

WESTERN AUSTRALIA

DEVELOPMENT DESIGN

SPECIFICATION

D1

GEOMETRIC ROAD DESIGN

(Urban and Rural)

PREFACE

The City of Swan has adopted the Aus-Spec #1 Design Guidelines for Development and Subdivision of Land. Amendments have been incorporated into these Design Guidelines to suite the City of Swan. This forms part of the Policy E7-8 (Revised 2002).

All consultants and developers/subdividers are urged to use these guidelines and the accompanying construction specifications for developments and subdivisions within the City of Swan. Submitted plans received by the City of Swan are assessed according to these guidelines and the use of these guidelines to prepare a submission will result in more efficient turnover periods for approval or review.

The guidelines (including a handbook on drainage design criteria), drawings and specifications are available from the City of Swan web site: www.cityofswan.com.

All interested parties are encouraged to provide feedback regarding these documents to the Infrastructure Management Business Unit of the City of Swan.

Any amendments will be indicated on the web site and interested parties should refer to the web site for the latest copies.

Amendment Record for this Specification Part

This Specification is Council's edition of the AUS-SPEC generic specification part and includes Council's primary amendments.

Details are provided below outlining the clauses amended from the Council edition of this AUS-SPEC Specification Part. The clause numbering and context of each clause are preserved. New clauses are added towards the rear of the specification part as special requirements clauses. Project specific additional script is shown in the specification as italic font.

The amendment code indicated below is 'A' for additional script 'M' for modification to script and 'O' for omission of script. An additional code 'P' is included when the amendment is project specific.

Amendment Sequence No.	Key Topic addressed in amendment	Clause No.	Amendment Code	Author Initials	Amendment Date
1	Scope	D1.01.3	A	AW	July 2002
2	Reference and source documents – State Authorities – WAPC	D1.03 (c)	A	AW	July 2002
3	Reference and source documents – Other – IMEA WA Guidelines	D1.03 (d)	A	AW	July 2002
4	Road Hierarchy	D1.07.1	A	AW	July 2002
5	Access Place – Figure D1.2	D1.07.3	M	AW	July 2002
6	Access Way – Figure D1.3	D1.07.4	M	AW	July 2002
7	Cross Falls	D1.15.1	A	AW	July 2002
8	Characteristics of roads	D1.5 table notes	A,M	AW	July 2002
9	Turning movements – single unit bus turning path radius	D1.17.9	M	AW	July 2002
10	Carriageways	D1.27.1	M	AW	July 2002
11	Carriageways	D1.27.1	A	AW	July 2002
12	Critical Dimensions	D1.19 2 (f)	A,M	AW	July 2002
13	Carriageways	D1.27.1	M, A	YKW	January 2008

CONTENTS

CLAUSE	PAGE
GENERAL.....	1
D1.01 SCOPE	1
D1.02 AIMS.....	2
D1.03 REFERENCE AND SOURCE DOCUMENTS.....	2
D1.04 CONSULTATION.....	3
D1.05 PLANNING CONCEPTS	3
D1.06 DRAWING REQUIREMENTS.....	4
URBAN DESIGN CRITERIA.....	5
D1.07 ROAD HIERARCHY	5
D1.08 ROAD NETWORK.....	9
D1.09 DESIGN SPEED	9
D1.10 LONGITUDINAL GRADIENT.....	10
D1.11 HORIZONTAL CURVES AND TANGENT LENGTHS.....	10
D1.12 VERTICAL CURVES	12
D1.13 SUPERELEVATION.....	13
D1.14 ROAD RESERVE CHARACTERISTICS.....	14
D1.15 CROSSFALL	18
D1.16 VERGES AND PROPERTY ACCESS	18
D1.17 INTERSECTIONS	19
D1.18 ROUNDABOUTS.....	20
D1.19 TRAFFIC CALMING.....	21
D1.20 PARKING	22
D1.21 RESERVED	23
RURAL DESIGN CRITERIA.....	23

GEOMETRIC ROAD DESIGN

D1.22 GENERAL23

D1.23 SIGHT DISTANCES24

D1.24 HORIZONTAL AND VERTICAL ALIGNMENT25

D1.25 INTERSECTIONS25

D1.26 PLAN TRANSITIONS27

D1.27 CARRIAGEWAYS.....27

D1.28 SUPERELEVATION27

D1.29 SCOUR PROTECTION.....27

SPECIAL REQUIREMENTS 28

D1.30 RESERVED28

D1.31 RESERVED28

D1.32 RESERVED28

DEVELOPMENT DESIGN SPECIFICATION D1 GEOMETRIC ROAD DESIGN (Urban and Rural)

GENERAL

D1.01 SCOPE

- | | |
|--|---|
| <p>1. This section sets out the specifications developed specifically for the design of subdivision roadworks using principles of street design to ensure safety and improved amenity and to reduce pedestrian/vehicular conflicts.</p> | <p><i>Subdivision
Roadworks</i></p> |
| <p>2. A fundamental requirement of the design process is for designers to determine the vehicle speed which is deemed acceptable for a particular subdivision or section of road. The concept of designing to regulatory street speeds is contrary to the current principles of subdivision road design.</p> | <p><i>Acceptable
Vehicle
Speed</i></p> |
| <p>3. All relevant design principles must be integrated in the development of the road network. A careful balance is required between maximising amenity, safety and convenience considerations and those related to the drivers' perception of driving practice. Reference should be made to Liveable Neighbourhoods Community Design Code for current best practice.</p> | <p><i>Integrated
Design
Principles</i></p> |
| <p>4. The words "street" and "road" are interchangeable throughout all parts of this Specification.</p> | |
| <p>5. For the purpose of this Specification the definition of terms used to define the components of the road reserve shall be in accordance with AS 1348.1 and AMCORD.</p> | <p><i>Road
Reserve
Component
Definitions</i></p> |

AS 1348.1 terms:

- | | |
|--------------------|--|
| <p>Carriageway</p> | <p>- That portion of the road or bridge devoted particularly to the use of vehicles, inclusive of shoulders and auxiliary lanes.</p> |
| <p>Footpath</p> | <p>- The paved section of a pathway (verge).</p> |
| <p>Pathway</p> | <p>- A public way reserved for the movement of pedestrians and of manually propelled vehicles (AMCORD verge).</p> |
| <p>Pavement</p> | <p>- That portion of a carriageway placed above the subgrade for the support of, and to form a running surface for, vehicular traffic.</p> |
| <p>Shoulder</p> | <p>- The portion of the carriageway beyond the traffic lanes and contiguous and flush with the surface of the pavement.</p> |

AMCORD term:

- | | |
|-----------------|--|
| <p>Verge: -</p> | <p>That part of the road reserve between the carriageway and the road reserve boundary. It may accommodate public utilities, footpaths, stormwater flows, street lighting poles and plantings.</p> |
|-----------------|--|

D1.02 AIMS

1. The provision of a road system within a subdivision is to be designed so as to achieve the following aims:

- Provide convenient and safe access to all allotments for pedestrians, vehicles and cyclists.
- Provide safe, logical and hierarchical transport linkages with existing street system.
- Provide appropriate access for buses, emergency and service vehicles.
- Provide for a quality product that minimises maintenance costs.
- Provide a convenient way for public utilities.
- Provide an opportunity for street landscaping.
- Provide convenient parking for visitors.
- Have appropriate regard for the climate, geology and topography of the area.

D1.03 REFERENCE AND SOURCE DOCUMENTS

(a) Council Specifications

All Specifications for Design and Construction.

(b) Australian Standards

AS 1348.1	-	Road and traffic engineering – Glossary of terms, Road design and construction.
AS 2890.1	-	Parking facilities: Off-street car parking.
SAA HB69.14	-	Guide to traffic engineering practice - Bicycles.
AS/NZS 3845	-	Road safety barrier systems.

(c) WA State Authorities

Western Australian Planning Commission Policies

DC1.4	-	Functional Road Classification for Planning (July, 1988)
Guidelines	-	The Design and Geometric Layout of Residential Roads (Nov, 1989)
DC1.5	-	Bicycle Planning (Feb, 1990)
DC2.6	-	Residential Road Planning (Dec, 1992)
DC4.1	-	Industrial Subdivisions
Liveable Neighbourhoods Community Design Code Edition 2		
Liveable Neighbourhoods – Street Layout, Design and Traffic Management Guidelines		

Policy for Installation by Public Utility Authorities within the Road Reserve

(d) Other

AUSTROADS	RURAL ROAD DESIGN - Guide to the Geometric Design of Rural Roads.
	Guide Policy for the Geometric Design of Major Urban Roads.

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Guide to Traffic Engineering Practice:	
PART 5,	Intersections at Grade
PART 6,	Roundabouts
PART 10,	Local Area Traffic Management
PART 13,	Pedestrians
PART 14,	Bicycles

The Institute of Municipal Engineering Australia, WA Division – 1998: Subdivisional Development Guidelines

ARRB Special Report No. 33, L E Comerford: A Review of Subdivision Road Design Criteria.

Commonwealth Department of Housing and Regional Development – 1995: Australian Model Code for Residential Development. (AMCORD). A National Resource Document for Residential Development

Stapleton, C 1984: Streets Where We Live - A Manual for the Design of Safer Residential Estates.

Stapleton, C 1988, Dept of Transport South Australia: Planning & Road Design for New Residential Subdivisions.

Brindle, R 1988, ARRB: Planning & Design of the Local Distributor.

Colman, J 1978, ARRB: Streets for Living.

Pak-Poy Kneebone - 1989: Research Study into Road Characteristics for Residential Development.

D1.04 CONSULTATION

1. Designers are encouraged to consult with the Council and other relevant authorities prior to or during the preparation of design. Designers should in addition to requirements of this Specification ascertain specific requirements of these authorities as they relate to the designs in hand.

**Council,
Other
Authorities**

2. Public consultation on designs shall be provided where such action is required by Council's current policy.

**Public
Consultation**

3. The Designer shall obtain service plans from all relevant public utility authorities and organisations whose services may exist within the area of the proposed development. These services are to be plotted on the relevant drawings including the plan and cross-sectional views.

**Public
Utilities**

D1.05 PLANNING CONCEPTS

Differentiation

1. In new areas (as distinct from established areas with a pre-existing road pattern) each class of route should reflect its role in the road hierarchy by its visual appearance and related physical design standards. Routes should differ in alignment and design standard according to the volume of traffic they are intended to carry, the desirable traffic speed, and other factors.

**Road
Hierarchy**

2. The road pattern and width must be in conformity with that shown on any relevant Approved Subdivision Plan. In areas not covered by these plans, the pattern and width(s) will be determined by Council on their merits.

**Conformance
with ASP**

3. The road network for residential developments should have clear legibility.

Legibility

4. The road network should reinforce legibility by providing sufficient differentiation between the road functions. **Differentiation**
5. Distinct landmark features such as watercourses, mature vegetation or ridge lines should be emphasised within the structural layout so as to enhance the legibility. **Landmark Features**
6. Whilst legibility can be enhanced by introduced physical features such as pavement and lighting details, the road network should by its inherent design and functional distinction provide the necessary legibility. **Introduced Features**
7. The maximum number of turning movements at intersections or junctions that a driver should be required to undertake to reach a particular address within the development should be minimised. **Intersection Turning Movements**
8. There will be special constraints and costs associated with the design of roads through or adjacent to land known to be salt affected. Early planning shall consider avoiding detrimental interference with land known to be salt affected. Adjustments in horizontal and vertical line shall be considered to avoid recharge of subsurface water within or adjacent to the road reserve. Consultation with the relevant land and water resource authority shall be mandatory under the above circumstances. **Salinity Prevention, Early Planning, Mandatory Consultation**
9. Appropriate native deep-rooted species should be selected for plantings in association with road reserve works. Plantations should be of sufficient size and density, multiple row belts and relatively close spacings are recommended, to be effective in their desired role of lowering the groundwater table. **Landscaping, Salinity Prevention**

D1.06 DRAWING REQUIREMENTS

(a) Reduction Ratios

1. All plans for urban design are to be reduced to 1:500. Rural designs may be reduced to 1:1000.

Longitudinal Sections	1:500 H 1:100 V
Cross Sections	1:100 Natural

(b) Drawing Sheets

1. Separate sheets should be provided for
- Cover sheets
 - Plan views
 - Longitudinal sections
 - Cross sections
 - Structural details
 - Standard drawings

(c) Plan Presentation

1. Drawings are to be presented on A1 sheets unless otherwise authorised. They are to be clear and legible and prepared in consistent lettering and style. Council has the authority to refuse drawings that do not meet these drafting requirements. Drawings copied from other works will not be accepted. All drawings shall be clearly referenced with notations and tables as appropriate. The Designer should always be mindful that apart from being a permanent record and legal document, drawings should be easily read and understood by the Contractor, and others involved in the construction of the Works. **Clear and Legible, Permanent Record, Legal Document**

Terminology should be kept in 'plain English' where possible.

2. The scope and sequence of drawing sheets shall comply with the example provided in Annexure DQS-B of the Specification for QUALITY ASSURANCE REQUIREMENTS FOR DESIGN.

Compliance

(d) Certification

1. Drawings shall bear the signature of the design consultant and shall where required by the Council be certified as complying with the appropriate design specifications (D1 to D10). The certificate shall be in the format detailed in Annexure DQS-A of the Specification for QUALITY ASSURANCE REQUIREMENTS FOR DESIGN.

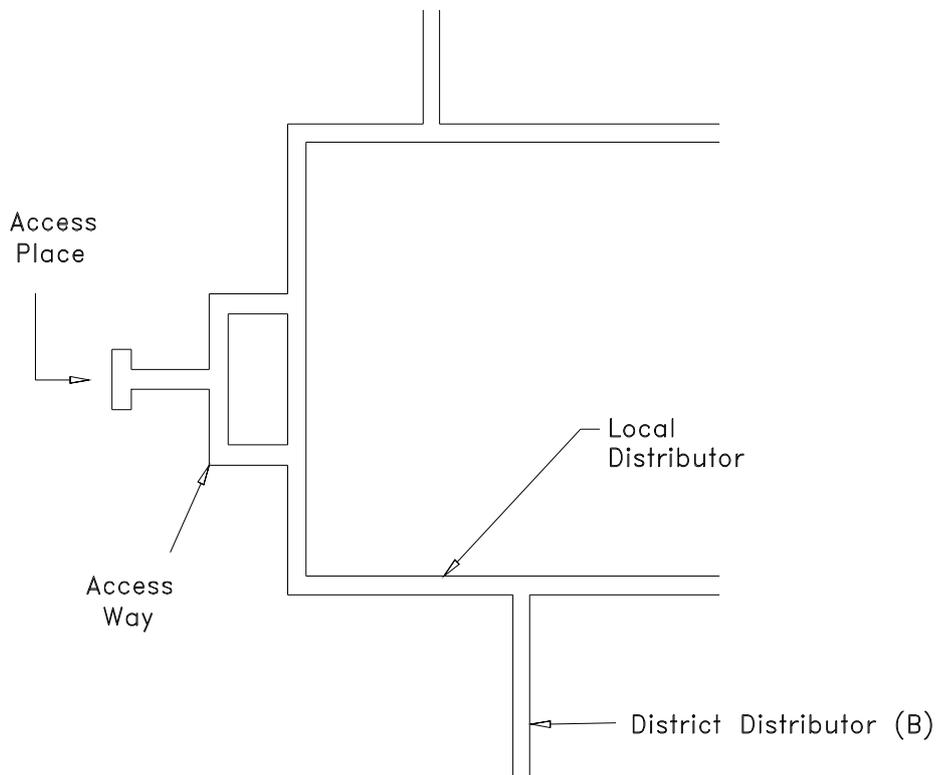
Design Consultant

URBAN DESIGN CRITERIA

D1.07 ROAD HIERARCHY

1. A hierarchical road network is essential to maximise road safety, residential amenity and legibility. Each class of road in the network serves a distinct set of functions and is designed accordingly. The design should convey to motorists the predominant function of the road. A typical hierarchy is shown on Figure D1.1. This is only a traditional example. Please refer to Liveable Neighbourhoods for current best practice.

Functionality



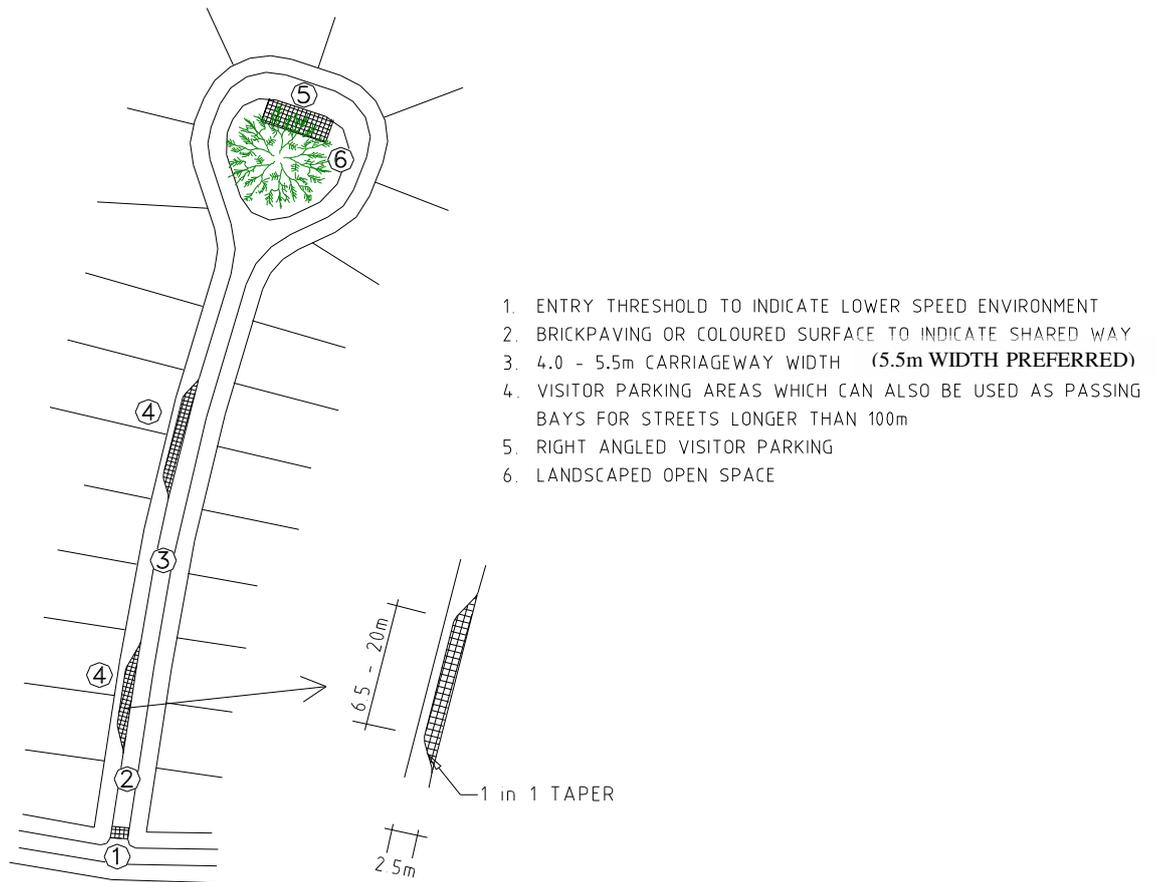
**Figure D1.1
Typical Road Hierarchy**

2. Four distinct levels of roads are:

- Access Place
- Access Way
- Local Distributor
- District Distributor (B).

3. The lowest order road (access place) having as its primary function, residential space - amenity features which facilitate pedestrian and cycle movements, and where vehicular traffic is subservient in terms of speed and volume, to those elements of space, amenity, pedestrians and cyclists. The features of a typical access place are shown in Figure D1.2.

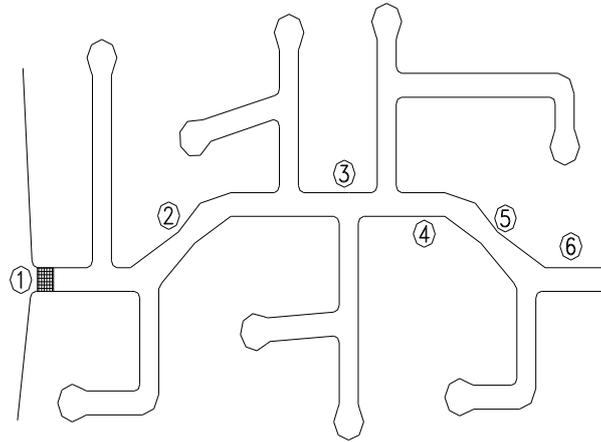
Access Place



**Figure D1.2
Access Place**

4. The next level road (access way) as a local residential street should provide a balance between the status of that street in terms of its access and residential amenity functions. Resident safety and amenity are dominant but to a lesser degree than access places. A typical access way is illustrated in Figure D1.3.

Access Way



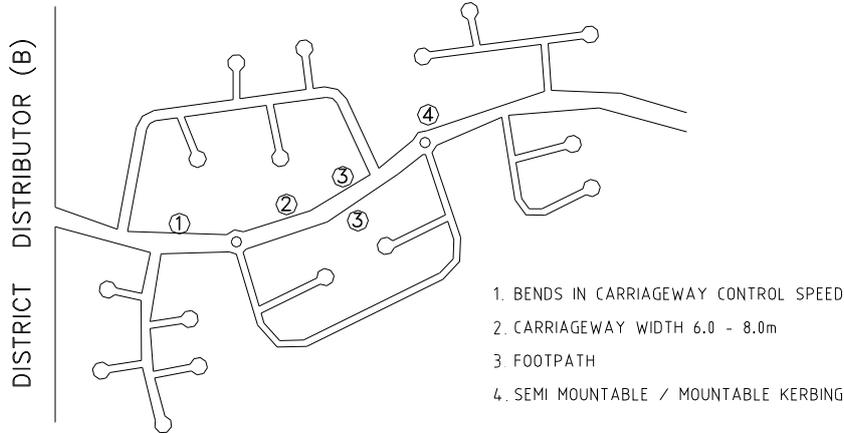
1. BRICK-PAVED ENTRY THRESHOLD SIGNIFIES ENTRY TO LOWER SPEED ENVIRONMENT.
2. BENDS IN CARRIAGE WAY CONTROL SPEED.
3. SHORT SECTIONS OF STRAIGHT CARRIAGEWAY CONTROL SPEED.
4. CARRIAGEWAY WIDTH 5.5 –6M (6.0M WIDTH PREFERRED).
6. 1.5M FOOTPATH ON ONE SIDE.
5. SEMI-MOUNTABLE.MOUNTABLE/FLUSH KERBING

Figure D1.3
Access Way

5. The second highest order road (local distributor) has a residential function but also carries higher volumes of traffic collected from lower order streets. A reasonable level of residential amenity and safety is maintained by restricting traffic volumes and speeds, however, amenity and resident safety do not have the same priority as access place and access way. A typical local distributor is shown in Figure D1.4.

**Local
Distributor**

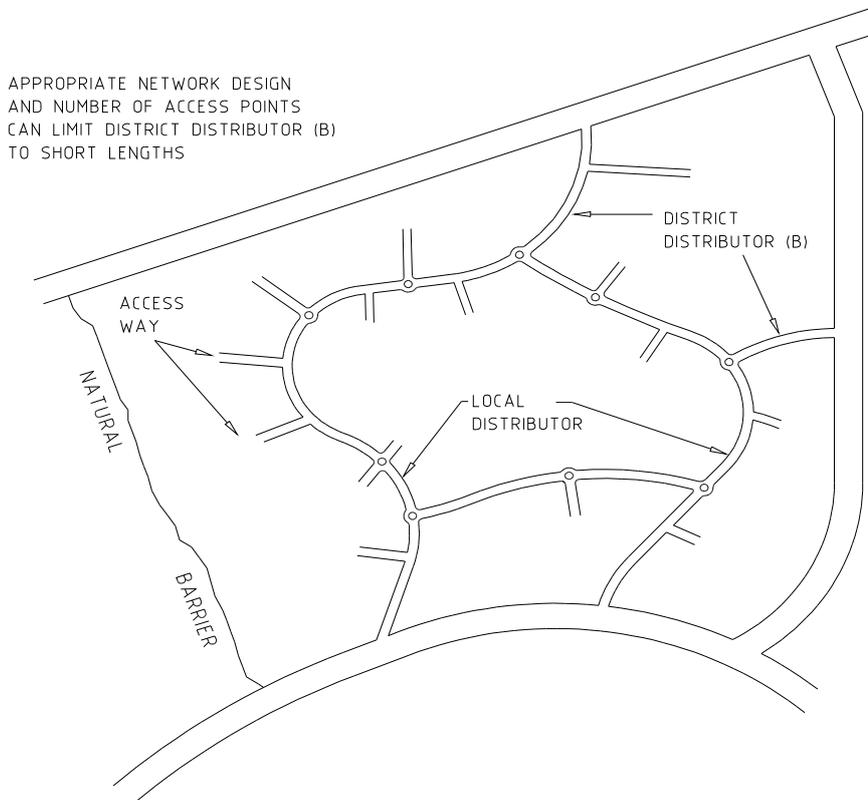
- * MAXIMUM VOLUME 3000 VPD WITH DIRECT ACCESS TO INDIVIDUAL DRIVEWAY, 6000 VPD OTHERWISE
- * MAXIMUM SPEED 50 km/h WITH DRIVEWAYS, 60 km/h OTHERWISE
- * CARRIAGEWAY SHARED BY VEHICLES AND CYCLISTS
- * AS A CUL-DE-SAC ARRANGEMENT SERVES APPROXIMATELY 16 Ha



**Figure D1.4
Local Distributor**

6. The highest order road (district distributor (B)) within a residential development should have as its main function the convenient and safe distribution of traffic generated by the development. Direct access should not be provided for single dwelling allotments but access can be provided to multi-unit developments and non-residential land uses. The district distributor (B) should serve only the development and should not attract through traffic. Figure D1.5 shows the layout of a district distributor (B) road.

***District
Distributor (B)***



**Figure D1.5
District Distributor (B)**

D1.08 ROAD NETWORK

- | | |
|---|--------------------------------------|
| 1. The design features of each type of road convey to the driver its primary functions and encourage appropriate driver behaviour (refer Figure D1.2 to D1.5). | Compatibility |
| 2. Traffic volumes and speeds on any road should be compatible with the residential functions of that road. | Compatibility |
| 3. The maximum length of an access place should ensure its status as a residential place is retained, where the traffic, in terms of speed and volume will enable the integration of pedestrian, bicycle and vehicular movements. This length will also ensure that residential convenience is not unduly impaired as a result of speed restraints. | Access Place |
| 4. The length of district distributor (B) within a development should be minimised. | District Distributor (B) |
| 5. The time required for drivers to travel on all streets within the development should be minimised. | Travel Time |
| 6. Where access places form part of a pedestrian or bicycle network, access links should provide suitable connectivity with adjoining access places or open space systems so as to ensure such pedestrian and bicycle network are functionally efficient. | Pedestrian or Bicycle Network |
| 7. The road network should ensure that no road links with another road which is more than two levels higher or lower in the hierarchy. In exceptional circumstances roads may link with others that are more than two levels apart, however, no access place or access way should have access to an access-controlled arterial road. | Road Links |
| 8. Connections between internal roads should be T-junctions or controlled by roundabouts. | Internal Road Connections |
| 9. The road layout should conform to the requirements of the external road network and satisfy the transport provisions of an outline development plan. | Transport Provisions |
| 10. The external road network should be designed and located to provide routes which are more convenient for potential through traffic within the network. Major roads should be provided at intervals of no more than 1.5 km and should be complete and of adequate capacity to accommodate through network movements. The internal road system should not provide through routes that are more convenient than the external road network. | External Road Network |

D1.09 DESIGN SPEED

- | | |
|--|---------------------------------|
| 1. Design speed is generally used as the basic parameter in the specification of design standards, determining the minimum design value for other elements. Some state road authorities base their current design standards on a travel speed rather than a design speed. Travel speed identifies a speed/horizontal radius relationship. This approach is intended for roads of a minimum travel speed of 60 km/h. The standard speed limit in WA for built-up areas is 60 km/h and this should be used in calculating design values which depend on speed, (eg local and district distributor roads) however, in difficult topography, the design speed may be reduced. Vehicular speeds are also limited by road intersections as well as changes in horizontal and vertical alignment. | Main Roads WA Guidelines |
| 2. Adoption of a low design speed discourages speeding, however, where vertical or | Low Speeds |

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GEOMETRIC ROAD DESIGN

horizontal curves of low design speed are located in otherwise high speed sections (tangents) the result is a potentially dangerous section of road. It should be recognised that in low standard roads, operating speeds will tend to be in excess of arbitrary speed standards. Attention should be given to ensuring that potentially hazardous features are visible to the driver and adopting traffic engineering measures which will help a driver avoid errors of judgement.

Hazardous Features

3. Generally the following design speeds should be adopted:

Access Place	40 km/h
Access Way	40 km/h
Local Distributor	60 km/h
District Distributor (B)	70 km/h

4. The need for road safety barriers shall be assessed and designed in accordance with AS/NZS 3845.

Road Safety Barriers

D1.10 LONGITUDINAL GRADIENT

1. A general minimum gradient of 0.5 per cent should be adopted. In very flat conditions it may be reduced to 0.3 per cent. Variable crossfall may be necessary to produce the required grade in the gutter. Maximum recommended grades are shown in Table D1.1.

Flat Terrain

Table D1.1 Maximum Recommended Longitudinal Grades

	Access Place/Way	Local Distributor	District Distributor (B)	Rural
Desirable maximum percentage*	12	10	8	10
Absolute maximum percentage*	16	12	10	12

* maximum length 150 m on straight alignment.

2. Longitudinal grade of the minor street on the approach to an intersection should not exceed 4 per cent, the actual gradient being dependent on the type of terrain. Design of the road alignment and the grades used are interrelated. A steep grade on a minor side street is undesirable if vehicles have to stand waiting for traffic in the major road.

Intersections

3. Turning circles in cul-de-sacs on steep grades should have grades less than 5 per cent.

Cul-de-Sacs

D1.11 HORIZONTAL CURVES AND TANGENT LENGTHS

1. The horizontal alignment of a road is normally in a series of tangents (straights) and curves which may be connected by transition curves. The choice of the horizontal alignment is normally determined from the design speeds for a particular street within the road hierarchy as described in Clause D1.09. Designers should ensure that, for a given design speed, the minimum radius of curvature utilised is such that drivers can safely negotiate the curve. Curves which progressively tighten produce an uncomfortable sense of disorientation and alarm. Sudden reverse curves which drivers cannot anticipate also have a potential to cause similar conditions.

Speed/Radius Relation

GEOMETRIC ROAD DESIGN

2. Where speed restriction is provided by curves in the street alignment the relationship between the radius of the curve and the desired vehicle speed is given in Table D1.2(a). **Speed Restriction**
3. To determine appropriate lengths for tangents between speed restrictions, which may be curves, narrow sections or other obstructions, Table D1.2(b) is recommended. **Tangent Length**
4. Sight distance on curves is determined by formula, values of which are tabulated in AUSTRROADS Guide to the Geometric Design of Rural Roads.

**Table D1.2(a)
Speed/Radius Relationship**

Desired Vehicle Speed (km/h)	Curve Radii (m) on Road Centreline	
	Curvilinear Alignment (no tangents)	Isolated Curve Alignment (with tangent sections)
20	15	10
25	20	15
30	30	20
35	50	30
40	90	40
45	105	50
50	120	60
55	140	70
60	160	80

**Table D1.2(b)
Speed/Tangent Length Relationship**

Desired Vehicle Speed in Curve (km/h)	Maximum Advisable Tangent Length (m) between Curves or Restrictions Appropriate to a Selected Design Speed.						
	DESIGN SPEED						
	25	30	35	40	45	50	60
20 or less	40	75	100	120	140	155	180
25	-	45	75	100	120	140	165
30	-	-	45	80	100	120	150
35	-	-	-	50	80	100	135
40	-	-	-	-	55	80	120
45	-	-	-	-	-	60	105

NOTE:
Tables D1.2(a) and D1.2(b) are derived from AMCORD.

D1.12 VERTICAL CURVES

1. Vertical curves will be simple parabolas and should be used on all changes of grade exceeding 1 per cent. The desirable minimum design speed is 60 km/h. The length of the crest vertical curve for stopping sight distance should conform with AUSTROADS Guide to the Geometric Design of Rural Roads. These standards are based on 1.5 seconds reaction time which provides a reasonable safety margin for urban conditions, where drivers' reaction time is usually considered to be lower than in rural conditions.

Criteria

2. For adequate riding comfort, lengths of sag vertical curves should conform with the AUSTROADS Guide to the Geometric Design of Rural Roads. As residential roads are usually lit at night, the criterion for designing sag vertical curves is a vertical acceleration of 0.05g for desirable riding comfort, and 0.10g for minimum riding comfort. The minimum length for sag vertical curves are shown in Table D1.3.

Riding Comfort

**Table D1.3
Minimum Length of Sag Vertical Curves**

	Access Place/Way (m)	Local Distributor (m)	District Distributor (B) (m)
Minimum length of vertical curve	25	35	50
Absolute minimum length of vertical curve (to be applied at road junctions only)	6	12	20

3. Junctions of roads should be located at a safe distance from a crest, determined by visibility from the side road. Location of a side road at a crest should only occur if there is no suitable alternative.

Side Road Junctions

4. Drainage poses a practical limit to the length of sag curves and a maximum length (in metres) of 15 times the algebraic sum of the intersecting vertical grades (expressed as a percentage) has been suggested. This is to avoid water ponding in excessively flat sections of kerb. A minimum grade of 0.5 per cent should be maintained in the kerb. This may require some warping of road cross sections at sag points.

Sag Curves

5. The three dimensional coordination of the horizontal and vertical alignment of a road should be aimed at improved traffic safety and aesthetics. Economic considerations often require a compromise with aesthetic considerations. The following principles should be applied:

Horizontal and Vertical Alignment Coordination

- The design speed of the road in both horizontal and vertical planes should be of the same order.
- Combined horizontal and vertical stopping sight distance and minimum sight distance should be considered three dimensionally.
- Sharp horizontal curves should not be introduced at or near the crest of a vertical curve. A horizontal curve should leave the vertical curve and be longer than the vertical curve.
- A short vertical curve on a long horizontal curve or a short tangent in the

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gradeline between sag curves may adversely affect the road's symmetry and appearance.

D1.13 SUPERELEVATION

1. The use of superelevation in association with horizontal curves is an essential aspect of geometric design of roads with design speeds in excess of 60 km/h. Local access places and ways which are designed for speeds of 40 km/h or less and with curves of 60m radius or less generally have the pavement crowned on a curve instead of superelevation. Design standards for such curves have little meaning as drivers usually cut the corners and rely on friction to hold them on a curved path. As the radius of the curve falls, friction becomes more important than superelevation.

Low Design Speed, Crowned Pavement

2. The maximum superelevation for urban roads of higher design speeds should be 6 per cent. Any increase in the longitudinal grade leading to excessive crossfall at intersections should be considered with caution. While it is desirable to superelevate all curves, negative crossfall should be limited to 3 per cent.

High Design Speed

3. In general, curve radii larger than the minimum and superelevation rates less than the maximum should be used where possible. The minimum radius of curves is determined by the design speed, the minimum superelevation (or maximum adverse crossfall) at any point on the circular portion of the curve, and the maximum coefficient of side friction which allows safe lane changing. This is 0.15 where there is positive superelevation and 0.12 where there is adverse crossfall. The coefficient of side friction depends upon the type and condition of tyres, the pavement, and on speed.

Criteria

4. Recommendations for minimum curve radii (in metres) on major urban roads under varying superelevation/crossfall are shown in Table D1.4.

**Table D1.4
Minimum of Radius of Curvature**

	Design Speed km/h	60	70	80
Minimum Superelevation (%)	5	145	195	255
	4	150	205	265
	3	160	215	280
	2	170	230	300
	1	180	245	315
Maximum Crossfall (%)	0	190	260	340
	1	260	355	460
	2	285	390	505
	3	315	430	560

(Source: NAASRA (Now AUSTRROADS), Guide policy for the geometric design of major urban roads.)

5. Plan transitions are desirable on superelevated curves for appearance and to provide a convenient length in which to apply the superelevation. On urban roads, superelevation may be conveniently applied to the road cross section by shifting the crown to 2m from the outer kerb. The axis of rotation of the cross section for urban roads will normally be the kerb grading on either side which best enables access to adjacent properties and intersections.

Transitions, Offset Crowns

D1.14 ROAD RESERVE CHARACTERISTICS

1. The cross section of the road reserve must provide for all functions that the road is expected to fulfil, including the safe and efficient movement of all users, provision for parked vehicles, acting as a buffer from traffic nuisance for residents, the provision of public utilities and streetscaping. Table D1.5 details characteristics of the road reserve.

Cross Section Provisions

GEOMETRIC ROAD DESIGN

Table D.1.5 Characteristics of Roads in Residential Subdivision Road Networks

Road Type	Maximum Traffic Volume (vpd) ⁽¹⁾	Maximum Speed (km/h) ⁽²⁾	Carriageway Width (m) ⁽³⁾		Parking Provisions Within Road Reserve ⁽³⁾	Kerbing ⁽⁴⁾	Footpath Requirement	Bicycle-path Requirement	Verge Width (each side)
			Minimum	Maximum					
Access Place	200	20	4.0 ⁽⁵⁾	5.5	1.0 widened parking strips	Semi Mountable /Mountable/Flush	No	No	4.0 - 4.5 ⁽⁶⁾
Access Way	800	30	5.5	6.0	On Carriageway Off Carriageway in widened parking strips	As Above	One side ⁽⁷⁾	No	4.0 - 4.5 ⁽⁶⁾
Local Distributor	3,000 with access to residential allotments, 6,000 otherwise	50 ⁽⁸⁾ with access to driveways, 60 otherwise	6.0	8.0	As above	Semi Mountable /Mountable ⁽⁹⁾	At least one side	Most likely ⁽¹⁰⁾	4.2 - 6.3
District Distributor (B)	8,000	70	7.4	10.0	As above	Semi Mountable /Barrier	At least one side	Yes	5.0 - 6.3

Industrial Subdivisions					
Road Type	Industrial Class	Carriage Way Width	Reserve Width	Kerbing	Verge Width
Local	Class 1 & 2 ⁽¹¹⁾	9m	20m	Semi-mountable	5m
Collector	Class 1 & 2	10m	25m	Semi-mountable	5m

Derived from AMCORD

NOTES:

1. For single dwelling allotments apply traffic generation rate of 10 vehicles per day (vpd)/allotment (equivalent to approximately one vehicle per hour (vph) in the peak hour) unless a lower rate can be demonstrated. Lower rates can be applied to multi-unit dwellings based on locally derived rates.
 2. See Clauses D1.09 and D1.11 on designing for specific operating speeds.
 3. Widening required at bends to allow for wider vehicle paths (using AUSTRROADS Turning Templates). Widths exclude parking areas.
 4. Maximum carriageway widths required if barrier kerbing used.
 5. Requires parking provision and provision for widening to 5.0m if necessary in the future.
 6. Minimum width required to provide for pedestrians, services, drainage, landscape and preservation of existing trees. Add additional width on one side for future widening of carriageway to 5.0m if required. For two lane carriageway design, no provision for widening required.
 7. A minimum of one footpath on one side of the street to be constructed initially with provision to construct a second footpath if required by residents in the future.
 8. Reduced speeds are required at designated pedestrian/bicycle crossing. A speed of 20 km/h is desirable, achieved by the road design principles outlined in this Specification.
 9. Barrier kerbing may be used if required for drainage purposes without reducing the carriageway width.
 10. Where bicycle way can be anticipated, a bicycle lane is required along the kerb.
 11. Class 1 – General and Composite Light Industrial Areas
Class 2 – Services and Trades Areas
- * Many elements are inter-related. Therefore variations from any particular recommended characteristic may require changes to others.

2. The carriageway width must allow vehicles to proceed safely at the operating speed intended for that level of road in the network and with only minor delays in the peak period. This must take into consideration the restrictions caused by parked vehicles where it is intended or likely that this will occur on the carriageway. Vehicles include trucks, emergency vehicles and, on some roads, buses.

Operational Aspects

3. The safety of pedestrians and cyclists where it is intended they use the carriageway must also be assured by providing sufficient width.

Pedestrians, Cyclists

4. The carriageway width should also provide for unobstructed access to individual allotments. Drivers should be able to comfortably enter or reverse from an allotment in a single movement, taking into consideration the possibility of a vehicle being parked on the carriageway opposite the driveway.

Access to Allotments

5. The design of the carriageway should discourage drivers from travelling above the intended speed by reflecting the functions of the road in the network. In particular the width and horizontal and vertical alignment should not be conducive to excessive speeds.

Discourage Speeding

6. Appropriate verge width should be provided to enable the safe location, construction and maintenance of required footpaths and public utility services (above or below ground) and to accommodate the desired level of streetscaping. Wherever possible services should be located in common trenches.

Verge Width

7. The verge when considered in conjunction with the horizontal alignment and permitted fence and property frontage treatments should provide appropriate sight distances, taking into account expected speeds and pedestrian and cyclist movements.

**Sight Distance
Across Verge**

8. Stopping sight distances and junction or intersection sight distances provided by the verge should be based on the intended speeds for each road type.

D1.15 CROSSFALL

1. Desirably, roads should be crowned in the centre. However, in narrow access roads, inverted roads with central drainage may be permitted. Typical pavement crossfalls on straight roads are:

<i>Pavement Type</i>	<i>Crossfall</i>
Bituminous seal coat	3 per cent
Bituminous concrete pavement	2.5 per cent (3 per cent preferred)
Cement concrete pavement	2 per cent

(Source: NAASRA (Now AUSTROADS), Guide policy for geometric design of major urban roads.)

2. There are many factors affecting levels in urban areas which force departures from these crossfalls. Differences in level between road alignments can be taken up by offsetting crown lines or adopting one way crossfalls. Sustained crossfalls should not exceed 4 per cent, although up to 6 per cent may be used where unavoidable. The rate of change of crossfall should not exceed: 6 per cent per 30m for through traffic; 8 per cent per 30m for free flowing turning movements; or 12 per cent per 30m for turning movements for which all vehicles are required to stop.

**Offset Crown
Lines**

**Rate of
Change**

3. The crossfall on a local distributor or district distributor (B) should take precedence over the grade in minor side streets. Standard practice is to maintain the crossfall on the major road and adjust the minor side street levels to suit. The crossfall in side streets should be warped quickly either to a crown or a uniform crossfall depending on the configuration of the side street. A rate of change of grade of two per cent in the kerb line of the side street relative to the centre line grading is a reasonable level.

Precedence

D1.16 VERGES AND PROPERTY ACCESS

1. A suitable design for the verge will depend on utility services, the width of footpaths, access to adjoining properties, likely pedestrian usage and preservation of trees. Low level footpaths are undesirable but may be used if normal crossfalls are impracticable. Crossfalls in footpath paving should not exceed 2.5 per cent, in accordance with AUSTROADS Guide to Traffic Engineering Practice, PART 13, Pedestrians. Longitudinal grade usually parallels that of the road and this may be steeper than 5 per cent.

Criteria

2. Differences in level across the road between road reserve boundaries may be accommodated by:

Options

- Cutting at the boundary on the high side and providing the verge at normal level and crossfall.

- Battering at the boundary over half the verge width with the half against the kerb constructed at standard crossfall.
 - A uniform crossfall across the carriageway.
 - The lower verge being depressed below the gutter level.
3. The above measures can be used singularly or combined. The verge formation should extend with a 0.5m berm beyond the road reserve boundary.
4. The Designer shall design a vehicular driveway centreline profile for the property access and check this design using critical car templates, available from Council, to ensure that vehicles can use the driveway satisfactorily.

***Driveway
Profile***

D1.17 INTERSECTIONS

1. The design of intersections or junctions should allow all movements to occur safely without undue delay. Projected traffic volumes should be used in designing all intersections or junctions on district distributor (B) roads.

***Traffic
Volumes***

2. Intersection design for the junction of subdivision roads with existing state rural, or urban roads and national highways should generally be in accordance with the publication AUSTRROADS Guide to Traffic Engineering Practice, PART 5, Intersections at Grade.

***State Roads,
National
Highways***

3. Intersections with state roads, or national highways are to be designed and constructed in accordance with the requirements of the Main Roads of WA.

***Approval of
MRWA***

4. Where major intersections are required to serve a development complete reconstruction of the existing road pavements will be necessary where the speed environment and irregularity of the existing road pavement may endanger the safety of traffic in the locality.

***Existing Road
Pavements***

5. Intersections should be generally located in such a way that:

Criteria

- The streets intersect preferably at right-angles and not less than 70°.
- The landform allows clear sight distance on each of the approach legs of the intersection.
- The minor street intersects the convex side of the major street.
- The vertical grade lines at the intersection do not impose undue driving difficulties.
- The vertical grade lines at the intersection will allow for any direct surface drainage.
- Two minor side streets intersecting a major street in a left-right staggered pattern should have a minimum centreline spacing of 50m to provide for a possible right-turn auxiliary lane on the major street.
- A right-left manoeuvre between the staggered streets is preferable, avoiding the possibility of queuing in the major street.

6. Adequate stopping and sight distances are to be provided for horizontal and vertical curves at all intersections.

Sight Distance

- | | | |
|-----|---|---------------------------------|
| 7. | Where required, appropriate provision should be made for vehicles to park safely. | <i>Parking</i> |
| 8. | The drainage function of the carriageway and/or road reserve must be satisfied by the road reserve cross-section profile. | <i>Drainage</i> |
| 9. | All vehicle turning movements are accommodated utilising AUSTRoads Design Vehicles and Turning Templates, as follows: <ul style="list-style-type: none"> • For intersection turning movements involving district distributor (B) roads, the "design semi-trailer" with turning path radius 15.0m. • For intersection turning movements involving access ways or local distributor roads, but not district distributor (B) roads, the "design single unit" bus with turning path radius 12.5m. • For intersection turning movements on access places but not involving district distributor (B) roads, local distributor or access ways, the garbage collection vehicle used by the local authority. • For turning movements at the head of cul-de-sac access places sufficient area is provided for the "design single unit" truck to make a three-point turn or where the length of the cul-de-sac is less than 60m for the "design car" to make a three-point turn. Where driveway entrances are to be used for turning movements, the required area is to be designed and constructed to withstand the relevant loads. | <i>Turning Movements</i> |
| 10. | Turning radii at intersections or driveways on district distributor (B) road accommodate the intended movements without allowing desired speeds to be exceeded. | <i>Turning Radii</i> |
| 11. | On bus routes 3-centred curves with radii 7.0m, 10.0m, 7.0m are used at junctions and intersections. | <i>Bus Routes</i> |

D1.18 ROUNDABOUTS

- | | | |
|----|--|------------------------|
| 1. | Roundabouts are to be approved by the Council and the MRWA. | <i>Approval</i> |
| 2. | Roundabouts should generally be designed in accordance with the requirements of the publication AUSTRoads Guide to Traffic Engineering Practice - PART 6 Roundabouts. Designs adopting alternative criteria will be considered on their merits. Roundabout design should generally comply with the following: <ul style="list-style-type: none"> • entry width to provide adequate capacity • adequate circulation width, compatible with the entry widths and design vehicles eg. buses, trucks, cars. • central islands of diameter sufficient only to give drivers guidance on the manoeuvres expected • deflection of the traffic to the left on entry to promote gyratory movement • adequate deflection of crossing movements to ensure low traffic speeds • a simple, clear and conspicuous layout • design to ensure that the speed of all vehicles approaching the intersection will be less than 50 km/h. | <i>Criteria</i> |

D1.19 TRAFFIC CALMING

1. Traffic calming devices are to be approved by the Council. **Approval**

2. Calming devices such as thresholds, slowpoints, speed humps, chicanes and splitter islands should be designed in accordance with the requirements of the publication AUSTRROADS Guide to Traffic Engineering Practice - PART 10, Local Area Traffic Management (LATM). Devices designs should generally comply with the following: **Criteria**

(a) Streetscape

- reduce the linearity of the street by segmentation
- avoid continuous long straight lines (eg. kerb lines)
- enhance existing landscape character
- maximise continuity between existing and new landscape areas.

(b) Location of Devices/Changes

- devices other than at intersections should be located to be consistent with streetscape requirements
- existing street lighting, drainage pits, driveways, and services may decide the exact location of devices
- slowing devices are optimally located at spacings of 100-150m.

(c) Design Vehicles

- emergency vehicles must be able to reach all residences and properties
- access ways with a 'feeding' function between arterial roads and minor access ways might be designed for a AUSTRROADS Design Single Unit Truck/Bus
- where bus routes are involved, buses should be able to pass without mounting kerbs and with minimised discomfort to passengers.
- in newly developing areas where street systems are being developed in line with LATM principles, building construction traffic must be provided for.

(d) Control of Vehicle Speeds

- maximum vehicle speeds can only be reduced by deviation of the travelled path. Pavement narrowings have only minor effects on average speeds, and usually little or no effect on maximum speeds
- speed reduction can be achieved using devices which shift vehicle paths laterally (slow points, roundabouts, corners) or vertically (humps, platform intersections, platform pedestrian/school/bicycle crossings)
- speed reduction can be helped by creating a visual environment conducive to lower speeds. This can be achieved by 'segmenting' streets into relatively short lengths (less than 300m), using appropriate devices, streetscapes, or street alignment to create short sight lines

(e) Visibility Requirements (sight distance)

- adequate critical sight distances should be provided such that evasive action may be taken by either party in a potential conflict situation. Sight distances should relate to likely operating speeds
- sight distance to be considered include those of and for pedestrians and cyclists, as well as for drivers
- night time visibility of street features must be adequate. Speed control devices particularly should be located near existing street lighting if practicable, and all street features/furniture should be delineated for night time operation. Additional street lighting shall be provided by the Developer at proposed new speed control devices located away from existing street lighting.

(f) Critical Dimensions

Many devices will be designed for their normal use by cars, but with provision (such as mountable kerbs) for larger vehicles. Some typical dimensions include:

- pavement narrowings
 - single lane 4.00m between kerbs, 3.50m on 50km/h roads subject to Main Roads WA approval
 - 4.00m between obstructions
 - two lane 5.50m minimum between kerbs
- bicycle lanes (including adjacent to pavement narrowings) – 1.2m absolute minimum (1.0m in special circumstances in accordance with AUSTRROADS Guide to Traffic Engineering Practice – PART 14, Bicycles.)
- plateau or platform areas
 - 75 mm to 150 mm height maximum, with 1 in 15 ramp slope
- width of clear sight path through slowing devices
 - 1.0m maximum

(ie. the width of the portion of carriageway which does not have its line of sight through the device blocked by streetscape materials, usually vegetation)
- dimensions of mountable areas required for the passage of large vehicles to be determined by appropriate turning templates.

D1.20 PARKING

1. The parking requirements for normal levels of activity associated with any land use should be accommodated on-site.

On-Site

2. All on-site parking should be located and of dimensions that allow convenient and safe access and usage.

3. Adequate parking should be provided within the road reserve for visitors, service vehicles and any excess resident parking since a particular dwelling may generate a high demand for parking. Such parking is to be convenient to dwellings.

Road Reserve Parking

4. The availability of parking should be adequate to minimise the possibility of driveway access being obstructed by cars parked on the opposite side of the street.

Obstruction

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5. On single lane access places parking spaces should be provided within the verge. Such parking should be well defined and an all-weather surface provided. Such parking shall not restrict the safe passage of vehicular and pedestrian traffic. **Verge Parking**
6. Parking spaces provided on the verge or carriageway should be of adequate dimensions, convenient and safe to access.
7. For non-residential land uses the opportunity for joint use of parking should be maximised by being shared by a number of complementing uses. **Joint Use**
8. Two car parking spaces (which may be in tandem) are provided on-site for each single dwelling allotment. **2 Spaces**
9. Three spaces are provided on-site for each two dwelling units for multi-unit residential developments. **3 Spaces**
10. Of the on-site parking one space for each residential unit is provided within the allowable building area and has a minimum dimension of 5.0m by 3.0m. **On-Site Space Dimension**
11. On single lane carriageways one space for each two allotments is constructed on the verge within 25m of each allotment, with scope to provide one additional space for single dwelling allotments or for each two units in a multi-unit development if required at a future time. **Future Spaces**
12. On single lane carriageways a number of verge spaces are combined to provide for short term truck parking within 40m of any allotment. **Short Term Truck Parking**
13. A single (car) space is 6.5m by 2.5m and combined spaces are 13.0m by 2.5m (for two cars) and 20m by 2.5m (for truck parking) with adequate tapers at both ends to allow the necessary parking manoeuvres determined by using AUSTRROADS Turning Templates. **Road Reserve Space Dimensions**
14. All verge spaces and indented parking areas are constructed of concrete, interlocking pavers, lawn pavers, bitumen with crushed rock or other suitable base material and are designed to withstand the loads and manoeuvring stresses of vehicles expected to use those spaces. **Verge Spaces, Indented Parking**
15. Right-angled parking is provided only on access places and access ways where speeds do not exceed 40 km/h. **Right-angled Parking**
16. The number of on-site parking spaces for non-residential land uses conforms to parking standards as determined by the relevant authority.
17. The layout and access arrangements for parking areas for non-residential land uses should conform to Australian Standard 2890.1.

D1.21 RESERVED

RURAL DESIGN CRITERIA

D1.22 GENERAL

1. In addition to the foregoing sections this section specifically applies to all those sites identified as being suited to rural subdivisions inclusive of rural home sites and hobby farms types of developments.
2. Design speed is to be generally used as the basic parameter of design standards **Design Speed**

and the determination of the minimum design value for other elements in rural subdivisions is to be based on the concept of a "speed environment" as outlined in AUSTRROADS Guide to the Geometric Design of Rural Roads.

3. Where appropriate superelevation, widening and centreline shift and their associated transitions are to comply with the AUSTRROADS Guide to the Geometric Design of Rural Roads.

4. All rural subdivisions should be designed to restrict access to major roads.

5. Access should be limited to one point on to local distributor or district distributor (B) road networks. **Access**

D1.23 SIGHT DISTANCES

1. Stopping sight distance should be provided at all points on the road. The stopping distance is measured from an eye height of 1.15m to an object height of 0.20m, using a reaction time of 1.5 seconds. A table is provided in the AUSTRROADS Guide to the Geometric Design of Rural Roads. **Stopping Distance**

2. Stopping distance is the sum of the braking distance and the distance the vehicle travels during a reaction time of 1.5 seconds, and may be calculated using the following formula: **Braking Distance**

$$d = 0.42V + \frac{V^2}{254f}$$

Where d = stopping distance (m)
 V = speed of vehicle (km/h)
 f = coefficient of longitudinal friction

(Source: AUSTRROADS Guide to the Geometric Design of Rural Roads,)

3. Recommended sight distances (based on the above formula) are shown in Table D1.6.

**Table D1.6
 Stopping Sight Distance**

Travel Speed km/h	Coefficient of * longitudinal friction	Stopping sight distance (m)
40	0.52	30
50	0.52	40
60	0.48	55
70	0.45	75
80	0.43	95

* bituminous or concrete surfaces

4. These figures may apply on crest vertical curves only where there are straight alignments. Adjustments should be calculated for steep grades.

D1.24 HORIZONTAL AND VERTICAL ALIGNMENT

1. Horizontal and vertical curves are to be designed generally to the requirements of AUSTROADS - Guide to Geometric Design of Rural Roads. These requirements are essential to satisfy the safety and performance of proper road design. Roads having both horizontal and vertical curvature should be designed to conform with the terrain to achieve desirable aesthetic quality and being in harmony with the landform.

Criteria

D1.25 INTERSECTIONS

1. Intersections should generally be designed in accordance with the publication AUSTROADS Guide to Traffic Engineering Practice - PART 5, Intersections at Grade. Generally intersections with existing main and local roads will conform to the layouts shown in Figure D1.6 below. The type of intersection required will depend on existing and planned connecting roads.

Criteria

2. Adequate sight distance should be provided at intersections both horizontally and vertically. Each intersection location shall be examined for conformance with the criteria for Approach Sight Distance (ASD), Entering Sight Distance (ESD) and Safe Intersection Sight Distance (SISD).

Sight Distance

ASD relates to the ability of drivers to observe the roadway layout at an anticipated approach speed.

ESD relates to the driver entering the intersection from a minor road and ability to observe the roadway layout and assess traffic gaps.

SISD relates to an overall check that vehicles utilising the intersection have sufficient visibility to allow reaction and deceleration so as to provide adequate stopping distance in potential collision situations.

Tabulated speed/sight distance requirements together with detailed explanations for each of the sight distance criteria are given in Part 5 of the AUSTROADS Guide, Intersections at Grade. Repositioning of an intersection may be required to obtain conformance with the sight distance criteria.

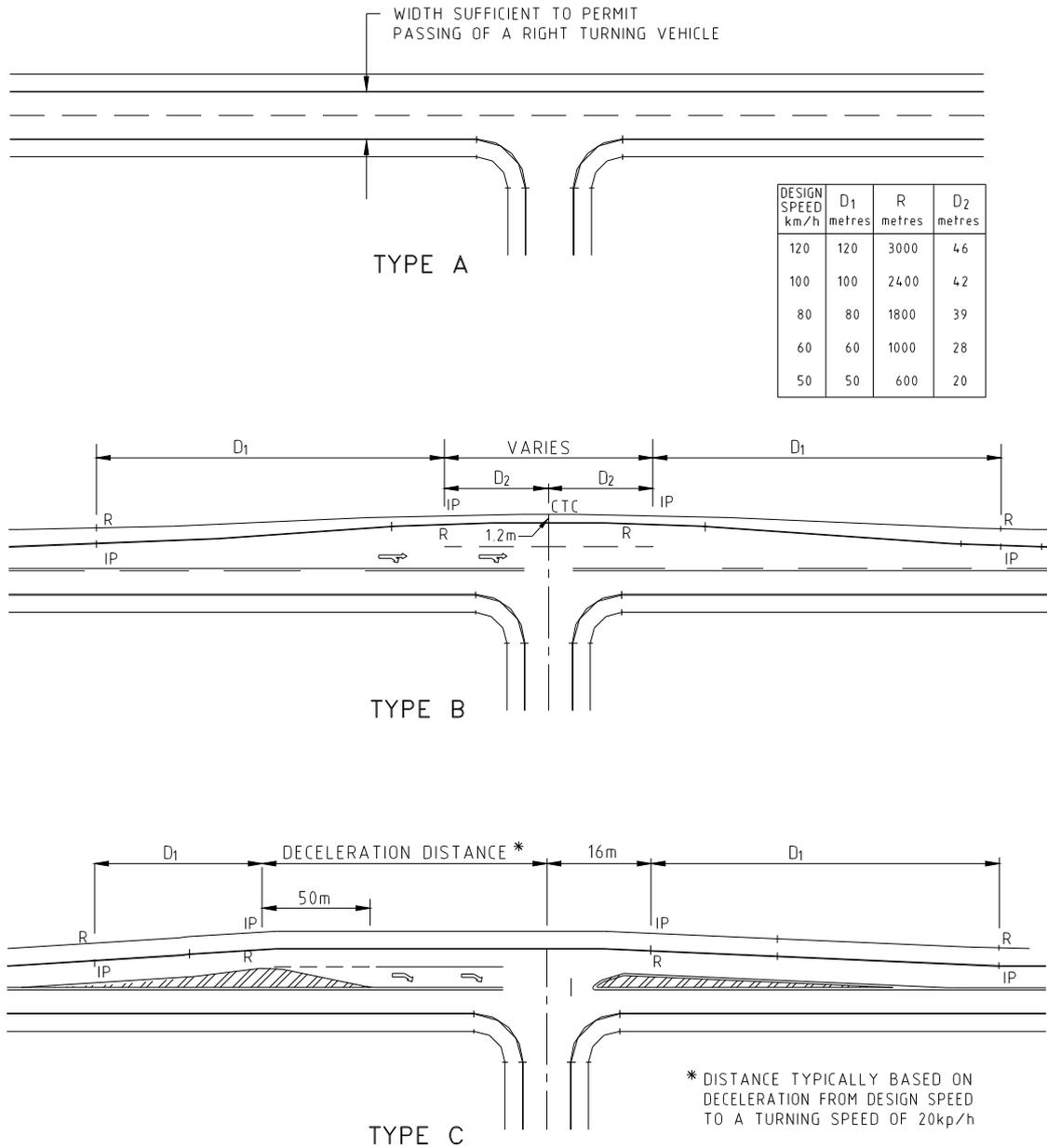


Figure D1.6
Typical Rural Intersection Treatments

Source: AUSTRROADS Guide to Traffic Engineering Practice PART 5, Intersections at Grade.

3. Staggered-T arrangements proposed for rural cross-intersections should preferably be of the “right to left” type. This arrangement eliminates traffic queuing in the major road, the need for additional pavement for right turn lanes and greater stagger length associated with “left to right” T-intersections. Figures and discussion on staggered-T treatments are given in Part 5 of the AUSTRROADS Guide, Intersections at Grade.

Staggered-T Intersections

D1.26 PLAN TRANSITIONS

1. A plan transition is the length over which widening and shift is developed from the "tangent-spiral" point to the "spiral-curve" point; ie, the length between the tangent and the curve. In urban road design it is often impracticable to use plan transitions as kerb lines are fixed in plan and any shift requires carriageway widening. Widening on horizontal curves compensates for differential tracking of front and rear wheels of vehicles; overhang of vehicles; and transition paths. Where proposed roads are curved, the adequacy of carriageway width should be considered.

Widening and Shift on Curves

2. Abrupt changes in crossfall, can cause discomfort in travel and create a visible kink in the kerb line. A rate of change of kerb line of no more than 0.5 per cent relative to the centreline should ensure against this. The wider the pavement the longer the transition. Superelevation transitions should be used at all changes in crossfall, not just for curves. Drainage problems can arise with superelevation transitions which may require extra gully pits and steeper gutter crossfalls. Where crossfalls change at intersections, profiles of the kerb line should be drawn. Calculated points can be adjusted to present a smooth curve.

Crossfall Changes

D1.27 CARRIAGEWAYS

1. Carriageway widths for rural roads should generally be as follows:

Major road over 1,000 AADT 2 x 3.7m lanes with 1.2m shoulders

Minor road up to 1,000 AADT 2 x 3.0m - 3.5m lanes with 1.2m shoulders

Minor no-through road up to 150 AADT 2 x 2.8m lane with 1.2m shoulders

Rural Residential street with kerb	
up to 250 AADT	6 metres
over 250 AADT	7.4 metres

Minimum rural road reserve width 20 metres

D1.28 SUPERELEVATION

1. Use of maximum superelevation will be considered where the radius of the curve in approaching the minimum speed environment. Reference should be made to AUSTRoads Guide to Geometric Design of Rural Roads for superelevation calculation. At low and intermediate ranges of design speed (ie below 80 km/h) it is desirable to superelevate all curves at least to a value equal the normal crossfall of straights.

Design Speed

D1.29 SCOUR PROTECTION

1. Scour protection of roadside drainage and table drains is required. The level of protection will depend on the nature of the soils, road gradients and volume of stormwater runoff. Protection works may involve concrete lined channels, turfing, rock pitching, grass seeding, individually or any combination of these. Geotechnical investigations should be carried out to determine the level and extent of any protection works prior to proceeding to final design stage.

Roadside Drainage and Table Drains

SPECIAL REQUIREMENTS

D1.30 RESERVED

D1.31 RESERVED

D1.32 RESERVED