VicRoads Managed Motorway Design Guide* for additional layout variations and up-to-date versions of the available layouts.

12.0. Ramps on Two-Lane Freeways

Departure

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 Traffic Engineering Manual*.

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

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

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*.

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*.

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 Motorway Design Guide*.

15.3. Lighting of Interchanges

Additional Information

Refer to *VicRoads TCG 006: Guidelines for Street 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.

17.0. Other Considerations

Emergency Service Access

Additional Information

Median crossings for emergency vehicles may be provided up to 500 metres from the end of acceleration tapers. The general spacing of emergency median crossings is dependent on interchange spacing and would normally only be required for spacings greater than 2 km in urban areas and 5 km in rural areas.

In some cases in rural areas, emergency gates and median crossings may be required for fire fighting access to the adjacent State Forest.

Where continuous median barriers exist, provision will generally have to be made for removable sections of barrier to allow access for emergency vehicles.

17.2. Service Centres

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

Appendices

Appendix C

AGRD Part 4C, Appendix C provides limited examples of ramp and merge layouts for freeway ramp signals. Refer to *VicRoads Managed Motorway Design Guide* for additional layout variations and up-to-date versions of the available layouts.

Appendix A

Note: Some information in this appendix is duplicated in *VicRoads TEM Volume 1 Part 2.06: Supplement to Austroads Guide to Traffic Management Part 6: Intersections, Interchanges and Crossings*.

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: Road Interchanges*.

A.1.0. General (from RDG 5.2.1)

A.1.1. 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.

A.1.2. Project Planning (from RDG 5.2.1.2)

The planning aspects of interchanges include:

a) Choice of locations which have regard for travel demands, current and future operating conditions on the freeway, and geometric and other physical constraints.
b) Selecting the type of interchanges which will operate safely and also provide appropriate operating conditions for all traffic movements.
c) Reduction of accident potential by removal of conflict between major traffic movements.
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.

A.2.0. WARRANTS (from RDG 5.2.2)

A.2.1. 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 A2.1: Economic Warrants (from RDG 5.2.2.1)

BASIC INTERCHANGE WARRANT

Expressway volume (vpd)	Cross Road Volume (vpd)
7500	3600
10000	3300
12500	3000

BASIC OVERPASS WARRANT

Expressway volume	Cross Road Volume
7500	1800
10000	1650
12500	1500

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 A2.1.

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.

A.2.2. 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 4, Appendix A Section A.10.4. and Section A.12*.

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:

$$E = 2\sqrt{(V_1 \times V_2)}$$

Where:

V_1 is the sum of traffic volumes entering from the major route (v.p.d.), and

V_2 is the sum of the traffic volumes entering from the minor legs

See also *VicRoads Supplement to AGRD Part 4 and 4A* for further information on Wide Median Treatments.

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 A1.2 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 *VicRoads TEM Vol 1 Part 2.06 Section 6*;
- 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 A2.2.* 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 A2.3*.

Common criteria include the design principles listed in *AGTM Part 6, Section 6.3, Section A2.3.4* 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 A2.0*, Warrants.

Appendix B

Note: Most of the information in the *VicRoads Supplement to AGRD Part 4C Version 2 (2011)* of this appendix has been transferred to *VicRoads TEM Volume 1 Part 2.06: Supplement to Austroads Guide to Traffic Management Part 6: Intersections, Interchanges and Crossings*.

B.1.0. Trumpet Interchanges

B.1.1.1. Trumpet Type A (previously BV6.5.6)

Trumpet Type A

Additional Information

The Trumpet caters for all movements at a three-leg 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 B1.1.

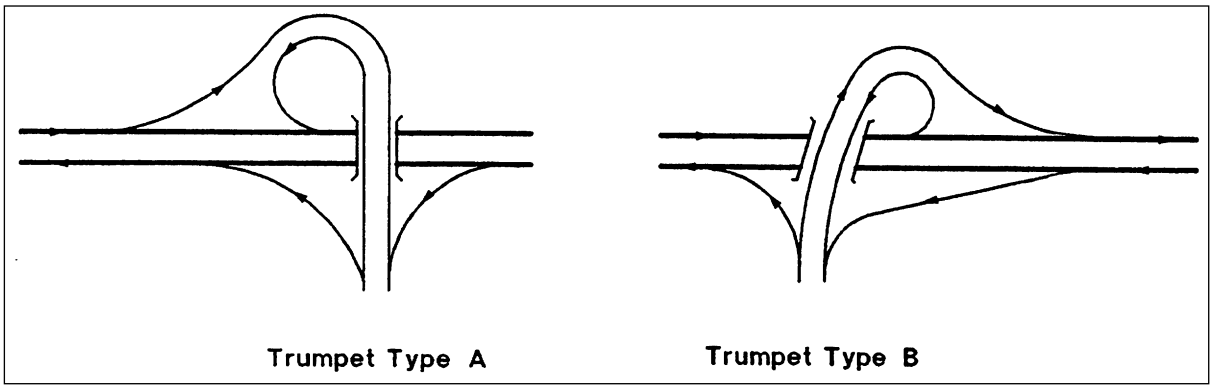
The main hazard with the Type A layout is that approach speeds on the secondary road exceed the safe speed on the loop, and the loop is obscured from view by the bridge parapet. For these reasons, this layout should not be used unless:

(a) traffic volumes in the quadrant served by the loop are low, and

(b) loop approach speeds can be controlled.

Figure B1.1 Trumpet Interchange (previously VB6.4)

(from RDG Figure 5.4.3.3).



B.1.1.2. Trumpet Type B (previously BV6.5.7)

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 B1.1.

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.

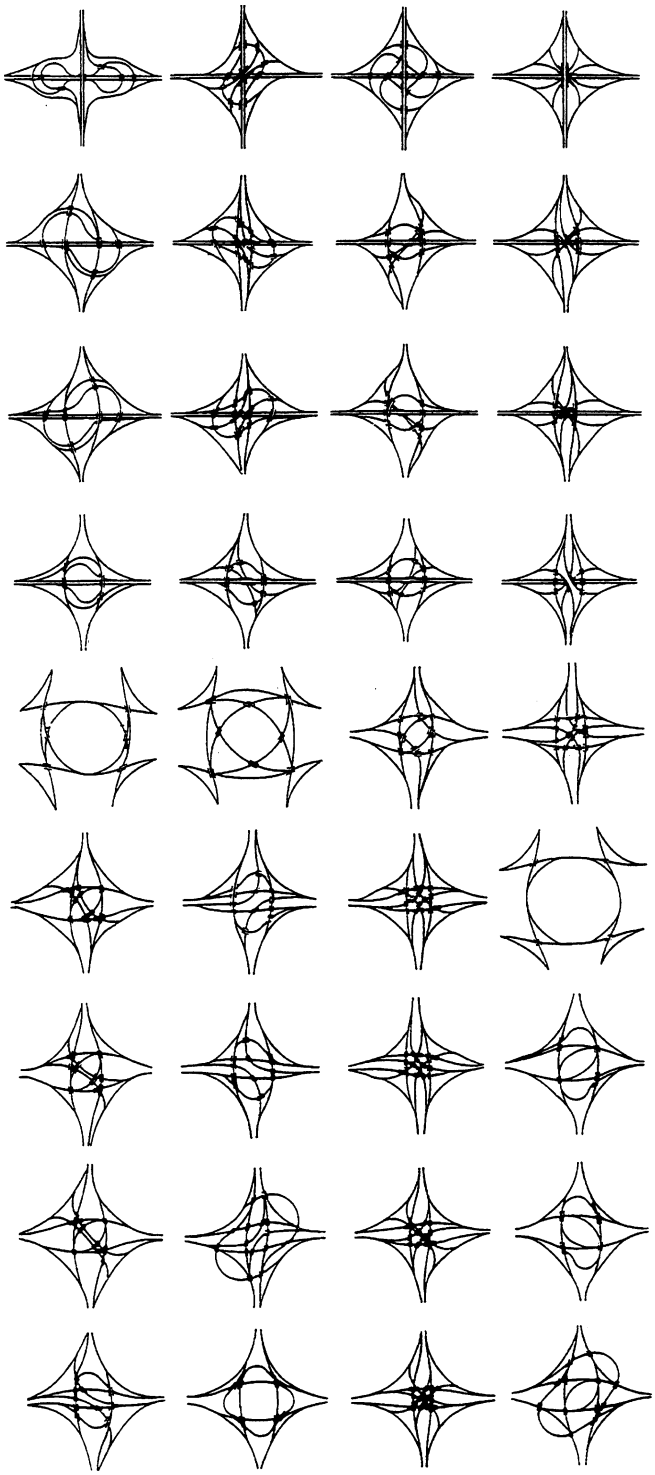
Appendix C

C.1.0. Interchange Forms

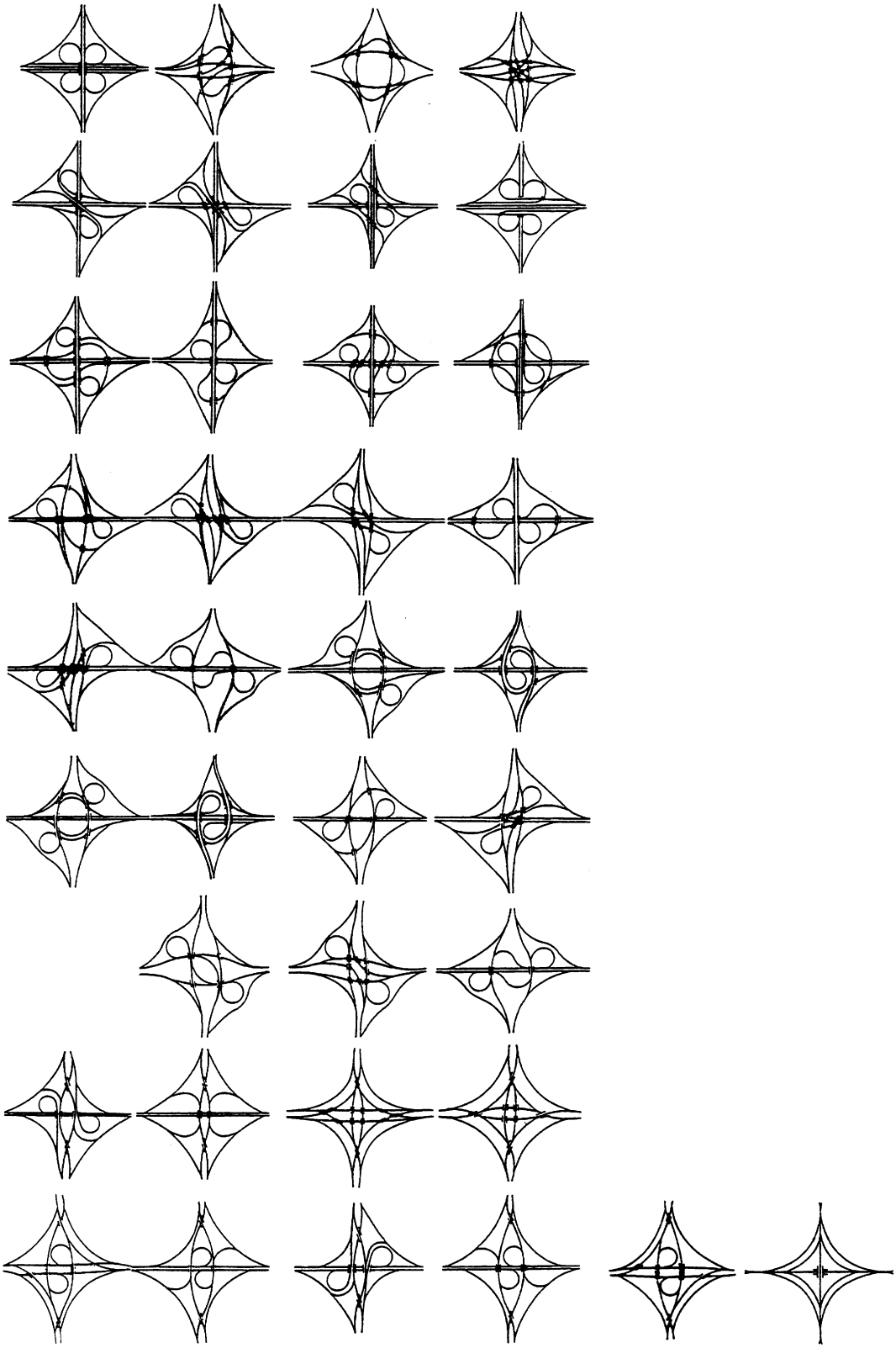
(from VicRoads RDG Part 5: Interchanges Appendix 5.2.A.1)

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

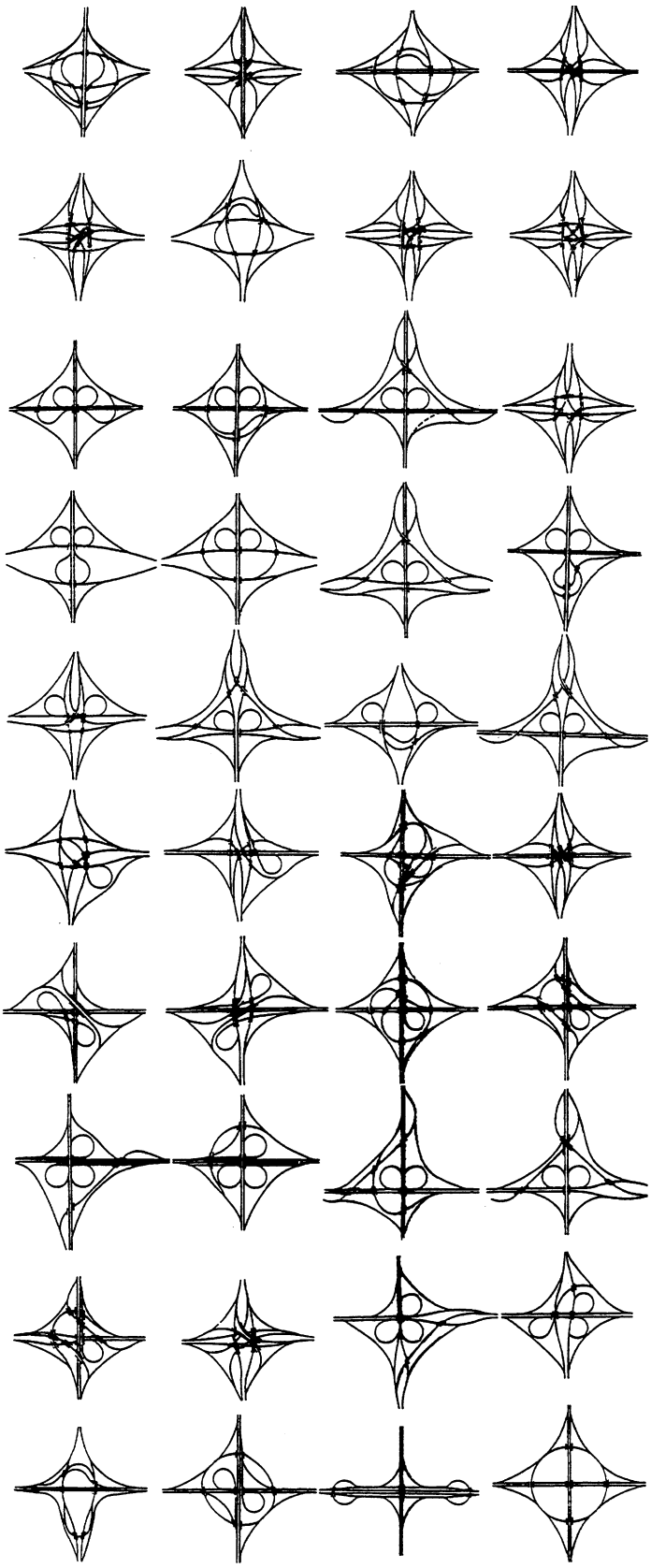
Interchange Layouts by Kenichi Takebe



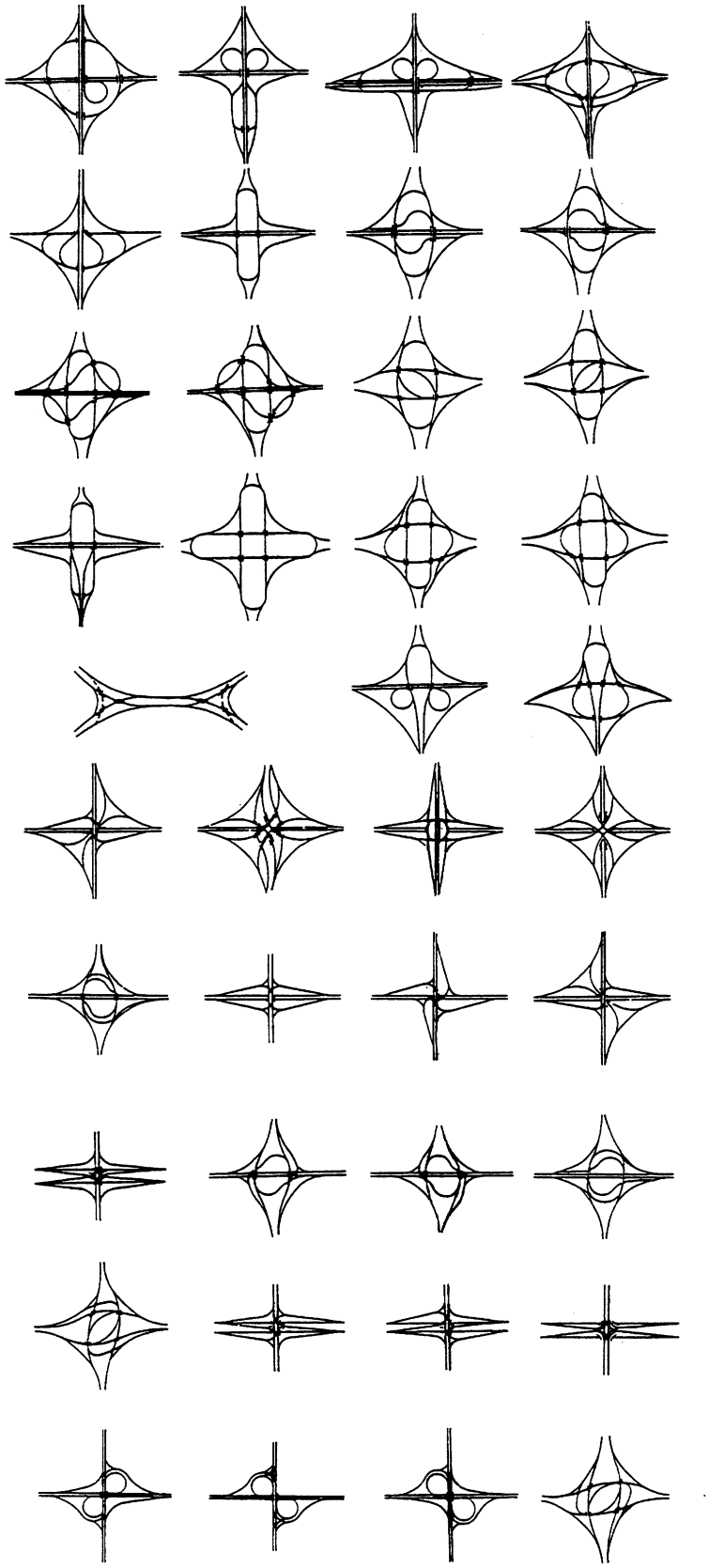
Interchange Layouts by Kenichi Takebe (continued)



Interchange Layouts by Kenichi Takebe (continued)



Interchange Layouts by Kenichi Takebe (Continued)



Appendix D

D.1.0. Ramp Accident Rates (Previously Appendix VD)

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

The accident rates in Table D1.1 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 D.1.0: Accident Rates on Ramps (In Accidents per Million Vehicles)

(from RDG Figure 5.4.B.1)

TYPE OF RAMP	ROAD OVER FREEWAY		ROAD UNDER FREEWAY		TOTALS FOR EACH RAMP TYPE		TOTALS FOR ALL RAMPS
	Entry	Exit	Entry	Exit	Entry	Exit	Both
Diamond Ramps	0.35	0.67	0.46	0.66	0.40	0.67	0.53
Loops without CD road	0.76	0.83	0.82	0.94	0.78	0.88	0.83
Cloverleaf loops with CD road	0.39	0.52	0.38	0.08[1]	0.38	0.40	0.69
Right hand exit ramps	0.74	1.74	1.38	2.64	0.93	2.19	1.91
Buttonhook ramps					0.64	0.96	0.80
Scissor ramps					0.88	1.48	1.28
Averages[2]	0.59	0.89	0.6	1.07	0.59	0.95	0.79

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

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