3.0 ROAD PLANNING, DESIGN AND CONSTRUCTION

3.1 AIM

Councils aim under its Transport Infrastructure Program is to efficiently and effectively provide and manage transport infrastructure to ensure safe and economical systems for social and business movement of the Community.

The road system within a subdivision/development shall be designed to achieve the following objectives:-

- Provide a convenient, efficient and safe access for pedestrian, vehicles and cyclists that is economical to the community in terms of capital, cost of construction, maintenance costs and user costs;
- Provide a safe, logical and hierarchical transport linkage within the existing system;
- Provide a convenient, efficient and safe access for emergency and service vehicles;
- Provide a convenient and efficient access for public transport;
- Provide a convenient and efficient space for public utilities;
- Provide an opportunity for street landscape that would enhance the amenity of the environment;
- Provide convenient parking for visitors;
- Have appropriate regard for the climate, geology and topography of the area;
- Provide an acceptable layout for the community to socially interact;
- Provide a safe and efficient Major Drainage System;
- Provide ease of recognition for the function of each street.

3.2 ROAD PLANNING

3.2.1 ROAD HIERARCHY

A road hierarchy relies on the adoption of a road classification scheme which defines the function of the roads in terms of their traffic mobility and access/amenity functions. A road hierarchy provides the basis for determination of appropriate road design elements such as widths, speeds and management devices etc. that would be compatible with the function of the road.

The Livingstone Landuse/Transport Study (1992) adopted a hierarchy for the existing road network in the Shire that is appropriate for this area. Application should be made to discuss with Council the hierarchy for the proposed development.

The four basic functional classes are listed below together with a diagrammatic representation:-

DIAGRAM OF FOUR BASIC FUNCTIONAL CLASSES

ARTERIAL

These are the highest order roads, whose main function is to provide the principal links between urban centres (either between conurbations or within a conurbation), or between urban centres and rural regions. Within an urban area, they should have the capacity to be developed into multi-lane facilities with access control being a desirable feature to enhance traffic flow. Consequently, development of maximum traffic capacity must be the prime consideration. Aspects of noise, intrusion etc must be accepted and where this creates an unacceptable disturbance, solutions should be found elsewhere, other than by the removal of traffic. Such roads could be expected to be candidates for the full range of traffic management schemes, including intersection upgrading, full access control and parking restrictions. Application of these techniques would be consistent with the movement of traffic through given localities.

SUB-ARTERIAL

These are roads whose main function is to connect arterial roads to centres within a rural area and supplement the arterial roads in providing for traffic movements from one part of the urban area to another. They may be either two-lane or multi-lane roadways and as with roads classified as arterial, aspects of noise, intrusion etc must be accepted or reduced by means other than removal of traffic. The prime concern is still with the movement of traffic, so that on a two-lane roadway, extensive use of traffic management techniques could be expected to be applied. This could mean promotion of the movement of traffic through the locality, even at some inconvenience to local traffic.

COLLECTOR

These roads are intended to carry traffic between the arterial or sub arterial roads and local and access streets. They are not expected to carry high traffic volumes, and are not used for longer distance travel, except at the beginning or end of the journey. These roads help to distribute traffic at the neighbourhood level and may provide access to abutting properties.

Ideally they should discourage through traffic by not providing continuous through routes between arterials or higher order distributors. They are generally the lowest order road that may be used as a bus route.

LOCAL AND ACCESS

These are the lowest order roads in the tributary local system and consist of local streets and access streets, which provide access to residential properties. Their main functions are to provide both property access and residential amenity (resident safety and amenity are dominant). Residential amenity can be preserved if traffic volumes are limited to 2000 vehicles per day. As for collector streets, higher traffic volumes would be acceptable in industrial areas.

The arterial and sub-arterial roads form the basis for the major road system, whilst the collectors and the local accesses form the basis for the internal road system within the subdivision/development. Generally, the provision of arterials and sub-arterials would be part of Council's overall planning (Reference : Livingstone Land/Use Transportation Study - Road Hierarchy Plan). However, in some large subdivisions, the provision of these major roads may be required. Where arterial or sub-arterial roads are required, their location must be satisfactory to Council. Subdivision and development proposals are to include a proposed road hierarchy in its traffic assessment report and linkages to existing and proposed road networks.

Local and access roads should not interact directly onto a sub-arterial or arterial road. In preparing the proposed road hierarchy plan for the subdivision proposal, consideration is to be given to the function of the road, the expected traffic volume and the connection with the adjacent road network.

3.2.2 ROAD CLASSES AND CHARACTERISTICS

The road network in subdivision developments can be further divided into classes to reflect the land use categories that they serve.

ROAD ELEMENTS

1. RURAL ROADS

Traffic Volume or Road Class	<100VPD	100 - 199	200 - 999 (or rural collector)	1000 - 7999 (or Sub-Arterial)	>8000 (or Arterial)
Road Reserve (flat terrain ≤ 5%)	20m	20m	20m	25m	25m
Road Reserve ** (Undulating/Hilly > 5%)	25m	25m	25m	30m	30m
Formation	8m	8m	8m	10m	12m
Pavement Depth	CBR 35 150mm	CBR 35 150mm	To Design	To Design	To Design
Pavement Width	*5.5m gravel	5.5m gravel	6.5m	8m	10m
Seal width	Nil	4m	6.5m	8m	10m
Shoulders***	1.25m Select material from site	1.25m gravel	0.75 gravel	incl. 0.5m sealed on each side	incl. 1.5m sealed on each side
Desirable Speed Environment	100 kph	100 kph	100 kph	100 kph	100 kph
Design Speed for Individual Elements (Minimum)	80 kph	80 kph	80 kph	100 kph	100 kph

*** NOTE:**
(a) Sealing shall be required for longitudinal grades in excess of 10% for Rural B zone and in excess of 16% for Rural A zone.
(b) Sealing may be required at sites where existing adjacent roads are sealed. In this instance the seal width shall be 4m.

** In undulating terrain this width shall be increased to enable services to be constructed on accessible flatter land on top and below batters.

*** Where the road is a designated on-road bicycle route (signposted and pavement marked), the shoulder provision needs to conform to the AUSTROADS - BICYCLES

2. RESIDENTIAL & PARK RESIDENTIAL ROADS

Road Class	Access Street	Local Street	Collector Road
Road Reserve (min*)	18m	20m	20m
Seal Width (between inverts)	6.5	8m	10m
Parking			3m
Kerb & Channel	Mountable	Mountable	Barrier
Footpath (min)	4m	4m	4m, paving may be required.
Catchment	<20 lots		
Traffic Catchment Volume	<200 vpd	<2000vpd	2001→5000vpd
Design Speed	50 kph	50 kph	60 kph

* In undulating country this width shall be increased to enable services to be constructed on accessible flatter land on top and below batters.

3. BUSINESS & COMMERCIAL

Road Reserve	25m
Seal Width	13m
Parking	3m + 3m
Kerb and Channel	Barrier
Footpath	5m minimum and may require full width paving
Design speed	60 kph

4. INDUSTRIAL

Road Reserve	25m
Seal Width	13m
Parking	3m + 3m
Kerb & Channel	Barrier
Footpath	5m
Design Speed	60 kph

5. URBAN SUB-ARTERIAL & ARTERIAL

Road Class	**Sub-arterial**	**Arterial**
Road Reserve (minimum*)	25m	40m
Seal Width	13m	10.4m + 10.4m
Median		5m
Parking	3m + 3m	
Kerb & Channel	Barrier	Barrier
Traffic Volume	5000 - 20000	>20000 vpd
Design Speed	80 kph	80 kph Frontage Access 100 kph No Frontage Access

6. RURAL RESIDENTIAL & VILLAGE RESIDENTIAL

Road Class	**Access Street**	**Collector Road**
Road Reserve(min*)	20m	25m
Pavement width	8m	10m
Seal width	6.5m	8m
Kerb and Channel	nil	nil
Footpath	4m	4m
Design Speed	60 kph	80 kph

* In undulating country this width shall be increased to enable services to be constructed on accessible flatter land on top and below batters.

3.2.3 LAYOUT

There are a number of factors that shall be considered when designing the layout of the internal network of a subdivision or development and these include:-

- Connectivity (internal circulation, including consideration for safe pedestrian and cyclist routes);
- Permeability to through traffic;
- Legibility of layout;
- Economy;
- Bus routes;
- Recognition of road functions;
- Stormwater drainage paths

3.2.3.1 CONNECTIVITY

Connectivity refers to internal circulation within the site. A reasonable degree of connectivity should be provided to:-

- Allow vehicular, pedestrian and cyclist access within the subdivision/development to facilities located in the subdivision/development, such as schools, shops and recreation facilities, without the need to use the external traffic routes (ie. Sub-arterial and arterial road);
- Minimise travel time from the traffic routes to the allotments;
- Allow for alternative routes for emergency vehicles. Desirably, every precinct of more than 100 lots should have more than one (1) possible access route;
- Allow for bus routes;

Connectivity should not be excessive (especially at the local and access street level) so as:-

- Not to encourage through traffic to use the internal network to "short cut" the traffic routes (arterial and sub-arterial road);
- Not to cause undesirable levels of traffic volume in the local access street level as a result of the above;
- Not to result in too confusing a layout to visitors;

Pedestrians and cyclists require a high degree of connectivity for access to the internal facilities, bus services and transport facilities located within the external traffic routes. This can be achieved by provision of pedestrians/cyclists network within the subdivision or development and have links to the external system. The network can be provided along local and access streets and public parklands. Particular attention shall be given to public parklands. Particular attention shall be given to ensuring that pedestrian/cyclist links are not denied at the ends of cul-de-sac streets. The route selection shall consider safety in terms of accident potential and crime exposure, as well as convenience and attractiveness that would encourage pedestrians and cyclists to use these routes.

3.2.3.2 PERMEABILITY TO THROUGH TRAFFIC

The network shall be designed to discourage through traffic from using it as "short cuts" to bypass the external traffic routes. Through traffic reduces the amenity and safety to residents within a precinct.

Permeability to through traffic may be discouraged by:-

- Making the external traffic routes more attractive, ie. Less delays and more direct;
- Making the internal network sufficiently circuitous and less convenient to the through traffic
- Not having connections within the internal network that link traffic routes that are parallel or perpendicular to each other;
- Provision of appropriate local area traffic management devices such as threshold treatments at entries to the internal network, so as to physically discourage through traffic and reinforce the cue that one is entering a local precinct;
- Identifying the most likely "rat running" movements through the internal network and designing the connections to be at right angles, rather than parallel to the main traffic movements;
- Off-setting the intersections of the internal streets to the major external roads, rather than using a 4 way intersection or roundabout;

Generally internal roads which loop back onto the same major road are unlikely to cause problems.

3.2.3.3 LEGIBILITY

Legibility refers to the ease with which the street layout can be "read" and used by street users, particularly visitors. Legibility in a street layout helps reduce travel times and provides convenience to the road user. The emphasis should be on:-

- Simplicity of layout;
- Minimum of alternative routes;
- Minimum number of turns needed to reach a destination:

3.2.3.4 ECONOMY

Economy can be achieved through construction costs when:-

- The length of street within the internal network to which residential frontage is denied is minimised;
- No street is designed in excess of its required through capacity or pavement strength or parking requirements

Economy can also be achieved through low user costs and maintenance costs to the community. User costs reduction would be through efficient travel time is to limit the turning movements at intersections or junctions to no more than three (3), in order to travel from/to any address to/from the most convenient collector street or higher order road.

3.2.3.5 BUS ROUTES

The layout of the internal network shall take bus route provision into consideration even though at the time of application, the site may not have existing bus services. The factors to consider in provision for bus services include:

- Distance from 90% of the allotments are to be within 400 m straight line distance of a potential bus route;
- Bus routes should be restricted to collector roads and above, if possible;
- Bus route selection requires consideration of routes in the surrounding area;
- Bus route within the internal network should be reasonably direct, with no doubling back if possible, and minimum travel distance in low speed roads.

3.2.3.6 RECOGNITION OF ROAD FUNCTION

The recognition of road function by road users would help alleviate the problems of "rat-running" by through traffic in the internal road network.
The recognition and acceptance of the road function can be promoted by the use of visual or physical cues such as :-

- Threshold treatments or other LATM devices at entries to internal network;
- Local area traffic management devices such as at mid blocks along local accesses;
- Appropriate carriageway widths and road design elements, including the type of kerb and channels, geometry, type of pavement surface etc;
- Appropriate streetscape, such as landscaping and signage to differentiate between major external traffic roads and internal higher amenity network.

3.2.3.7 STORMWATER DRAINAGE PATH

The layout shall place great emphasis on stormwater drainage paths for both the minor and major systems. Economy in construction costs and maintenance costs shall be further enhanced if the major system takes advantage of overland flow within the road reservations and parklands.

3.3 ROAD DESIGN

The following design vehicles are to be used for the particular functional road class unless otherwise stated.

DESIGN VEHICLES FOR FUNCTIONAL ROAD CLASS

CLASS	DESIGN VEHICLE
Arterial	Semi-trailer(19m)
Sub-arterial	Semi-trailer(19m)
Collector	Semi-trailer(19m)
Local	Single unit truck (10.97m)
Access	Single unit truck (10.97m)

3.3.1 DESIGN SPEED

The design speed has been documented in the Road Element tables in Section 3.2.2. These speeds are the minimum level in each area and reduction below these levels will generally only be considered in severe terrain.

3.3.2 CROSS SECTION ELEMENTS

Standard cross sections are shown on Council's standard drawings.

3.3.2.1 WIDTHS

Where variations from the standard cross sections are approved by Council, the following cross section elements are to be conformed with.

(i) TRAFFIC LANE

Generally, a traffic lane is to be 3.5m wide, except for local and access roads where the traffic lane is to be 3.0m wide. On low radius curved alignments, vehicle turning templates are to be used to check on adequacy of width provided. Kerb side traffic lanes for shared bicycle/car use shall be a minimum of 4.0m wide and a maximum of 4.5m wide; a single traffic lane against an isolated median shall be 3.5m wide plus a 0.5m offset.

(ii) PARKING LANE

Parking lanes for parallel parking shall be 2.5m wide, except where there is a high turnover, then it is to be 3.0m wide. For angle parking provisions, refer to AUSTROADS - Guide to Traffic Engineering Practice, Part 11 - Parking. Shared bicycle/parking lane shall be 4.0m wide.

(iii) TURN LANE

Turn lanes shall be 3.0m wide (the 0.5m offset is not required).

(iv) MEDIAN (Refer to Section 3.3.10.10)

(v) SHOULDER (Refer to Tables in 3.2.2)

Where the road shoulders are to incorporate bicycle use, a minimum sealed shoulder width of 1.5m is to be provided outside a defined edge line where the speed environment is 60kph and below. Refer to AUSTROADS - BICYCLES for provisions in a higher speed environment.

3.3.2.2 CROSSFALLS

(i) PAVEMENT

Generally the pavement shall have a central crown with a 2 way crossfall on straight alignment and the minimum crossfall being:-

Unsealed pavement 5%
Spray seal 3%
Asphaltic concrete 3%
Portland cement concrete 2%
Interlocking pavers 3%

Where steeper or flatter crossfalls than the above are required, eg. At intersections or turning circles of cul-de-sacs, the design shall ensure that the pavement is adequately drained and subject to Council's satisfaction.

Offset crown on a two way road is permissible, provided that sufficient stormwater capacity for the Q100 flowpath is retained in the channel and the roadway on the high side of the road or the full road profile must cater for the full Q100 flowpath.

On divided carriageways, each pavement shall generally grade to drain from the median to the outer channel.

(ii) SHOULDERS

Sealed shoulders are to have a minimum crossfall of 3%. Unsealed gravel shoulders are to have a minimum crossfall of 4%. Where the pavement is also unsealed, the shoulder shall have a similar crossfall as the pavement.

3.3.2.3 KERB AND CHANNEL

Kerb and channel shall be provided in all Residential zones, the Park Residential zone, the Industrial zone and the Business zone on both sides of the road.

Generally the standard type of kerb and channel shall be the mountable type except:-

- At traffic islands and medians, continuous - extruded semi-mountable kerb is to be used;
- At urban arterial, sub-arterial (and some major collector roads as specified by Council), barrier type kerb and channel is to be used;
- At locations where there is a need to match the existing adjacent kerb and channel, the type used shall be decided in consultation with Council.

Refer to Council's Standard Drawings for kerb and channel profiles.

The longitudinal grading of the kerb and channel shall generally conform to the road centreline grading, but it shall not be less than 0.5% unless otherwise agreed to by Council.

Vertical curves shall be provided at changes of grades similar to that provided for road centreline alignment.

3.3.2.4 TABLE DRAINS

Table drains shall be provided in rural roads outside the shoulders and due consideration shall be given to potential scour problems and incorporating anti-scour measures. Where the nature of the natural material and/or catchment size and/or grades shall cause a potential scour problem, concrete lining or alternative treatments may be required. Table drain blocks shall be clearly detailed where such design assumptions for the culvert operation have been made. Refer to Section 5 for more details.

3.3.2.5 BATTERS

Required batter slopes shall not be steeper than 1 to 4. At locations where cuts and fills are less than 600 mm high, batter slopes not steeper than 1 to 6 are preferred.
Where earthwork volumes are significant, batter slopes may be steeper, but vehicles may need to be protected with safety measures such as guard rails or fencing in embankment situations.
On high batters (exceeding 5 m vertical height) or where batters are of unstable material or where there is a need to improve sight distance on horizontal curves, benching shall be considered.
Bench widths shall vary from 3 m to 5 m with maximum crossfall of 10% away from roadway.
Catch drains or diversion banks may be required above the batters depending on catchment size, slopes and material types. Stabilising of exposed batters is essential and revegetation or other means should be established within 14 days of construction to control erosion.

3.3.3 GRADES

3.3.3.1 MINIMUM GRADE

Whilst no minimum longitudinal road grade is herewith specified, the designer shall ensure adequate drainage of the kerb and channel or table drains.

3.3.3.2 MAXIMUM GRADE

Generally, the desirable maximum grades shall be adopted for normal purposes. In constrained locations where the topography makes the desirable maximum grades difficult to achieve, Council may consider submissions for steeper grades and the length of these grades shall be taken into consideration.

TABLE 3.3.3 (I)

CLASSES	DESIRABLE MAX
Arterial	6%
Sub-arterial	6%
Collector	8%
Access street	16%
Local street	16%
Industrial	6%
Business & Commercial	6%
Rural roads (except for sub-arterial & arterial)	16%

Where grades exceed 10% in rural roads in Rural B zone and 16% in rural roads in Rural A zone, bitumen sealing and kerb and channel or concrete lined table drains shall be required.

3.3.4 SIGHT DISTANCE

3.3.4.1 ABSOLUTE MINIMUM STOPPING AND DESIRABLE MINIMUM STOPPING

The absolute minimum sight distance is that required for a driver to perceive an object 0.20m high on the road ahead and to stop the vehicle before reaching the object. This sight distance shall be available at every point on every road. It is measured between a point 1.15m above the road surface and another point 0.20m above the surface.

The desirable minimum sight distance is that required for the drivers of two opposing vehicles in a two-way road to perceive each other and stop before colliding. It is measured between two points 1.15 m above the road surface. The sight distances shall be based on a reaction time of 2.5 seconds which is under normal operating conditions.

Where the sight distance available on a two-way road is less than the Desirable Minimum, Council may require provision of pavement markings restricting overtaking and/or may require an increased pavement width. Refer to AUSTROADS for minimum stopping sight distances.

3.3.4.2 INTERSECTION SIGHT DISTANCE

Intersection Sight distances shall be in accordance with AUSTROADS.

i) APPROACH SIGHT DISTANCE

This is the minimum sight distance required for vehicles approaching an intersection to perceive the roadway layout and any object at the intersection, including pavement markings, kerbs, island etc and to have adequate time to react and stop if necessary before entering the conflict area.

The rural road approach sight distance desirable reaction time shall be 2.5seconds.

ii) SAFE INTERSECTION SIGHT DISTANCE (SISD) AND ENTERING SIGHT DISTANCE (ESD)

The Safe Intersection Sight Distance is the minimum distance that is required to provide sufficient time for a vehicle on the major road to perceive a vehicle approaching in the minor road to the conflict point, to decelerate to a stop before reaching the conflict point. This is generally sufficient time for vehicles in the side road to cross a major road safely.

The Entering Sight Distance is the sight distance required for the minor road vehicle to enter a major road via a left or right turn at intersections where vehicles in the minor road or within a median are required to stop or give-way before entering the intersection, such that traffic on the major road is unimpeded. Refer to Fig 3.3.4 (I) below.

Figure 3.3.4(I)

(SISD) SAFE INTERSECTION SIGHT DISTANCE AND

ENTERING SIGHT DISTANCE (ESD)

Ref: Guide to Traffic Engineering Practice

Intersection at Grade AUSTROADS

3.3.5 VERTICAL CURVES

Where sub-standard curves are used, warning devices or drivers' aid should be included in the design and construction to enhance safety. Refer to the Manual of Uniform Traffic Control Devices - Queensland Department of Main Roads.

3.3.5.1 MAXIMUM CHANGE OF GRADES

A vertical curve based on the parabolic form shall be provided at the changes of grade exceeding the values shown in the following table :

TABLE 3.3.5 (I)

DESIGN SPEED (kph)	MAXIMUM ALGEBRAIC GRADE CHANGE WITHOUT A VERTICAL CURVE (%)
40	1.0
50	0.9
60	0.8
70	0.7
80	0.6
90	0.5
100	0.4

In selecting the appropriate length for a vertical curve, consideration is to be given to the following :-

- Stopping sight distance requirements
- Appearance of the curve
- Riding comfort related to vertical acceleration
- Overtaking sight distance available on approaches
- Stormwater drainage
- Headlight performance or overhead restrictions to the line of sight

3.3.5.2 CREST CURVES

The absolute minimum length of a crest curve is governed by the absolute minimum sight distance requirements. Refer to AUSTROADS for the absolute minimum lengths for crest curve based on this criteria.

3.3.5.3 SAG CURVES

The absolute minimum length of a sag curve is based on riding comfort and shall be such that the maximum vertical acceleration is 0.10 g for access and collector streets and 0.05g for sub-arterial and arterial roads. On high standard roads (eg. sub-arterial and arterial) without roadway lighting, the desirable minimum length based on headlight sight distance shall be provided (to a maximum sight distance of 150m).

Refer AUSTROADS for absolute minimum and desirable minimum sag curve lengths.

Where the sight distance on a sag curve may be limited by an overhead obstruction such as road or rail overpass, the length of vertical curve can be determined for a particular sight distance using the formula, based on the sight line constant C given in AUSTROADS.

3.3.5.4 APPEARANCE CRITERIA

In addition to the requirements for vertical curves outlined in AUSTROADS, the length of vertical curves shall not be less than that given in AUSTROADS for satisfactory appearance.

3.3.5.5 VERTICAL CURVES AT INTERSECTIONS

i) In the case of a vertical curve in the side road of a "T" intersection, there the side road joins the through road, a reduced length of vertical curve can be acceptable because of the lower traffic speed in the side road at the intersection.

ii) The minimum length of such a vertical curve, based on riding comfort, shall be:

a) On a local access street L = 0.7A
b) On a collector road L = 1.25A

Where L = minimum length of vertical curve (metres)

A = algebraic change of grade, between grade of the side road and crossfall of the through road.

iii) Notwithstanding (ii) above, from a consideration of appearance, a vertical curve in the side road at an intersection shall be not less than 10.0 m in length.

iv) The tangent point of a vertical curve in the side road shall be located at, or outside of the kerb line of the through road.

v) Alternatively, where an invert crossing is approved across the side road on the channel line of the through road, the above requirements still apply but the approach grade in the side road at the crossing shall be a grade of 0.30% falling to the crossing. The tangent point of the vertical curve may be located at the lip of the crossing.

3.3.5.6 VERTICAL CURVE COMBINATIONS

i) "Broken-Backed" Vertical Curves - (ie two vertical curves, either both sag or both crest, with a short length of straight grade between) are unsightly, and should be avoided, one long vertical curve being much preferred.

If their use is unavoidable, the minimum length of straight grade between the tangent points of similar vertical curves shall be :-

Minimum Length of straight grade between tangent points of similar vertical curves

Access & Local Streets	30 m
Collector street	50 m
Sub-arterial	75 m
Arterial	100 m

ii) Compound Vertical Curves - ie two vertical curves, either both sag or both crest, with a common tangent point, are permissible.

iii) Reverse Vertical Curves - ie one sag, the other crest, with a common tangent point, are permissible, provided that the sum of the vertical accelerations for the two curves does not exceed the maximum permissible for a single curve (0.10 g for access and collector roads, 0.05g for subarterial and arterial roads), and provided that the length of each curve complies with all minimum length requirements.

iv) Combined Vertical and Horizontal Curves - Where combinations of vertical and horizontal curves occur, it is preferable that the curves in the two planes approximately coincide, as such an arrangement gives both satisfactory appearance and better safety at crest.

Ideally, the horizontal curve should extend slightly beyond the limits of the vertical curve. Particularly to be avoided is the situation where a crest vertical curve masks the commencement of a horizontal curve, as such a combination is potentially dangerous.

3.3.5.7 VERTICAL CURVE GEOMETRY

PARABOLIC VERTICAL CURVE GEOMETRY

Calculation of Levels on Parabolic Vertical Curve

a) Mid-ordinate (OM) = (MN) = $\frac{L(G_1 - G_2)}{800}$

b) Level at (Q) equals to level at (P) less the distance (PQ)

where (PQ) = $x^2 \frac{(OM)}{(L/2)^2}$

3.3.6 HORIZONTAL ALIGNMENT

Generally, curves are designed such that a positive side friction is provided (ie frictional force on the vehicle is acting towards the centre of the curve).

The horizontal curve is based on the following formula :

$e + f = \frac{V^2}{127R}$ where

e = pavement superelevation
f = co-efficient of side friction between tyres and road pavement
V = vehicle speed (kph)
R = horizontal curve radius (m)

Refer to AUSTROADS for co-efficient of side friction.

FRICTION COEFFICIENTS

Speed (km/h)	Coefficient of Longitudinal Deceleration (d)*	Coefficient of Side Friction (f)**
50	0.52	0.12
60	0.48	0.11
70	0.45	0.10
80	0.43	0.10
90	0.41	0.09
100	0.39	0.09
110	0.37	0.08

* values from AUSTROADS (1989) for **sealed surfaces** (refer to Section 4.1.6)

** values from Road Construction Authority (1983) for gravel or unsurfaced pavements (with interpolation)

Source: AUSTROADS (1989) and Road Construction Authority (1983)

The selection of superelevation is based mainly on safety grounds, but consideration should be given to comfort and appearance.

Where superelevation is required in the design, it shall be in accordance with the following sections.

Where sub-standard curves are used, warning devices or drivers' aid should be included in the design and construction to enhance safety. Refer to the Manual of Uniform Traffic Control Devices - Queensland Department of Main Roads.

3.3.6.1 MAXIMUM SUPERELEVATION

i) For roads with frontage property access, the maximum superelevation on a curve shall be 5%.

ii) For roads with no frontage property access, the absolute maximum superelevation shall be 8%, with a desirable maximum of 6%.

3.3.6.2 MINIMUM SUPERELEVATION

Where superelevation is provided, the minimum superelevation shall not be less than the normal crossfall on the straights, except within the superelevation transition lengths.

3.3.6.3 MINIMUM HORIZONTAL CURVE RADIUS

The radius of a horizontal curve is dependent on the design speed, side friction and superelevation available.

The minimum horizontal curve radii adopted for the various design speeds and road classes are shown in Table 3.3.6 (I).

TABLE 3.3.6 (I)
MINIMUM HORIZONTAL CURVE RADIUS (Bituminous Surfaces)

ROAD CLASS	DESIGN SPEED (kph)	MAX SUPERELEVATION (%)	MINIMUM CURVE RADIUS (m)
Arterial (rural)	100	5	465
Arterial (urban)	80	5	280
Arterial (rural) No Frontage Access	100	8	400 Abs max super
Arterial (urban) No Frontage Access	100	6	440 Des max super
Sub - Arterial (rural)	100	5	465
Sub - Arterial (urban)	80	5	280
Res. Access Street	50	0	90
Res. Local Street	50	0	90
Res. Collector Road	60	0	130
Rural-Res. Access Road	60	0	130
Rural-Res Collector Road	80	5	230
Rural Road	100	5	350
Industrial Street	60	5	105

* See Section 3.3.6.4 for local and access streets.
For roads without bituminous surfaces, Consultants shall make a separate submission to Council.

It is important to note that curves of minimum radius do not necessarily meet the sight distance requirements, and if the curve radius cannot be increased, checks should be made as to whether restricted visibility widening and/or visibility benching should be applied. The absolute minimum sight distance should be available over the full length of the curve on all rural roads, collector roads, sub-arterial and arterial roads.

It should also be noted that a curve of minimum radius may not be sufficient length for the required superelevation transition. It is desirable that there should be full superelevation for a length of 30 m. The absolute minimum standard is that the curve be brought to full superelevation even if only instantaneously.

3.3.6.4 LOCAL AND ACCESS STREETS

It is impracticable to apply ideal standards of curvature to all local and access streets, as the limitations of allotment layout often necessitate 90° bends of very small radius, which can be negotiated only at speeds well below the normal design speed.

However, as drivers expect such sharp changes in alignment on these roads, traffic safety need not be prejudiced provided that such curves are easily visible. Deflections of 60° or less, however, which are less easily recognisable as a potential hazard to an approaching driver, should have curves of appropriate radii, in accordance with Section 3.3.6.3 above.

For a deflection greater than 60°the minimum centreline curve radius shall be 20m (which is consistent with a speed of approximately 20 km/hr) without superelevation.

3.3.7 SUPERELEVATION TRANSITION

Refer to AUSTROADS - Guide to Geometric Design of Rural Roads for methods of superelevation, location of superelevation transition, superelevation of control lines and the length of superelevation transition..

3.3.7.1 GRADING OF CONTROL LINES

i) In general, crossfall shall be varied uniformly throughout the transition length, resulting in control line grading being straight grades, provided that the design road grade is a straight grade over the transition length.

ii) Exceptions to this general rule are :-

Superelevation on the inner half of the pavement of a two way road shall commence at the tangent point of the curve, and vary uniformly to the end of the transition.

Where changes in grade of control lines greater than specified in Section 3.3.5.1 occur, vertical curves shall be provided, of minimum length in accordance with the requirements of vertical curve design as outlined in Section 3.3.5.

iii) It is necessary to plot the grade line of all control lines particularly on flat grades, and where vertical curves or changes of grade in the design grade line occur within the transition length, to ensure that control lines are smoothly graded for good appearance, and that no undrained low points are caused. If necessary, transition length should be increased, or control line gradings adjusted, to provide a satisfactory transition.

3.3.7.2 LENGTH OF TRANSITION

The two criteria governing the length of superelevation transition are riding comfort (controlled by the rate of rotation of pavement) and appearance (governed by the difference in grades between the edges of the carriageway and the axis of rotation - control line).

i) RIDING COMFORT

The maximum rate of rotation should not exceed 2.5% per second, or :-

$L = \frac{SV}{9}$ where L = minimum length of transition (m)
S = algebraic change of crossfall (%)
V = design speed (kph)

ii) APPEARANCE

The difference in grade between any two control lines, (ie longitudinal sections between which the pavement crossfall is constant, such as pavement centreline, pavement edge, or lane edge), shall not exceed the values given in AUSTROADS.

3.3.8.6 REAL PROPERTY ALIGNMENT

Where the application of shift to the centreline would result in the reduction of footpath widths to less than that required for that class of road, the Real Property Alignment shall be varied to maintain the footpath width required.

3.3.9 CURVE WIDENING ON HORIZONTAL CURVES

3.3.9.1 ROADS REQUIRING CURVE WIDENING

Curve widening shall be applied to curves in accordance with AUSTROADS on collector, sub-arterial and arterial roads without kerb and channel. It shall also apply to half road or stage construction in existing road reserves of the above road classes.

For curves with radius less than 30m, turning templates for articulated vehicles shall be used to determine the amount of widening required.

3.3.9.2 METHOD OF CURVE WIDENING

The widening shall be applied such that half of the widening is applied before the tangent point and terminated at the end of the superelevation development length on the arc.

The curve widening shall be applied at a uniform rate equally on each side of the curve and to coincide with the plan transition. When two curves are located such that the points of nil curve widening are less than 30 m apart, the curve widening is carried through at a uniform variation from the maximum values on each curve. The position of the maximum values do not change. Refer to Road Design Manual Volume 1 (MRD) for details.

3.3.10 INTERSECTIONS

Refer to AUSTROADS Intersections at Grade

3.3.10.1 GENERAL PRINCIPLES

The following basic principles shall be observed in the design of intersections in order to achieve the prime objective of safety with consideration given to secondary objectives of capacity and delay.

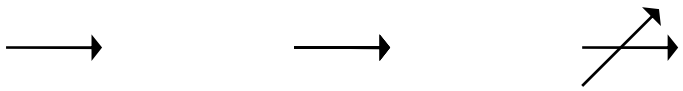
i) Provision of adequate sight distance

The three types of sight distance to check are:-

- approach sight distance;
- entering sight distance;
- safe intersection sight distance.

ii) Avoid the use of multiple manoeuvres

Simple manoeuvres should be used as multiple manoeuvres can confuse drivers and result in operational, capacity and safety problems.



Diverge Merge Cross Weave

Simple Manoeuvres

Diverge Merge Cross Weave

Multiple Manoeuvres

iii) Minimise the number of conflict points

The number of conflict points for the different types of intersection are shown below:-

Cross intersection	T-junction	Roundabout
32 conflict points	9 conflict points	8 conflict points

iv) Separate the points of conflict

Points of conflict shall be separated so that motorists are confronted with only one decision at a time. Desirably, points of conflict should be at least 5 seconds travel time apart.

v) Prohibit undesirable or unnecessary movements

This can be achieved by appropriate signing or the use of traffic islands.

vi) Control the speed and angle of conflicting traffic movements

Merging, diverging and weaving manoeuvres should be designed to occur at low relative speed. The angle of conflicting traffic movements should be between 70° and 90°.

vii) Clearly define vehicular paths and conflict areas

Approach and departure paths and actual conflict areas should be clearly defined and be obvious to the motorists. This can be achieved with the aid of suitably designed traffic islands and pavement markings.

viii) Minimise the area of conflict

Unnecessary pavement areas in the conflict area should be eliminated by using suitably designed islands.

ix) Give preference to the major movements

The major movements should be provided with the more direct paths for operational safety and capacity reasons.

x) Avoid unnatural or unusual movements

All required movements should appear logical and reasonable to all road users.

xi) Provide for turning and crossing vehicles

Adequate provision should be made for turning and crossing vehicles.

xii) Provide for buses (where applicable)

Adequate provision should be made for buses. An example may be a space clear of the traffic lane should be considered for bus stops near intersections.

xiii) Provision for pedestrians and cyclists

Adequate provision should be made for the protection of pedestrians and cyclists. An example may be a refuge in an arterial road median.

xiv) Provide for adequate capacity

Generally, capacity plays a more important part in urban intersection than in a rural intersection.

xv) Provide traffic control devices

Appropriate traffic control devices including signs, markings and traffic signals should be provided where warranted. These should be logical and appear reasonable to the road user.

However, inappropriate or excessive use of these facilities in lieu of the application of good design principles should be avoided as they can confuse the motorists.

xvi) Provide for adequate spacing between intersections

Adequate spacing shall be provided to reduce confusion to motorists. Refer to Section 3.3.10.5 for minimum spacing required.

xvii) Control access from abutting properties

Points of access from abutting properties should not be permitted close to or within the intersection. Where this is unavoidable, it should be a controlled movement only, eg left in and left out.

3.3.10.2 TYPES OF INTERSECTIONS AND APPLICATIONS

All intersections of local access and collector streets shall generally be of a T-junction type. Uncontrolled four-way intersections should be avoided. Where four-way intersections cannot be avoided, these should be designed to incorporate local area traffic management devices (including roundabouts, threshold treatments, etc) to slow down the traffic and reduce the potential of conflicts.

Local and access streets shall not intersect directly onto any arterial road. The following tables 3.3.10(I) and 3.3.10(II) show the most appropriate intersection management for urban and rural intersections.

TABLE 3.3.10 (I)
URBAN INTERSECTIONS

APPROACH ROAD CLASSIFICATION	MOST APPROPRIATE ACTION ON APPROACH ROAD Intersection Road Classification			
	Arterial	**Sub-Arterial**	**Collector**	**Local**
Arterial	GS or S & EC	S or EC	S & EC or EC	*
Sub-Arterial	S & EC	R or S & C	EC or R	C
Collector	T & C or S & C	T & C or R	R or T & C	DN
Local	*	ST/GW or T	ST/GW or T	R or T

TABLE 3.3.10 (II)
RURAL INTERSECTIONS

APPROACH ROAD CLASSIFICATION	MOST APPROPRIATE ACTION ON APPROACH ROAD Intersection Road Classification			
	Arterial	**Sub-Arterial**	**Collector**	**Local**
Arterial	EC or R or GS	EC or R	EC	*
Sub-Arterial	T & EC or R	R or T & EC	EC	C
Collector	EC & ST/GW	ST/GW & C	R or C	DN
Local	*	ST/GW & T	ST/GW	R or ST/GW

LEGEND:

GS	Grade Separation	**ST**	Stop Sign
S	Signalization	**GW**	Give Way Sign
EC	Extensive Channelisation or median break	**T**	T- Intersection
C	Channelisation or median break	*****	Intersection undesirable
R	Roundabout	**DN**	Do Nothing

NOTES:

(a) The tables indicate the most appropriate management action to be applied on the approach road to the intersection (as defined by the rows of the table). For example: Local Road approach to Sub- Arterial - apply STOP sign on Local Crossing Road.

(Refer Manual of Uniform Traffic Control Devices - Queensland Department of Main Roads).

Several points should be noted in reference to the Tables above.

(i) Intersection controls are selected to maintain the hierarchical relationship between road classes.

(ii) Roundabouts are an appropriate form of intersection control only when used on roads of equivalent or similar classification (see (a) above). If used inappropriately, for example on roads of dissimilar function, they will assign equal priority to the intersection roads when this should not occur.

Intersections for a new subdivision or development (or expansion of an existing subdivision or development) shall be designed in accordance with the requirements of these guidelines and AUSTROADS - Intersections at Grade with consideration given to traffic volumes and accident potential. This includes upgrading of existing intersections to cater for increased traffic generation and accident potential.

The traffic generation due to subdivision or development used in intersection assessment and design shall be estimated using the rates outlined in the appendix 3.1.

3.3.10.3 INTERSECTION ANGLE

Road centrelines shall intersect as close to 90° as possible and shall not be less than 70^{o}.

3.3.10.4 LOCATION OF INTERSECTIONS

Intersections onto a curve on the through road shall be avoided if possible. Where they are unavoidable, the angle between the centreline of the side road, and a tangent to the centreline of the through road at the point of intersection shall be 90°.

An intersection shall not be located on the inside of a curve on the through road, unless the radius of the through road is not less than twice the minimum radius permissible for the through road.

In instances where it is unavoidable in both cases above, signposting should also be provided to enhance safety.

3.3.10.5 SPACING OF INTERSECTIONS

The spacing between two intersections, measured along the centreline of the through road between the centrelines of the side roads, shall not be less than the following :-

URBAN INTERSECTIONS

THROUGH ROAD	SIDE ROADS ON OPPOSITE SIDES	SIDE ROADS ON SAME SIDE
Minor Access Street	40	60
Local Street	40	60
Collector Road	80	80
Sub-Arterial Road	200	200
Arterial Road (to allow for signalisation)	500	500

RURAL INTERSECTIONS

THROUGH ROAD	SIDE ROADS ON OPPOSITE SIDES	SIDE ROADS ON SAME SIDE
Minor Access Street	80	80
Local Street	80	80
Collector Road	200	200
Sub-Arterial Road	250	250
Arterial Road	500	500

3.3.10.6 SIDE ROAD

i) Minimum Length

The minimum length of straight alignment measured along the centreline of the side road from the kerb line or shoulder point of the through road to the tangent point of a curve on the side road shall be :-

Minor Access Street	10 m
Local Street	50 m
Collector Road	60 m
Sub-Arterial Road	100 m
Arterial Road	100 m

ii) Grade

(a) The finished levels of an intersection shall be such that the pavement crossfall of the through road is continuous out to the kerb line or the outer edge of the travelling lane so that the through traffic on the through road does not go over a "hump" which is caused when the crowned centreline of the side road is carried to the through road;

(b) Where the grade of the side road exceeds or is not in the same direction as the crossfall of the through road, the vertical alignment of the side road can be improved with vertical curves (subject to the requirements of Section 3.3.5) and emphasis is placed on checking the visibility at the intersection.

3.3.10.7 TRUNCATIONS

The minimum truncation of the real property boundary at an intersection shall be the following amount and by three (3) or more chords.

Minor access and local street to any street or road;	6 m
Collector road to a collector road, sub-arterial or arterial road;	8 m
Sub-arterial or arterial road to a sub-arterial or arterial road.	10 m

The truncations may be greater than the above minimum values, depending on the site, with particular consideration given to future intersection improvements, such as channelisation etc and provision of safe intersection visibility.

3.3.10.8 KERB RADII

The minimum radius of the lip of the channel at an intersection for roads intersection at 90°angle shall be :-

Minor access or local street onto any street or road;	9m
Collector street onto a sub-arterial or arterial road;	12m
Sub-arterial or arterial roads onto a sub-arterial or arterial road.	15 m

Turning templates for AUSTROADS 19m articulated vehicles shall be used to determine kerb radii for intersection angles other than 90°.

3.3.10.9 CHANNELISATION

i) Need

Channelised intersections shall be provided in accordance with the requirements of these guidelines and AUSTROADS - Intersections at Grade.

Painted medians may be used in instances (eg staged construction) with prior approval of Council, based on traffic management techniques. In such instances the layout shall meet these standards.

Generally, the need to provide channelised intersection and the design of the layout are based on various factors, including the following :-

- swept path of AUSTROADS vehicle semi-trailer 19m
- traffic volumes and patterns at the intersection;
- layout of the intersection;
- available area within the road reserve to accommodate the channelisation;
- topography of the site;
- pedestrian and cyclist movements;
- bus and heavy vehicle movements, including bus stopping facilities;
- parking provision;
- planned ultimate development.

Channelisation is usually achieved through the use of traffic islands such as medians, separators, roundabouts, pedestrian refuges, lane allocation such as slip lanes, right turn lanes, merging lanes etc.

ii) Locations

As a general guide, channelised intersection may be required at the following locations :-

a) at the intersections of arterial, sub-arterial roads and arterial, sub-arterial roads;

b) at the intersections of collector street and sub-arterial or arterial roads;

c) collector to collector intersections (occasional);
d) local street to collector, or local street to local street intersections (rare).

iii) Design Principles

In addition to the general design principles for intersection design as outlined in Section 3.3.10.1, the provision of a channelised intersection shall consider the following :-

a) Provide sufficient space for signposting and traffic signals;

b) Provide sufficient advance warning to motorists of the channelisation;

c) Physically control prohibited movements;
d) Provide sufficient delineation to guide motorists through the intersection;
e) Clearly highlight any raised islands and medians so that these devices are not hazards themselves;

f) All channelisation shall be designed to accommodate the turning path of a design semi-trailer vehicle and to provide a clearance of not less than 0.6 m between the vehicle track and the kerb at all points. (Not for local or minor access)
g) Flaring of kerb or kerb and channel on the left hand approach to an intersection is to be provided with a 1 in 5 parabolic flare with a kerb offset a minimum of 1.0m from the lane edge.

3.3.10.10 RAISED MEDIAN ISLANDS

i) DESIGN PRINCIPLES

All median islands shall be in accordance with the following:-

a) Kerb - Concrete semi-mountable type;

b) Minimum Width and Length - The minimum width of a median shall be 1.2 m or for pedestrian refuge the minimum width shall be 2.5 m.
The minimum length of a median shall be 10 m; for design speed (v) of less than 60 kph, 12 to 20 m for $60 < v < 80$ kph and 20 to 60 m for $80 < v < 100$ kph.

c) Surface Treatment - A concrete infill shall be provided where the median width is 2.0 m or less and generally grass surfacing is provided kerb to kerb where the median is wider than 2.0 m for a minimum length of 50 m;

d) End Radius - The minimum end radius of a median shall be:-

0.6m for diverging movements on the approach end of the median;
0.3 m for merging movements on the departure end of the median;
0.6m for opposing movements on the approach and departure ends of the median;
1.0-1.5 m for diverging movements perpendicular to each other.

e) End Offset - The approach end of the first median approached by a driver is to be offset 0.6 m (absolute minimum 0.3 m)(at the nose T.P.) from the right hand edgeline of the adjacent traffic lane;

f) Side Tapers - The tapers of the side of a median compared to the normal lane edge shall be not less than 1 in 10, but desirably should be a minimum of 1 in 20;

g) Line Marking - Generally line marking and pavement marking associated with median treatments shall be in accordance with the Queensland Department of Main Roads Manual of Uniform Traffic Control Devices. The approach end of the first median is to be preceded by a length of painted median being parallel bar chevrons at 45° to the outline markings.

In urban areas, the minimum width of the bars or chevrons measured normal to the marking shall be 0.6m and the gap separating the parallel bars may vary from a minimum of 1m to a maximum of 5m. In rural areas the bars shall be a minimum of 1.2m wide with a minimum separation gap of 3m.

The angle between the bars or chevrons and the line of the approach should be 45° maximum. On high-speed rural approaches the angle may be reduced to 30° for diagonal markings or 22°30' for chevrons (ie 45° included angle between sides of chevron).

The outline marking shall be 100mm wide with a 100mm gap between the outline and the bars or chevrons. See Fig 3.3.10(I)(a) and (b) below.

LEGEND

Angle A_1	=	45^o Urban 30^o Rural
Angle A_2	=	45^o Urban 22^o 30' Rural
B	=	0.6m min. Urban 1.2m min. Rural
S	=	0.6m to 5m Urban 3m min. rural
W	=	Equal dimensions 100mm or 150mm

Depending on length and locations

(a) Traffic to left side only (b) Traffic to either side

FIGURE 3.3.10 (I)

The transition length of the painted chevron median shall be:

$$T_d = \frac{Vy_d}{3.6\ s}$$ where V = design speed kph
Y_d = lateral movement of vehicle (m)
S = rate of lateral shift
= 1.0 m/s
T_d = Transition length (m)

The maximum transition length shall be 30m in an urban area and 50m in a rural area. The transition shall be preceded by a minimum length of 30m of barrier line.

h) Shoulder Kerb Flare - Concrete semi-mountable type; segmental units shall generally not be approved

i) Side Road Offset - When a median is placed on a side road, the end adjacent to the through road shall be set back 0.6m behind the prolongation of the kerb line or edge line in the through road;

j) Signs - At the end of the median a reflectorised "Keep Left" sign shall be erected at a minimum of 2m and maximum of 8m from the end of the nose facing the approaching traffic;

k) Approach Sight Distance - Unless stopping sight distance 1.15m to 0.0m is available, the end of the first median approached by a driver from any direction shall not commence on the arc of a horizontal curve or beyond a crest. It is usually satisfactory if a median commences at or before the first tangent point or 30m beyond the second tangent point of a horizontal curve;

l) Sub-soil Drainage - Medians should be provided with sub-soil drainage where the median is pervious to moisture penetration.

(ii) MEDIAN OPENINGS

All median openings shall be constructed and line-marked in accordance with the following:

a) Spacing - on collector roads, the median openings shall be provided at all but very minor streets. On sub-arterial and arterial roads, the minimum spacing of median openings shall be approximately 400m.

b) Opening Length (Control Radii) - The length of median openings shall be based on the following control radius (radius of the inner edge of turning path).

	Road Classification	Control Radius
(i)	Local and access Street	12.0m
(ii)	Industrial local street and collector road	15.0m
(iii)	Collector road	15.0m
(iv)	Sub-arterial or arterial	18.0m

c) Minimum Length - The minimum length of median openings shall be not less than 12.0m.

d) End Radii - The ends of medians at median openings shall have a minimum radius of 0.6m.

e) End Offset - The end of medians at openings shall have a minimum offset of 0.6m from the edge of the through traffic lane unless the particular end has a right turn lane.

f) Side Tapers - The median sides shall taper from the end at not less than 1 in 10 out to the full width of the median.

g) Opening with Right Turn Lane - Where the median opening incorporates a right turn lane, the median end opposite the right turn lane shall be offset from the edge of the through traffic lane. This offset distance shall be equal to the right turn lane width (YL), and the sides shall taper as in (f) above to assist drivers who have mistakenly entered the right turn lane, to regain their correct path.

h) Signs - Each end of the median at the opening shall have a reflectorised “Keep Left” sign erected a minimum of 2.0 m from the end of the nose. Sleeve arrangement for signposts anchorage shall be used for signs set in concrete.

i) Pavement Crossfalls - Pavement crossfalls in median openings shall be an absolute maximum of 6%.

iii) RIGHT TURN LANES IN MEDIANS

When provided in medians, right turn lanes shall conform to the following (see typical layout in the appendix 3.2) :-

a) Minimum Width - of the lane shall be 3.0 m;

b) Length - The length of the right turn lane is based on providing sufficient storage length to accommodate the predicted peak hour queue at the 95% probability level. This storage length is estimated using the procedure set out in AUSTROADS - Intersection at Grade. The total length of right turn lane is composed of the required storage length plus a minimum 30 m taper for an urban low speed environment. On the higher class road with higher speed environment exceeding 60 kph, the total length of the right turn lane shall be based on the sum of the required storage length, plus an appropriate deceleration length which includes the tapered approach. The deceleration and taper lengths are estimated using AUSTROADS - Intersection at Grade with the required correction for grade.

3.3.10.11 RAISED TRAFFIC ISLANDS

All traffic islands shall be constructed and line-marked in accordance with the following (see typical layout in the appendix 3.3).

All approach ends of raised traffic islands and medians shall be lit. The lighting shall be in accordance with Australian Standards. Where raised devices/slow points are proposed in designs, the plan should show preliminary layout and design of lighting.

a) Kerb - Concrete and semi-mountable kerb;

b) Surface Treatment - Generally, traffic islands would be concrete surfaced. The ends of grassed traffic islands shall be concreted 1.0 m past the location of any signs or where the width between adjacent sides is 2.0 m or less.

c) Minimum Area - The area of any island shall not be less than 8.0 m2 in an urban area and 50 m2 in a rural area, except in special circumstances.

d) End Radii - The minimum end radius of a traffic island shall be :

0.6 m for the approach end;
0.3 m for the departure end;
1.0m for the “right angle” corner of a triangular shaped island.

e) Side Offsets - The “straight” sides of a triangular shaped island shall be offset a minimum of 0.6 m from adjacent traffic lanes. The “curved” side may be adjacent to the edge of the traffic turning lane, subject to (f) below.

f) End Offsets - In addition to the 0.6 m offset in (c) above, the approach end of the "straight" sides of an island shall be offset a further 1.0 m minimum (at the nose T.P.) from the edge of the adjacent traffic lanes. The approach end of the "curved" side shall be offset a total minimum of 1.0 m (at the nose T.P.) from the edge of the traffic turning lanes.

g) Side Tapers - The tapers (or flares) of the side of an island compared to the normal lane edge shall be not less than 1 in 10, but desirably should be 1 in 20.

h) Minimum Width and Side Length - When an island has to provide for stop lines, traffic signals or pedestrian crossings, the side of the island shall be a minimum of 6 m long and a minimum width of 1.2 m at the point where the signal pedestal or sign is to be erected.

i) Directional Hazard Markers (D4-2-3) - shall be erected on the traffic islands as appropriate.

j) Line Marking - shall be similar to the requirements of Section 3.3.10.10(i)(g).

k) Island Offset - Islands on the opposite side of an intersection to a right turn lane combined with a single through lane, shall be offset an additional one lane width of 3.0 m to assist with drivers who have mistakenly entered the right turn lane, but decide to continue through the intersection.

l) Approach Sight Distance - Stopping sight distance (1.15 m to 0.0 m) shall be available to the approach end and the island shall be designed and located so that the proper line of travel is obvious and any changes in direction are gradual and smooth.

m) Sub-soil Drainage - Traffic islands shall be provided with sub-soil drainage.

3.3.10.12 AUXILIARY LANES AT INTERSECTIONS

Auxiliary lanes at intersections are through lanes, left turn lanes and right turn lanes. They shall meet the requirements of AUSTROADS - Intersections at Grade

3.3.10.13 ROUNDABOUTS

(i) GENERAL

Roundabout is an effective measure to provide a channelised intersection. They may be categorised with respect to their design objective :-

a) Capacity - to reduce delay at an uncontrolled intersection. Turning movements are well catered for, but efficient operation requires reasonably balanced flows on the approach legs. Balanced flows do not necessarily mean that all the traffic movements are equal in volume, but that the predominant movements are "broken up" by the circulating traffic sufficiently to provide acceptable gaps for vehicles in the adjacent legs to enter the roundabout without major delays.

b) Safety - roundabout can resolve priority ambiguities and is particularly useful in reducing the impact of right turn accidents. Collision angles and speeds are usually reduced. However, there may be a slight increase in rear end accidents.

c) Amenity- as part of a Local Area Traffic Management Scheme, roundabouts can be used to reduce vehicle speeds, discourage large vehicles and through traffic in a residential precinct.

(ii) APPROPRIATE SITES

Despite the positive attributes listed above, the use of roundabouts should only be limited to those sites that are appropriate. Some of the factors to consider whether a site is appropriate or inappropriate are listed below :-

a) The classes of intersecting roads have to be considered. Section 3.3.10.2 tables the classes that may be appropriate for this form of treatment.

b) The traffic volumes and patterns need to be considered. At sites where unacceptable delays in the minor road may result from a Stop or Give Way control, or where there is a high proportion of right turning vehicles, a roundabout treatment may be a better alternative than signals with its lower delays and higher safety aspects.

c) At intersections with more than 4 legs, Stop or Give Way signs may not adequately define the priority of traffic movements as well as a roundabout, whilst traffic signals may be inefficient due to the large number of phases required and the increased delays.

d) At rural cross or high speed intersections with high accident potential, roundabout treatments have been found to achieve accident reduction.

e) At intersections where traffic growth is expected to be high and the future traffic patterns are uncertain or changeable.

f) As part of the Local Area Traffic Management Scheme in the subdivisional layout to discourage non local traffic from accessing the precinct.

g) At ill-defined intersections such as “Y” intersections where priority is not clear or where sight distance is poor.

h) The site is inappropriate if a satisfactory geometric design cannot be provided owing to insufficient space or unfavourable topography (eg grades greater than 3-4%) etc.

i) The site is inappropriate if traffic flows are unbalanced with high volumes on one or more approaches, and some vehicles would experience long delays.

j) The site is inappropriate if a major road intersects a minor road. A roundabout would cause delay and deflection to all traffic, whereas control by signs or T junction rule would result in delays to the minor road traffic only.

k) The site is inappropriate if peak period reversible lanes may be employed.

l) The site is inappropriate if high traffic volumes would make it difficult for pedestrians to cross either road.

m) The site is inappropriate where linked signal system would provide a better level of service.

n) The site is inappropriate if large combination vehicles or overdimensional vehicles frequently use the intersection.

o) The site is inappropriate if traffic flows leaving the roundabout would be interrupted by a downstream traffic control which could result in queuing back into the roundabout.

p) Preferably located at a sag vertical curve and not be located at a crest.

iii) DESIGN FACTORS

Roundabouts shall be designed in accordance with AUSTROADS - Roundabouts

a) Central Island

FUNCTIONAL ROAD CLASS	RANGE OF PREFERRED CENTRAL ISLAND SIZES (Radius in m)
Arterial/Arterial	20→30
Arterial/Sub-arterial	20→30
Arterial/Collector	18→22
Sub-arterial/Sub-arterial	15→20
Sub-arterial/Collector	12→20
Collect/Collector	8→15
Collector/Local	5→10
Local/Local	5→8

Unless the site constraints is prohibitive and justified to Council's agreement, the above table is to be used up to and including R5 fully infilled with an approved treatment.

b) Splitter Islands, Entry and Exit Points

In high traffic urban areas, the length of splitter islands shall not be less than that equivalent to 1.5 s travel time to control undesirable traffic manoeuvres.

In high speed environment (in excess of 70 kph), the length of the splitter islands shall be not less than that equivalent to 3 s travel time to give adequate advance warning to motorists.

c) Lighting

Lighting of roundabouts shall generally conform with the requirements of Australian Standard AS 1158 Parts 1 and 2. Factors to consider in the provision of lighting include the following :-

- Lights are to be located to provide good illumination on the approach nose of splitter islands, at the conflict area where traffic enters the circulating roadway and at the points where traffic streams separate prior to exiting.

- The area where pedestrians cross the roundabout or the pedestrian/vehicle conflict area shall be well illuminated if the pedestrian presence is high.

- No light poles should be placed in the splitter islands, on the central island directly opposite an entry point or on the left hand side of the circulating roadway immediately downstream of an entry point.

- For local and access street roundabouts, the following lighting requirements are to be provided:

  For local and access street roundabouts - one high pressure 250 w sodium light;

  Local/collector street roundabouts - one high pressure 250 w sodium light on each collector street approach;

- Consideration should be given to the glare intrusion and the use of cut-off devices in urban areas.
- Collector street/sub-arterial or arterial roundabouts -one high pressure 250 w sodium light on each approach.

d) Pedestrians and Cyclists

For cyclist treatment at roundabouts, refer to AUSTROADS - Bicycles

Pram crossings and pedestrian refuges shall be incorporated at roundabouts where there is a high pedestrian/cyclist activity. These should be located close to the entry and exit points of the roundabouts at 6 m from the holding line. If a marked foot crossing is to be provided for example, at sites with high proportion of young, elderly or infirm pedestrians, the crossing is to be located at 6 to 12 m back from the holding line on the entry carriageway and 12 to 24 m clear of the circulating roadway on the exit carriageway. It is preferred that marked footcrossing not be placed at roundabout locations.

e) Landscaping and Road Furniture

Landscaping and road furniture within the roundabout shall not restrict visibility nor be a hazard to motorists. Generally, the central island shall not have obstacles higher than 400 mm above the level of the circulating roadway.

On large central islands of arterial roads, roundabout trees and other high landscaping features may be considered, provided the island is large enough to ensure a minimum clearance of 2.5 m from the edge of the normal traffic lanes.

3.3.10.14 RURAL INTERSECTIONS

Rural intersection design shall be generally in accordance with the principles of intersection design outlined in the preceding sections and AUSTROAD - Intersections at Grade.

The following Council variations pertaining to Rural Type A intersections shall apply:

i) Type A1 (gravel road/ gravel road intersection)

Where the through road and side road volumes are less than and equal to 100vpd, the minimum intersection treatment shall be paving and sealing of each leg of the intersection for a distance of 50m. The minimum seal width shall be 4m. The minimum turn radius shall be 15m for a 90° turn.

ii) Type A2 (gravel road/ sealed road intersection)

Where the through road volume is between 101vpd and 500vpd, the minimum intersection treatment shall be:

a) the provision of a minimum 3.25m width travelling lanes in the through road;

b) shoulder widening in the through road on the opposite side of the terminating road shall be provided to a minimum width of 3m for 30m on either side of the side road centreline;

c) the shoulder widening shall taper back to the formation width at a rate of 1 in 10;

d) the side road shall be paved and sealed for a minimum distance of 50m from the through road centreline;

e) kerb returns to the side road shall be provided from tangent point to tangent point with a minimum throat width of 8m on the side road. The kerbs shall be offset to the through road centreline by a minimum of 5m. The ends shall be flared to the shoulders using a 1 in 5 parabolic flares;

f) the side road bitumen surface shall taper from the 8m throat (between kerbs) at a rate of 1 in 10;

g) minimum kerb radius shall be 15m for a 90° turn.

iii) Type A3 (left turn treatment for high speed and volume)

Where the traffic on the through road exceeds 2000vpd and the design speed exceeds 80kph, the following left turn treatment shall apply:

a) the kerb on the left turn entry to the side road shall be offset a minimum of 7m from the centreline of the through road;

b) the minimum throat width of the side road shall be increased to 10m where the side road volume exceeds 500vpd or where the percentage of commercial vehicles turning exceeds 10%. The minimum turn radius shall be 15m for a 90° turn.

Bus Route Provisions

Where a bus service exists on a rural road, provision shall be made for a bus stopping facility on the departure side of the intersection with the through road. The bus stopping facility shall incorporate shoulder widening to accommodate bus stopping clear of the travel lane plus sufficient hardstand area for passengers to alight from the bus.

3.3.11 CUL-DE-SACS

3.3.11.1 GENERAL

i) The desirable maximum number of lots to be served by a cul-de-sac is 12, with absolute maximum of 20 allotments in residential subdivisions.

ii) The maximum length of a cul-de-sac is:-
Residential subdivision - 120m
Rural and Rural Residential subdivision - 400m

iii) Where possible cul-de-sacs should be avoided in an industrial subdivision.

iv) The footpath width at any point in the cul-de-sac or in the turning head shall be a minimum of 4.0 m from the property line to the invert of channel.

3.3.11.2 TURNING HEADS AND RADII

i) A turning head shall be provided at the end of every cul-de-sac.

ii) The turning head can be circular or of the alternative designs such as "hammer head", "Y head" etc, as shown in the typical layouts in Fig 3.3.11 (I).

iii) The circular turning head shall have a radius of 9 m to the invert line of the kerb and channel, or edge of seal where there is no kerb and channel. In an industrial road cul-de-sac, circular turning head shall have a radius of 15 m. Turning templates should be used to check that Council's refuse vehicles (single unit vehicle) can use the turning head operation.

iv) The curved approach to the circular turning head shall have minimum radius in the kerb and channel or edge of seal of 30 m.

v) Turning templates shall be used to check the manoeuvrability of the alternative turning heads.

3.3.12 PROPERTY ACCESS

3.3.12.1 GENERAL

Proposed access points to the allotments from an existing or proposed roads are to be approved by Council and the Queensland Department of Main Roads (if impacting on a classified road), prior to construction. They may need to be placed at alternative locations, if the proposed locations are not satisfactory.

3.3.12.2 LOCATION OF ACCESS POINTS

The location of the access point shall take into consideration the following factors in order to minimise risk to the travelling public in the through road :-

- type of frontage road;
- sight distance;
- distance from intersections;
- conflicts

i) Type of Frontage Road

Direct access onto an arterial or sub-arterial road is generally restricted to large developments where appropriately designed turning facilities are provided to ensure maximum safety. Access to individual residential allotments onto a high speed rural road needs special assessment.

ii) Sight Distance

All access driveways should be located so as to obtain maximum sight distances. They should be situated so that any vehicle turning from or into the street can be readily seen by the driver of an approaching motor vehicle or pedestrian. The absolute minimum requirements to achieve this is stopping sight distance (including rural roads). Refer to AUSTROADS for sight distances.

Ideally the sight distance required is that which enables the driver of a vehicle waiting to leave a driveway to select a gap in the through traffic and to join the street without causing major disruption to it. This is the desirable entering sight distance. Refer to AUSTROADS for values.

These distances should be measured from the eye level (ie 1.15 metres above the ground) of a driver of a stopped car to a point 1.15 metres above the road in another vehicle on the public road. Measurement should be taken along the centre of the particular traffic lane being considered.

iii) Distance from Intersections

Access driveways should be located to optimise safety and public convenience. As a general rule they should be located as far as possible from intersections and should NOT be located in the sections of kerb shown by heavy lines in Fig 3.3.12 (I) (using the sight distance requirements in (ii) to check the locations). The minimum distance from the intersection, measured from the property boundary, should be increased to 25 m for signalised intersections, and to 100 m at the intersection of two major roads. These dimensions should be increased if necessary to move driveways beyond the influence of normal queue lengths at the intersections. In addition, they should not be located within 12 metres of the stop/holding line on the approaches to "Stop" or "Give Way" signs, and should not be located closer than 1 metre to site boundaries.

Where property boundaries render the attainment of the above guidelines impossible, great care should be taken in the design and control of access driveways, particularly in relation to sight distances. In general, the absolute minimum distance on the approach to a "Stop" or "Give Way" sign is 6 metres from the stop/holding line, and the absolute minimum distance from the property boundary is 6 metres. Under no circumstances should an exit driveway be provided onto a major road on the approach to another major road where exiting vehicles would have insufficient "weaving" distance or would otherwise conflict with vehicle movements at the intersection.

FIG 3.3.12(I) PROHIBITED LOCATION OF DRIVEWAYS

iv) Conflicts

Conflicts associated with driveways are often proportional to the traffic generating potential of the development which they serve.

Therefore driveways serving developments generating a large amount of traffic should not be located as far as is practicable :-

- On major roads;
- Close to intersections;
- Opposite other developments generating a large amount of traffic unless separated by a median;

- Where there is a heavy and constant pedestrian movement along the footpath;
- Where right turning traffic entering the facility would obstruct through traffic; or
- Where traffic using the driveways will interfere or block the operations of bus stops, taxi ranks, loading zones or pedestrian crossings, although in these instances it may be appropriate to relocate these types of facilities if this would result in the best overall design.

3.3.12.3 DESIGN PRINCIPLES

i) General

- The first vehicular driveway reached by using the kerbside lane adjacent to the site should be the entrance (for segregated entry and exit driveways);
- Reversing movements into or out of public streets should generally not be allowed, but may be permissible in the case of individual dwelling houses;
- The potential for on-street queuing should be eliminated;
- On major roads, particularly on isolated and/or high speed sections, motorists should be discouraged from parking on the opposite side of the road to a development and crossing the road to the site. The use of physical pedestrian barriers to prevent such practices may be necessary;
- Driveways should be clear of all obstructions which prevent drivers from having a timely view of pedestrians;
- Driveways should be delineated and sign posted by the use of "in" / "entrance", "out" / "exit" and "keep left" signs, for large developments with segregated entry and exit driveways.

ii) Types and Grades

a) Rural Access - Rural access driveway shall be designed in accordance with Council standard drawings.

b) Residential Access - Maximum grade for residential access should be 1 in 20 for a maximum distance of 2 m from the crossover and then a maximum grade of 1 in 6 (where the driveway is to be sealed, this grade may be increased to 1 in 4). Refer to Council standard drawings.

c) Access for Industrial and Commercial Developments - The selection of an access driveway for the development shall consider the following factors :-

- The type of development (generally categorised by the levels of traffic generation);
- The frontage road type;
- The size of the parking facility servicing the development;
- The type of vehicle likely to be generated as a result of the development.

Table 3.3.12 (I) and (II) gives a recommended driveway type to satisfy the above factors and Table 3.3.12 (III) outlines the requirements of the various driveway types.

TABLE 3.3.12 (I)
SELECTION OF RECOMMENDED DRIVEWAY TYPE - LIGHT VEHICLES
(See Table 3.3.12 (III) for details of driveway types)

LAND USE GENERATION CATEGORY	ROAD FRONTAGE TYPE	NUMBER OF PARKING SPACES						
		0-10	11-25	26-50	51-200	201-300	301-500	Over 500
Low	Major	1-2	2	2	3	3-4	4 or 7	7
	Minor	1	1	1	2	2-3	3-4	4
Medium	Major	2	2	3	3	3-4	7	7
	Minor	1	1	2	3	3	4	4
High	Major	2	2	3	3	3-4	7	7
	Minor	1	1	2	3	3	4	4

TABLE 3.3.12 (II)
SELECTION OF DRIVEWAY TYPE - HEAVY VEHICLES
(See Table 3.3.12 (III) for details of driveway types)

HEAVY VEHICLE TYPE	ROAD FRONTAGE TYPE	DRIVE TYPE
Rigid	Major	5-6
	Minor	4-5
Articulated	Major	6
	Minor	5-6

TABLE 3.3.12 (III)
RECOMMENDED DRIVEWAY TYPES

TYPE	ENTRY WIDTH (m)	EXIT WIDTH (m)	MINIMUM SEPARATION OF DRIVEWAYS (m)	SPLAY AT KERBLINE (m)	KERB RETURN TURNOUT RADIUS (m)
	W	W		S	R
1	3-6	combined	NA	0.5	-
2	6-9	combined	NA	1	-
3	6	4-6	1-3	1	2-9
4	6-8	6-8	1-3	1	2-9
5	8-10	8-10	3	1	2-9
6	10-12	10-12	3	1	2-9
7	Direct feed from a controlled intersection via a dedicated public roadway.				

Source: Policies, Guidelines and Procedures on Traffic Generating Developments - RTA, NSW

The grade of the access shall be similar to that for residential access.

d) Crossovers

The crossovers for the residential access and industrial and commercial access shall be in accordance with Council's standard drawings.

e) Existing Accesses

Where the road is to be constructed in a developed area with existing accesses, the access profiles together with cross sections shall be investigated to ensure that adequate access is available from the new road. These details are to be submitted to Council as part of the Application for Approval to Construct (Design Plans and Specifications) submission.

3.3.13 EASEMENT

Easements may be provided within a subdivision or a development to allow access to allotments or development or for services such as stormwater drainage or electricity.

3.3.13.1 PROPOSED EASEMENTS

Where easements are to be provided, they shall conform to the following requirement:-

i) The applicant shall submit to Council for approval, a copy of a duly executed grant of easement, stating the purpose of the easement together with an appropriate undertaking in writing by the applicant's Solicitor for lodgement of same in conjunction with the Plan of Survey and any necessary Department of Natural Resources (Titles Section) forms requiring the consent to Council prior to the release of the Plan of Survey.

ii) For any grant of easement to Council, such grant of easement shall be executed by both parties and an appropriate undertaking for the production of the Title Deed to the Department of Natural Resources by the applicant's solicitor, given to the Council's solicitor prior to the release of the Plan of Survey.

3.3.13.2 EXISTING EASEMENTS

The applicant, through his/her solicitor, shall ensure that all existing easements and rights pertaining to the parcels of land associated with the application shall be maintained.

3.3.13.3 ACCESS EASEMENTS

Where the easement is approved by Council, it shall meet the requirements of Policies No 6.2 and 6.6 and the following requirements:-

(i) It shall serve generally not more than 2 dominant allotments for residential subdivision and 3 dominant allotments for rural subdivision;

(ii) In a residential subdivision, the easement width shall be a minimum of 5m wide with a minimum carriageway width of 3m concrete paving or approved surface. The balance width of the frontage of the servient allotment shall not be less than that tabulated in the Town Planning Scheme for the particular zoning applicable.

(iii) In a rural subdivision, the easement width shall be a minimum of 20m wide with 4m wide all weather gravel surface. Where longitudinal grades exceed 10% sealing to minimum 4m seal width on a 6.0m formation will be required. In some instances, sealing may also be required if there is an existing house on the servient allotment (to reduce dust nuisance) or adjacent to the proposed subdivision.

(iv) For easements with long access roads (exceeding 100m for rural and 25m for urban) or where visibility along the easement is not available, a passing lane is to be constructed every 100m for rural and every 25m for urban subdivision.

(v) The services to allotments are to be extended up the access easement prior to the construction of access road.

3.3.13.4 DRAINAGE EASEMENTS

Where stormwater drainage is required to be constructed through private property, it shall be wholly contained within drainage easement in favour of Council.

Easement widths shall be in accordance with the following :-

i) The easement width for interallotment drainage shall not be less than 1.5 m. Council may require a wider easement in some cases, depending on the drainage design and site constraints (eg. very flat terrain may require more frequent maintenance and a wider easement would facilitate this).

ii) The easement width for drainage other than interallotment drainage shall be the greater of the following :-

a) For multiple conduits, the width shall be 1 m wider than the distance between the outer edges of the conduits;

b) For open channels, the width shall allow for freeboard and an access track of at least 4.5m wide for maintenance purposes. Refer to Queensland Urban Drainage Manual for details on these parameters;

c) Checking for the major 100 year ARI event - the width of the easement shall be of sufficient flowpath width to carry the Q100 Gap flow together with an allowance for freeboard as outlined in Queensland Urban Drainage Manual.

Notwithstanding the above criteria, the easement width shall not be less than 4.0 m.

3.3.14 FOOTPATHS

3.3.14.1 CROSS SECTION

The footpath reserve shall be minimum 4 m wide with a minimum useable width of 2 m as shown in the standard cross sections of Council's standard drawings.

3.3.14.2 LONGITUDINAL GRADES

The longitudinal grade of the footpath is generally based on road longitudinal grade, but where paving is provided, the footpath longitudinal grade should consider accommodation of disabled access.

3.3.14.3 FOOTPATH PAVING

Council may require as a condition of approval, the construction of footpath paving. Such paving may be on one or both sides of the road, depending on the classification of the road, and in accordance with the following :-

i) The width shall be 1.2 m, except :

(a) adjacent to commercial sites, in which case the paving shall extend the full width of the footpath, from the boundary alignment to the kerb;

(b) where footpath is a shared pedestrian/cycle path, the width shall be 2 m wide;

ii) Where full width paving is required, the footpath crossfall shall be minimum 2.5% and maximum 5% for the full width of the paving;

iii) The paving shall be a minimum 100 mm thick N25 concrete and reinforced with F62 steel reinforcing fabric. Crack control joints shall be at a maximum spacing of three (3) metres with an expansion joint every five (5) joints. In instances where vehicle loading is excessive, eg. industrial usage, the footpath design should accommodate the extra load.

iv) Other paving materials such as asphalt or segmental pavers may be used subject to the approval of Council;

v) The applicant shall liaise with Council's Engineering Department to determine the location of the paved path and construction details prior to commencement of work;

(vi) The desirable longitudinal grade of paved footpath is not to exceed 10% and the length of any continuous ramp shall not exceed 10 m to cater for disabled access.

vii) Kerb Ramps are to be provided in residential and commercial subdivisions, at all intersections and at the end of constructed footpaths/bikeways. At intersections, the ramps are to be located as close as possible to the tangent points.

viii) Kerb ramps are to be constructed to allow for disabled access and as such they shall conform to the current provision of Australian Standards.

3.3.14.4 SERVICE ALLOCATIONS

The allocation for services in the footpath is shown in Council's standard drawings.

3.3.14.5 GRASSING

The footpath area shall be re-graded, topsoiled and grassed where paving is not required. The topsoil provided shall be a minimum of 75 mm depth for flat surfaces, and a depth of 40 to 60mm for surfaces steeper than 1 in 4. The grassing is to be provided as turf for 600 mm minimum width behind the kerb and the remainder of the footpath shall be grassed with grass seeds or runners.

3.3.14.6 CLEARANCES

The minimum vertical clearance to isolated obstructions over footpath such as to the underside of a sign shall be 2.5 m (absolute minimum 2.0 m). The minimum horizontal clearance to an object shall be 0.5 m from invert of kerb and channel to the edge of the object.

3.3.15 SIGNS AND PAVEMENT MARKINGS

3.3.15.1 GENERAL

All signposting and pavement markings shall be provided in accordance with the current editions of "Manual of Uniform Traffic Control Devices" - Queensland Department of Main Roads and Australian Standards. Where there is conflict between the two references, the Queensland Department of Main Roads document shall take precedence.

Details of the sign positioning (horizontal and vertical) is to be shown on the plans or in the specifications and is to be in accordance with the Manual of Uniform Traffic Control Devices.

3.3.15.2 MINIMUM PROVISIONS

In addition to the provisions under other relevant sections of these Guidelines, the traffic control and management facilities to be provided shall include (but not be limited) to the following :-

i) Signs

a) Street name signs at each intersection. The colours shall be retro-reflective Class I, white background with black lettering on a standard street blade extrusion of 150 mm depth with (100 legend) for residential locations and (125 legend) for rural locations, as shown in Council standard drawings. Where sign blade exceeds 800mm which can cause it to become damaged by vandalism and deflections, double signpost may be required.

b) Warning signs at the approach to all hazards;

c) "Keep Left" signs at the approach end of the first island at all channelised intersections and at all median openings;

d) At a temporary termination of road construction or at ends of roads where approach speed is less than desirable sight distance, such as a subdivision boundary or a stage boundary, sight board (D4 - 4A) shall be erected. Where a sight board cannot be erected due to site constraints, sufficient reflectorised guide posts shall be erected across the full width of the terminating road (minimum of 3 posts with red reflectors);

e) At T-junctions for rural roads, sight boards (2/D4-1-1) shall be erected in the through road facing the terminating road lane and in some locations in the urban roads as required by Council;

f) Warning signs shall be provided on the approaches to the intersections of roads and bikeways. (For signposting on bikeways and shared pedestrian/cyclepaths, refer to AUSTROADS - Bicycles);

g) Obstruction markers at all bridges, grids or other restriction to the pavement width;

h) Provision for Floodway signposting

ii) Linemarkings and Pavement Markings

All linemarkings and pavement markings shall be white and reflectorised and be shown on a traffic control plan in accordance with sample markings.

a) Lane lines shall be provided on all divided roads;

b) Separation lines shall be provided on two way roads of collector class upwards and where the traffic volume exceeds 1000 vpd;

c) Barrier lines shall be provided at all locations on two way roads where the sight distances are less than the desired minimum or where a hazardous situation exists such as on the approaches to a major intersection where overtaking would be undesirable;

d) Edge lines shall be provided where kerb and channelling is not constructed or where there are sealed shoulders. Edgelines are not to be marked on roads with pavement widths less than 6.25 m;

e) Chevron markings, continuity lines, turn lines, marked foot crossings, arrows etc as appropriate at intersections , median and traffic islands;

f) The outline marking for chevron shall be 100mm wide with a 100mm gap between the outline and the bars or chevrons.

iii) Provisional Traffic Control Devices and Facilities

Irrespective of the requirements of the above sections, Council may require the following signs, associated linemarking and pavement markings :-

a) Give Way signs;
b) Stop signs;
c) No Standing signs;
d) No Parking signs;
e) Speed limit signs;
f) Retroreflective raised pavement markers;
g) Any other traffic control and management devices that are considered necessary for the safe and effective management of traffic (eg floodways).

3.3.16 GUIDE POSTS, GUARD RAILS AND DELINEATORS

Guide posts, guard rails and delineators shall be provided in accordance with the provisions of the Manual for Uniform Traffic Control Devices - Queensland Department of Main Roads and the provisions of this section.

3.3.16.1 GUIDE POSTS

Guide posts shall be constructed of 100 mm x 50 mm sawn hardwood, painted white and be mounted with delineators. The top is to have a 30^0 saw cut. The wider face is to be placed facing oncoming traffic. Guideposts to be provided with a 200mm bar at the base of the post to act as a locking pin to reduce vandalism. Alternative designs may acceptable, subject to the approval of Council.

i) Location

Guide posts shall be provided at all locations where there is no kerb and channel and also at locations to highlight the presence of a hazard, including but not limited to the following situations :-

a) Temporary termination of a road construction (see Section 3.3.15.2(i)(d));

b) Culvert crossing and bridges where guard rails are not provided;

c) At the edge of half road staged construction where there is no kerb and channel;

d) Sub-standard horizontal curve.

ii) Siting

Guide posts shall generally be 1 m high unless site requirements control the height. They shall be erected no less than 1.5 m from the edge of the pavement or in line with the shoulder edge. Wherever practicable, guide posts shall be placed at uniform distance from the pavement edge, and the height of the posts shall be adjusted so that the tops of the posts are on a uniform grade, taking into account shoulder contours and the effect of superelevation. The guide post positions as proposed shall be shown on the working plan in rural areas and Traffic Control layout plan in urban areas as outlined below.

iii) Spacing

The maximum spacing of guide posts shall be as follows :-

(a) On Straight Sections - 150m with posts in pairs

- 60m in localities subject to fog

(b) On Circular Curves (including Circular Portions of Transitioned Curves)-

Guide posts are to be erected at the tangent points and in accordance with the following table.

TABLE 3.3.16(I)

GUIDE POST SPACING

Source: Queensland Department of Main Roads Standard Drawing

	SPACING m	
CURVE RADIUS m	Outside of Curve	Inside of Curve*
< 199	10	20
200 - 299	15	30
300 - 399	20	40
400 - 599	30	60
600 - 799	40	60
800 - 1199	60	60
1200 - 2000	90**	90**
> 2000 inc. straights	150**	150**

* Posts on inside of curve to be located opposite a post on the outside of the curve where practicable

** Reduce to 60 m in areas subject to fog

(c) On Curve Transitions - the spacing for the transition portion shall be the same as the spacing required for the circular portion of the curve (as determined from the table above). The first posts shall be located at a point along the transition portion, which is one quarter of the transition length, measured from the tangent point at the straight.

(d) Crests - the spacing of posts shall be such that the delineators on a minimum of two pairs of posts (beyond 40 m) are always visible from a driver's eye height of 1.15 m.

(e) Bridges and Culverts - where guard rails are not provided, guide posts are to be erected as follows :-

* at structures 5 m or more in length - four posts, one at each corner of the structure;

* at structures less than 5 m in length - two posts, one on each left-hand approach end;

* at all pipe and single cell box culverts, one post at each headwall, except where wing fences or balustrades have been constructed or where the width between kerbs is greater than the approach formation width.

3.3.16.2 GUARD RAILS

Guard rails shall be an approved steel beam type erected on timber or steel posts, in accordance with Queensland Department of Main Roads standard drawings.

i) Locations

Guard rails shall be erected at, but not limited to the following locations :-

a) Embankments exceeding 4.5 m in height and with side slopes steeper than 1 vertical to 4 horizontal or other locations where the consequence of a vehicle leaving the road would be severe, eg. adjacent to a railway, river or retaining wall;

b) Narrowing of formation where the effective carriageway width is reduced to the extent that a hazard exists, eg on the approach to bridges, culverts or other obstruction where the shoulder and/or pavement width is reduced below that provided on the immediate approaches;

c) Steep Grades of 8% or more where the traffic volume is 200 vehicles per day or more and an 85^{th} percentile approach speed is 65 km/hr or more, guard rails are to be erected on the outside of the curve;

d) Structures, Pedestrians and Medians which require protection from/for traffic, eg footways on bridges, narrow medians, pedestrian refuge areas, etc;

e) On the outside of sub-standard horizontal curves where height (measured from toe to formation level) of the edge of the bank exceeds 2 m and the side slope is steeper than 1 vertical to 4 horizontal.

ii) Erection

a) The clearance from the edge of the pavement to the face of the guard rail shall be equal to the normal design shoulder width and the shoulder width shall be increased to accommodate the guard rail posts;

b) The installation of the guard rails shall be in accordance with Queensland Department of Main Roads standard drawings as appropriate;

c) Bull nose terminal treatment shall be provided as detailed in Queensland Department of Main Roads standard drawings.

3.3.16.3 DELINEATORS

Retro-reflective delineators shall be used on guide posts, guard rails, obstructions such as bridge and posts etc to delineate the carriageway edges as an aid to night driving.

i) Colour

a) White colour is to be used on the right side of the carriageway;

b) Red colour is to be used on the left side of the carriageway;

as seen by the approaching traffic.

ii) Type and Size

The delineators shall be the corner cube (between a Class 1 and Class 2) round delineators of 80 mm diameter with the retro-reflective performance conforming with the requirements of Australian Standards. Where higher retro-reflectivity is required the "diamond grade" Class 1A may be used, eg. in areas where the background lighting, such as those caused by the lit advertising signs for commercial activities, are competing for the driver's attention and create a confusing vista.

iii) Mounting Locations

a) On Guide Posts

Delineators shall be affixed to all guide posts provided on public roads. They shall be centrally placed on the post between 50mm and 100mm clear distance from the top of the post. In order to present a coherent line and pattern of delineators to the night driver, particular attention should be paid to the vertical and horizontal alignment of guide posts and to their spacing. Not more than one delineator should be displayed in any one direction on any guide post, guard fence post, bridge end post, etc. Extraneous delineators not conforming with the pattern, eg on trees or at private entrances, should not be used.

b) On Guard or Safety Fence

Delineators on guard fences, bridge end posts, etc, should be located so as to conform with the spacing specified for guide posts. Delineators are usually attached to plates mounted on the fence posts so that they protrude above the top line of the fence. In such cases, consideration should be given to use of frangible mountings. They shall be placed on any fence not more than 4m from the nearest edge of running lane with one on the first post and thence at standard spacings. Short lengths of guard fence, less than 30m, including wing fences at bridges, shall have at least one delineator at each end of the fence.

Where the fence is more than 4m from edge of running lane, delineators shall be placed on guide posts located inside the fence line and at the normal shoulder width from edge of running lane.

3.3.17 LATM's

Local Area Traffic Management is a traffic management strategy to control traffic and speed in a residential precinct with the purpose of discouraging through traffic, reducing accidents and increasing residential amenity.

The LATM devices shall not be used in an ad hoc manner at isolated locations, the scheme should address the whole precinct. LATM should not be used for the sake of using it, but should have definite goals to target at. It is important that for LATM's to work, there has to be a clear road hierarchy in place and the residential precinct clearly identified. It is also important that for LATM's to work, the scheme should be monitored and adjustments made if necessary after implementation.

Designers are referred to the various texts available on this subject including AUSTROADS, Australian Standards and the Federal Office of Road Safety document - "Towards Traffic Calming".

3.4 PAVEMENT DESIGN

3.4.1 GENERAL

(i) A Pavement Design Report shall be submitted to Council and approved for all new sealed roads and sealed road pavement widenings. The design report shall set out the basis for the pavement depth(s) and include the test results and geotechnical reports as required together with the traffic catchment data.

(ii) The pavement design shall be based on the procedures set out in the current edition of the Pavement Design Manual - Queensland Department of Main Roads and the provisions of these guidelines and/or ARRB Special Report No. 41. In areas where the proposed pavement shall be confined by kerb and channel, the pavement design shall be based on the laboratory determination of subgrade CBR using four (4) day soaked specimens and Test Q113A. In other situations where testing under soaked conditions may not be appropriate, other procedures for design subgrade CBR estimation may be approved upon prior consultation with and approval by Council.

(iii) Road Pavement widening which are essentially only the provision of a parking lane to an existing pavement or only a very minor widening, shall require the existing pavement to be matched or the minimum pavement depth for the particular class of road which ever is the greater. Testing for the subgrade CBR in these instances shall not generally be required.

(iv) Surface types shall be either asphaltic concrete or sprayed bitumen seal and shall generally be specified in Council's development approval conditions. Widenings to existing sprayed bitumen seal pavements shall be permitted in either sprayed bitumen seal or asphalt to match existing seal treatment.

(v) Pavement depths shall be calculated for a minimum design life of 20 years assuming initial full development, a traffic generation figure of five (5) return trips per day per lot, and a minimum ESA value in accordance with Table 3.4.3 (I).

(vi) The samples selected for CBR determination shall be representative of the insitu finished subgrade material(s). The samples shall be collected by suitably qualified personnel. A report, the test results and a certificate shall be submitted attesting to the samples(s) representing the subgrade.

(vii) At the "Subgrade Inspection" the Supervising Engineer shall provide/advise the Council Officer of the following:-

(a) The areas of the subgrade where unsuitable material has been replaced and/or treated;

(b) The subsoil drainage design if not previously approved;

(c) Documentary evidence from the NATA Testing Authority of the subgrade compaction results.

3.4.2 TESTING

(i) A Testing Schedule shall be prepared by the Consultant to ensure the critical items of work meet an acceptable standard and shall be submitted with the overall design documentation to be approved by Council. Refer to Section 9 for the minimum test schedules.

(ii) The testing shall be undertaken by an organisation registered by the National Association of Testing Authorities for the method used. All materials used on construction shall conform to approved specifications. The Council's approval of the Testing Schedule shall not preclude Council from requiring additional testing to provide additional satisfactory evidence of the soundness and suitability of a particular construction material.

(iii) Full documentation of the test results or a certified summary shall be submitted together with the "As Constructed" data prior to the inspection for the purpose of acceptance of the works. Any non-compliance shall be highlighted and a submission presented regarding acceptance and/or rectification.

(iv) QT test methods shall be used where an applicable test method is available.

3.4.3 DESIGN TRAFFIC LOADING

The submitted pavement design report shall set out the basis for the assessment of the design traffic loading including catchments, traffic type, % commercial vehicles assumed. Not withstanding the assessment, the minimum ESA values shall be not less than that in the Table 3.4.3 (I) below.

TABLE 3.4.3 (I) MINIMUM TRAFFIC LOADINGS

Functional Class	% Commercial Vehicles (CV)	ESA/CV	Minimum ESA's
Access Street	3.6	1.0	$5x10^4$
Local Street	5	1.0	$1x10^5$
Collector	10	1.0	5×10^5
Urban Sub - Arterial	12	1.1	1×10^6
Urban Arterial	15	1.1	5×10^6
Industrial	18	1.3	1×10^6
Rural Collector	9	1.0	1×10^6
Rural Residential Collector	7	1.0	1×10^5

3.4.4 FLEXIBLE PAVEMENT

The relevant design charts from the Queensland Mains Roads Department - Pavement Design Manual or ARRB Special Report No. 41 shall be used. For traffic loading less than $1x10^5$ ESA's refer to ARRB Special Report No. 41 and for traffic loading equal or greater than $1x10^5$ ESA's refer to Queensland Main Roads Department - Pavement Design Manual (chart 1).

(i) In determining the pavement thickness, the asphalt surfacing shall not be considered as contributing, unless it is equal or greater than 50mm in depth.

(ii) The minimum pavement thickness and surfacing thickness shall be in accordance with Table 3.4.4.(I) below.

(iii) The minimum thickness for the base course shall not be less than 125mm.

(iv) The design pavement depth shall be subject to confirmation by Council, following inspection and further testing of the pavement box if required and prior to placement of the pavement material. Council may require either local or general variations of the design pavement depth, dependent on the actual subgrade condition encountered.

3.4.4.1 MINIMUM PAVEMENT AND SURFACE THICKNESS

For each Functional Class, the minimum surface thickness and pavement depth shall be in accordance with Table 3.4.4. (I)

TABLE 3.4.4 (I) MINIMUM PAVEMENT AND SURFACING THICKNESS

Functional Class	Asphalt Minimum Surfacing Thickness	Minimum Pavement Depth *
Rural - Access Street & Local Street	NIL	150
Rural Residential & Access Street & Local Street	2 Coat Bitumen Seal	200
Residential & Park Residential Access Street	25	200
Residential & Park Residential Local Street	25	200
Residential & Park Residential Collector Road	25	250
Business & Commercial	40	250
Urban Sub - Arterial Road	50	300
Urban Arterial road	50	350
Industrial Roads	50	300

* The minimum Pavement Depth refers to the compacted pavement depth and does not include the asphalt thickness where such asphalt thickness is less than 50mm.

3.4.4.2 PAVEMENT MATERIALS

The base and sub-base shall have minimum soaked CBR (Q113A) not less than the values set out in Table 3.4.5.(I)

TABLE 3.4.5 (I) MINIMUM CBR's FOR PAVEMENTS

Pavement Layer	Design Traffic Loading (ESA's)	Minimum CBR	MRD TYPE
Base	**$\geq 1 \times 10^6$**	**80**	**Type 2.1**
	$< 1 \times 10^6$	**60**	**Type 2.2**
Sub-Base	**$\geq 1 \times 10^6$**	**45**	**Type 2.3**
	$< 1 \times 10^6$	**35**	**Type 2.4**

3.4.4.3 PAVEMENT SURFACE

Generally an asphalt surface shall be used in urban areas (Residential, Business and Commercial), Park Residential, Industrial and Urban Sub-Arterial and Arterial.

In Rural, Rural Residential and Village Residential developments, a two coat bitumen surface may be used. Variations from these standards shall be subject to Council approval.

(i) The asphalt used in the road pavement construction shall be in accordance with approved specifications and not be less than the thicknesses shown in Table 3.4.4.(I)

(ii) Where asphalt is to be used, the finished pavement shall be primed with a medium curing cut back bitumen. Generally a minimum of 48 hours delay shall be allowed between the priming and the asphalt surfacing unless otherwise approved by Council and no traffic is permitted during this time on the primed surface. A tackcoat shall be applied immediately prior to the asphalt surfacing.

(iii) Where a sprayed bitumen seal is used, a prime coat and two coats of bitumen and aggregate shall be applied and the aggregate size shall be:-

Rural Roads	16/10
Urban Roads	10/7

In some instances, variation from these requirements may be approved depending on the specific site. A primerseal coat of 16mm and a second coat of 10mm shall be acceptable in situations where the road is under traffic. The minimum time between the primerseal coat and the second coat shall be seven (7) days.

3.4.4.4 PAVEMENT TREATMENTS

Council may permit the use of cement and lime stabilisation and modified bitumen. A detailed submission shall be submitted to Council for approval.

3.4.5 OTHER PAVEMENT TYPES

3.4.5.1 CONCRETE PAVEMENT

Where a concrete pavement is approved by Council, the design and construction shall be in accordance with the principles and guidelines of the Cement and Concrete Association of Australia.

3.4.5.2 INTERLOCKING PAVERS

Where interlocking pavers are approved by Council for use in pavement construction, the design and construction shall be in accordance with the Design Manual for Interlocking Concrete Pavers (Concrete Masonry Association of Australia) and the Clay Segmental Pavement Design Manual (Brick Development Research Institute).

In either type of paving, the pavement depth calculated shall not be less than that for an unbound flexible pavement.

3.4.5.3 ASPHALT PAVEMENTS

Structural asphalt pavements where approved for use by Council shall be designed in accordance with the requirements of the Pavement Design Manual - Queensland Department of Main Roads.

3.4.6 CONSTRUCTION

(i) **Joining to Existing Pavement** - where new works join to existing sealed pavement, a saw cut edge is to be made 200mm into the existing pavement to enable a smooth joint to be made.

(ii) **Compaction Standard** - The minimum standard of compaction for the top 150mm of the subgrade shall be 100% Standard compaction and for any pavement course shall also be 100% Standard compaction. The materials shall be compacted in layers not more than 225mm and not less than 75mm thickness.

(iii) **Subgrade Profile** - Any tests in regard to the subgrade shall apply to the full width of the road profile (eg. Back of kerb to back of kerb).

(iv) **Kerb and Channel Base Material** - The pavement course shall extend under the kerb and channel for the full road width (eg. Back of kerb to back of kerb). Boxing out to the pavement depth after constructing the kerb and channel on subgrade material will not be permitted or approved by Council. The pavement material under the kerb and channel shall be compacted to a minimum 100% Standard compaction.

(v) **Construction Tolerances -** The construction tolerance for urban construction shall be in accordance with the following table:

URBAN CONSTRUCTION TOLERANCES	
Subgrade	+10mm to -25mm
Pavement Thickness	+20mm to -10mm per layer +20mm to -10mm overall
Wearing Course Thickness	+10mm to -0mm
Finished Road: (a) Horizontal Alignment (b) Vertical / Geometric tolerance (i) Primary tolerance (ii) Deviation from 3m straight edge (iii) Crossfall (iv) Rate of change of crossfall	 ±50mm ±15mm 5mm ±0.3% ±0.02%
Kerb and Channel absolute minimum	0.5% No ponding
Stormwater pipe inverts	±20mm

Sealed rural road construction shall conform to the above construction tolerances.

Unsealed rural road construction may require some variance from these standards. Prior approval shall be obtained from Council for any variance in either situation.

3.4.7 FLOODWAY DESIGN

Council may approve the use of floodway in some circumstances such as where traffic volumes are low, where the flow across the road is of a short duration, the road is low functional class serving a small catchment or it is impractical to construct a bridge or culvert. The designer should confer with Council prior to any proposal to use a floodway for drainage.

(i) Floodway design shall be in accordance with AUSTROADS "Waterway Design". The base course layer shall be required to be cement modified with upstream and downstream protection works. Batters shall be typically 3:1 with concrete/rock protection or 6:1 with bitumen seal scour protection depending on flow velocities.

(ii) The proposed design features shall be discussed and approved by the Council prior to the design being submitted for review.

(iii) Road signage, guide posts, flood gauge posts, line marking and/or guard rails shall be important elements of the design.