0041 GEOMETRIC ROAD DESIGN

1. General

1.1. Responsibilities

1.1.1. Objectives

General: Design and document a road system to provide the following:

- Improved urban structure and revitalisation;
- Convenient and safe access for movement of pedestrians, vehicles and cyclists;
- Appropriate access for buses, emergency and service vehicles;
- A quality road network using integrated design that minimises maintenance costs;
- A convenient zone for public utilities;
- An opportunity for street landscaping;
- Convenient Parking;
- Conformance to the Disability Discrimination Act;
- An appropriate response to climate, geology, topography, existing built fabric, heritage and cultural context of the area;
- Allowance for phasing of construction to suit access and funding where necessary;
- Drainage of elements within the road reserve;
- Street lighting;
- Fitting with the built fabric;
- Connecting modes and communities;
- Fitting with the landform;
- Creating a self-explanatory road environment;
- Potential for expansion of the road network with minimum reconstruction by considering traffic growth and development nearby;
- Achieving integrated design with minimal maintenance.

1.2. Cross References

1.2.1. General

Requirement: This is not a self-contained design document, conform to the following worksections:

- 0010 Quality Requirements for Design.
- 0021 Site Regrading;
- 0022 Control of Erosion and Sedimentation (Design);

- 0042 Pavement Design;
- 0043 Subsurface Drainage (Design);
- 0044 Pathways and Cycleways;
- 0061 Bridges and Related Structures;
- 0074 Stormwater Drainage (Design);

1.3. Standards

1.3.1. General

- Road design: To Austroads AGRD01;
- Geometric design: To Austroads AGRD03;
- Intersection design: To Austroads AGRD04 and AGRD04A;
- Geotechnical investigation and design: To Austroads AGRD01 Appendix B;
- Traffic management: To Austroads AGTM series;
- TfNSW supplements.

1.4. Interpretation

1.4.1. Abbreviations

General: For the purposes of this worksection the following abbreviations apply:

- AADT: Average annual daily traffic;
- ASD: Approach sight distance;
- AU: Auxiliary;
- BA: Basic;
- CH: Channelised;
- DDA: Disability Discrimination Act;
- EDD: Extended design domain;
- HOV: High occupancy vehicle;
- LATM: Local area traffic management;
- MGSD: Minimum gap sight distance;
- NDD: Normal design domain;
- SISD: Safe intersection sight distance;
- TfNSW: Transport for New South Wales;
- AGRD: Austroads Guide to Road Design;
- AGTM: Austroads Guide to Traffic Management.

1.4.2. Definitions

General: For the purpose of this worksection, the definitions given in Austroads AP-C87, Austroads AGRD03 and the following apply:

- The words 'street' and 'road' are interchangeable throughout all parts of this worksection;
- Activity centre: Urban planning term for those places that are vibrant hubs where people shop, work, meet, relax and often live;
- Approach sight distance: Relates to the ability of drivers to observe the roadway layout at an anticipated approach speed;
- Batter:
    - The uniform side slope of walls, banks, cuttings, etc. Usually expressed as a ratio of horizontal to vertical;
    - The amount of such slope or rake, usually expressed as a ratio of horizontal to vertical, distinct from grade;
    - To form a uniform side slope to a wall, bank, or cutting.
- Carriageway: That portion of a road or bridge devoted particularly to the use of vehicles, that is between guideposts, kerbs, or barriers where these are provided, inclusive of shoulders and auxiliary lanes;
- Crossfall: The slope of the surface of a carriageway measured normal to the design or road centreline;
- Cycleway: Portion of a road or footpath for the exclusive use of cyclists;
- Extended design domain (EDD): The design domain for the assessment of existing roads. EDD is a range of values below the lower bound of the NDD;
- Footpath (pathway): A public way reserved for the movement of pedestrians, motorised wheelchairs and personal mobility devices;
- Horizontal alignment: The bringing together of the straights and curves in the plan view of a carriageway. It is a series of tangents and curves that may or may not be connected by transition curves;
- Landform: The type and shape of terrain, usually including topography, geological characteristics, coastlines, rivers and water bodies;
- Length of superelevation development: The transition of crossfall from a normal roadway on straight alignment to that of a fully superelevated crossfall on a circular curve;
- Level of service: A qualitative measure describing operational conditions within a traffic stream such as speed and travel time, freedom to manoeuvre, traffic interruptions, comfort, convenience and safety and their perception by motorists and/or passengers;
- Legibility distance: The maximum distance that the various types of traffic control signs or devices can clearly be seen under normal operating conditions and where there is no restriction to the line of sight;
- Minimum gap sight distance: Critical acceptance gap that drivers are prepared to accept when undertaking a crossing or turning manoeuvre at intersections;

- Minor road: All roads which become part of the public road system and are supplementary to arterial and sub-arterial roads. Minor roads may include local sub-arterial roads, collector roads, local roads, and access streets;
- Network: Defined as:
    - A connected system of roads and infrastructure that heavy vehicles can travel on. Can be restricted to a certain class(es) of heavy vehicles (NHVR);
    - Set of roads which provide a means of road-based travel within a region. In transport terms it is defined in terms of links and nodes.
- Normal Design Domain (NDD): The design domain for a new road is referred to as the Normal Design Domain. The extent of the NDD defines the normal limits for the values of parameters that have traditionally been selected for new roads;
- Outer separator: The portion of the road reserve separating a through carriageway from a service road;
- Pathway: See footpath;
- Pavement: The portion of a carriageway placed above the subgrade for the support of, and to form a running surface for, vehicular traffic (subbase, base course, seal etc);
- Plan transition: The length over which widening and shift is developed from the 'tangent-spiral' point to the 'spiral-curve' point; i.e. the length between the tangent and the curve;
- Reaction time: The time taken for a driver to perceive and react to a particular stimulus and take appropriate action. It is measured in seconds;
- Road network: A framework for movement by other modes, including pedestrian, bicycle and bus and plays a vital role in supporting neighbourhoods and town centres;
- Road reserve: The strip of public land between abutting property boundaries, specifically gazetted for the provision of public road and controlled by the definitions of the Roads Act (as per applicable State legislation). It includes the road carriageway, as well as footpaths, verges and landscape;
- Roundabout: A form of intersection channelisation in which traffic circulates clockwise around a central island and all entering traffic is required to give way to traffic on the circulating roadway;
- Safe intersection sight distance (SISD): Relates to an overall check that vehicles utilising the intersection have sufficient visibility to allow reaction and deceleration so as to provide adequate stopping distance in potential collision situations;
- Service road: A low traffic volume roadway parallel to and separated from an arterial road by an outer separator to limit vehicular access direct to the low volume road;
- Shoulder: The portion of formed and sealed carriageway that is adjacent to the traffic lanes and flush with the sealed surface of the pavement;
- Shoulder width: The measurement taken from the outer edge of the traffic lane to the edge of usable carriageway and excludes any berm, verge, rounding or extra width provided to accommodate guideposts and guard fencing;
- Side friction factor (f): A measure of the frictional force between the pavement and the vehicle tyre;

- Sight distance: The distance, measured along the carriageway, over which the visibility occurs between the driver and an object or between two drivers at specific heights above the carriageway in their lane of travel;
- Speed (85th percentile): The speed at or below which 85% of the vehicles travel;
- Design speed: A speed fixed for the design and correlation of those geometric features of a carriageway that influence vehicle operation;
- Desired speed: The speed over a section of a road adopted by a driver as influenced by the road geometry and other environmental factors;
- Operating speed: The speed for an existing road at a time when traffic volumes are low and which allows a free choice of speed within the road alignment;
- Stopping sight distance: The sum of the braking distance and the distance the vehicle travels at a design speed during a reaction time of 2.5 seconds;
- Superelevation: A slope on a curved pavement selected to enhance forces assisting a vehicle to maintain a circular path;
- Traffic lane: That part of the roadway set aside for one-way movement of a single stream of vehicles;
- Traffic lane width: Traffic lanes are measured to the face of the kerb or to the lane line for multi-lane roads or roads with shoulders;
- Verge (rural): Defined area of the formation in rural roads outside the shoulder at the top of the batter slope;
- Verge (urban): That portion of the road formation not covered by the carriageway or footpath;
  Vertical alignment: The longitudinal profile along the centreline of a road consisting of series of grades and vertical curves.

1.5. Hierarchical Road Network

1.5.1. Road functions

Requirement: Design the network so that the predominant function of the road is conveyed to all road users. Each class of road in the network serves a distinct set of functions and a hierarchical road network is essential to maximise road safety, residential amenity and legibility. Refer to Figure 1: Typical Road Hierarchy Diagram**.**

Traffic management at network level: Conform to Austroads AGTM04.

Access management categories: Conform to Austroads AGTM05.

Traffic management objectives: Conform to Austroads AGTM06.

Road function and traffic hierarchy: Conform to Austroads AGTM08.

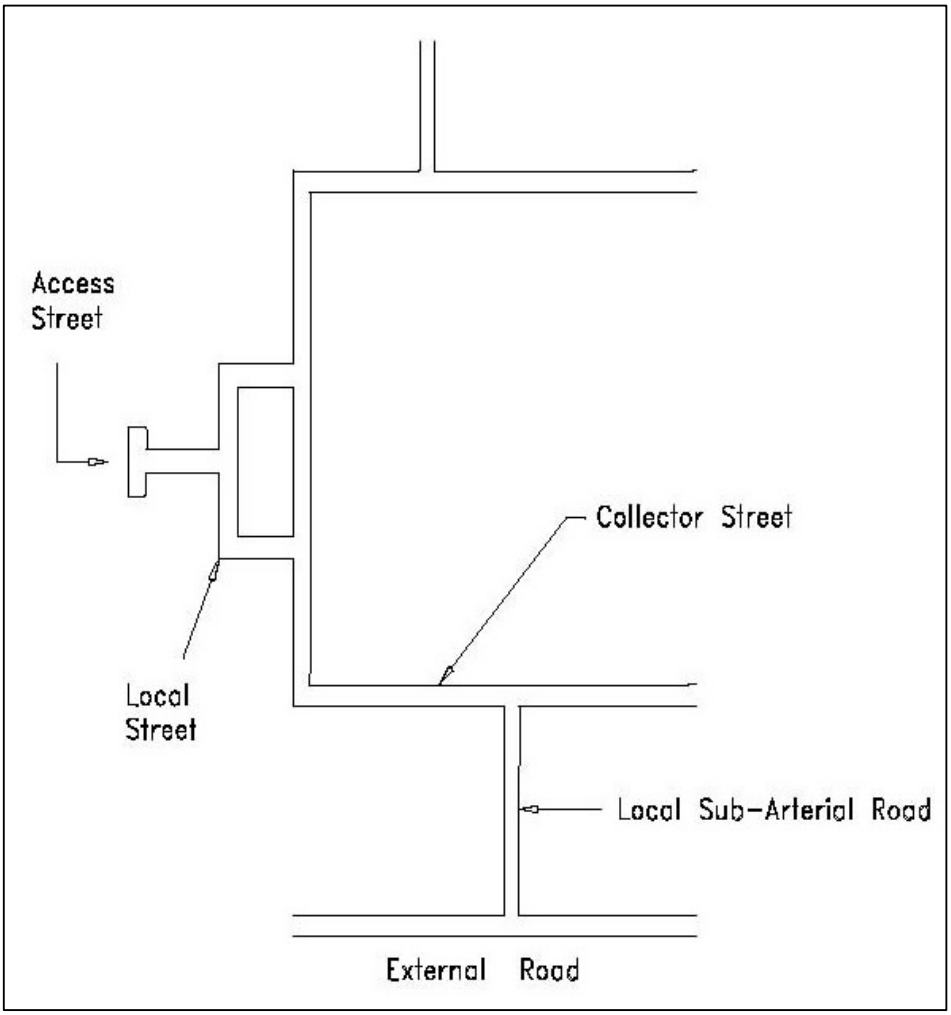

Figure 1: Typical Road Hierarchy Diagram

1.5.2. Road classification

Terminology: The terminology used to describe each class of road varies from state to state. This worksection uses the functional categories common to the majority of states.

Functional classification of urban roads: To Austroads AGRD01 Table 4.2.

Functional classification of rural roads: To Austroads AGRD01 Table 4.1.
Levels of roads: The four generic distinct levels of roads are Access Street, Local Street, Collector Street and Local Sub-Arterial Road.

1.5.3. Emergency access

Requirement: Provide at least two access routes for emergency access for each street type in all subdivisions.

Traffic calming: Provide calming geometry to conform with Austroads AGTM08.

1.5.4. Access Street

Road hierarchy: Lowest order road.

Function: Residential with amenity features which facilitate pedestrian and cycle movements. Vehicular traffic is compliant, in terms of speed and volume, to amenities, pedestrians and cyclists. The features of an example Access Street are shown in **Figure 2: Typical Access Street Layout.**

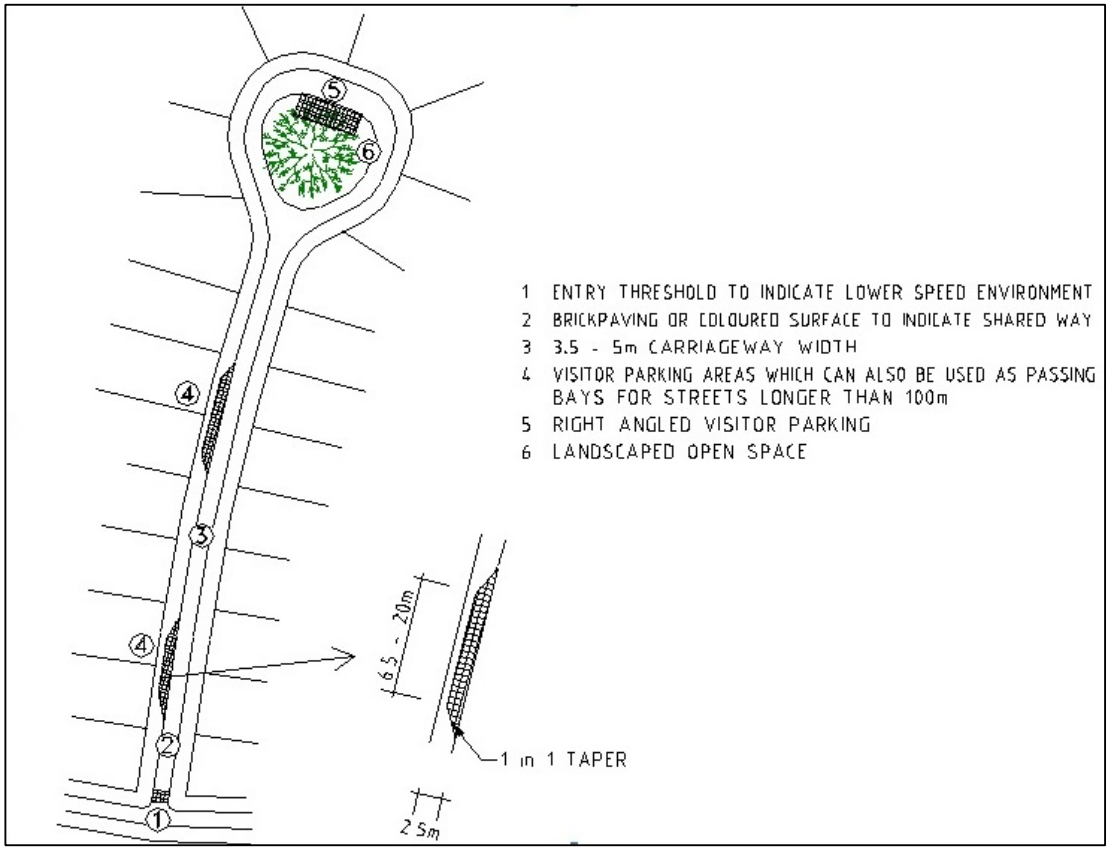

Figure 2: Typical Access Street Layout

1.5.5. Local Street

Road hierarchy: Second lowest order road.

Function: A local residential street, balancing the status of the street in terms of access with residential amenity functions. Resident safety and amenity are dominant but to a lesser degree than Access Streets. Typically, Local Streets link Access Streets with Collector Streets. Refer to **Figure 3: Typical Local Street Layout.**

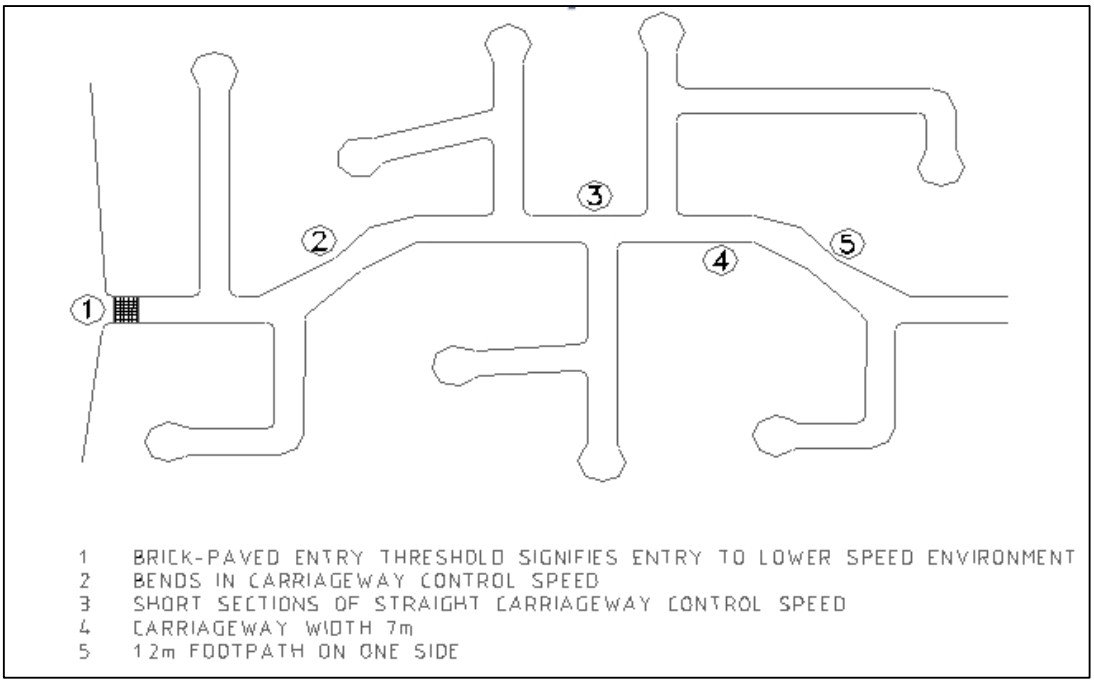

Figure 3: Typical Local Street Layout

1.5.6. Collector Street

Road hierarchy: Third lowest order road.

Function: Residential but also carries higher volumes of traffic collected from Local Streets and connects to Local Sub-Arterial Roads for community transport and business access. There is a reasonable level of residential amenity and safety through restrictions of traffic volumes and speeds. However, amenity and resident safety do not have the same priority as in Access Streets or Local Streets. Refer to **Figure 4: Typical Collector Street Layout.**

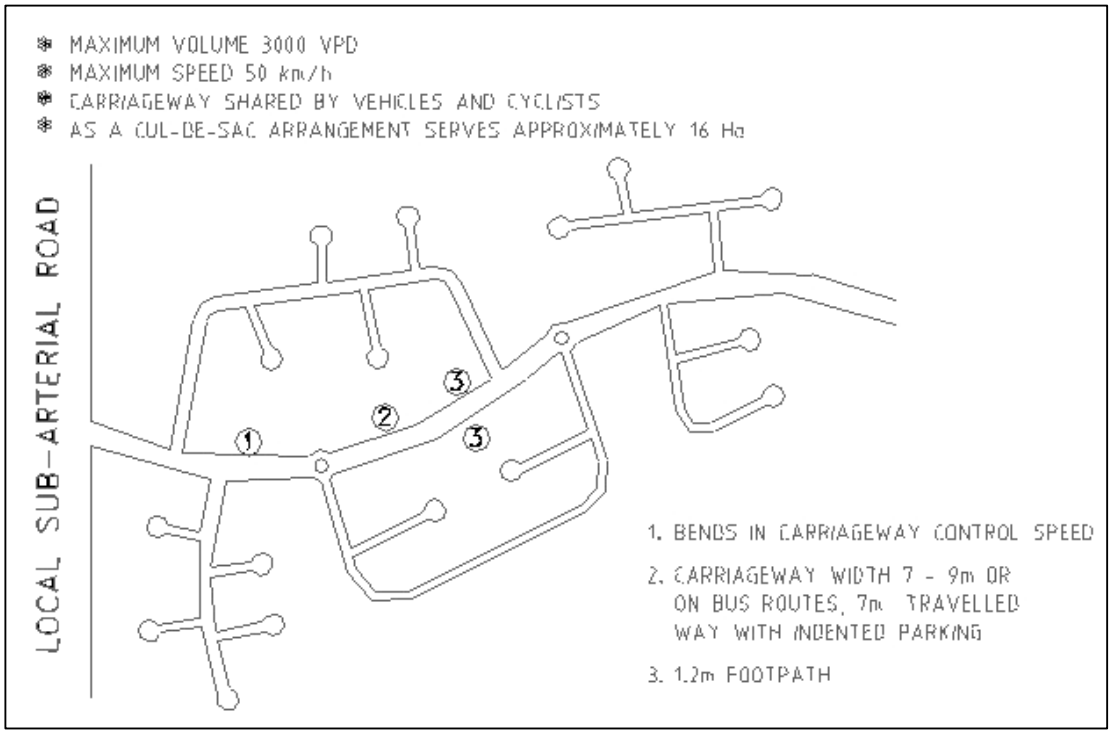

Figure 4: Typical Collector Street Layout

1.5.7. Local Sub-Arterial Road

Road hierarchy: Highest order road/street within a residential development.

Function: Convenient and safe distribution of traffic generated by the development. It provides direct access for single dwelling allotments and access for multi-unit developments and non-residential land uses as appropriate. The Local Sub-Arterial Road serves only the development and does not attract through traffic. Refer to **Figure 5: Typical Local Sub-Arterial Road Layout**, also showing connection to external roads and minor streets.

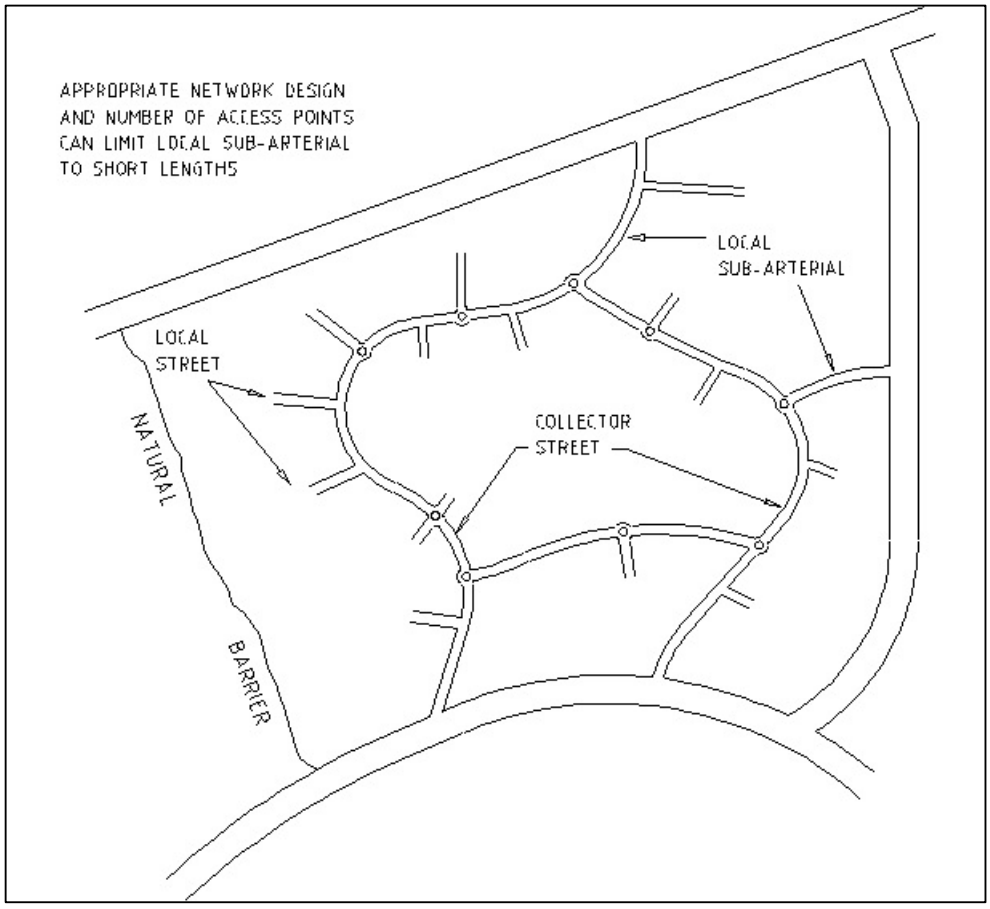

Figure 5: Typical Local Sub-Arterial Road Layout

2. Pre-Design Planning

2.1. General

2.1.1. Planning stages

General: Plan and design road network to the Australian Transport Assessment and Planning (ATAP) Guidelines. Carry out the following planning studies:

- Need study: A study to identify the requirements for new or upgrading the existing road network;
- Reconnaissance study: A qualitative study to identify all possible routes and feasibility of each route;

- Corridor study: A quantitative and qualitative study to select the preferred route;
- Route study: A graphical development of plans for all possible locations of routes of the proposed development.

2.1.2. Geometric design elements

General: The geometric road design comprises the following:

- Selection of the following road network elements to be incorporated in the design:
  - Cross section (e.g. widths of lanes, shoulders, medians and verges);
  - Horizontal curves;
  - Vertical curves and gradients;
  - Intersections;
  - Merge/diverge areas.
- Sizing of selected road network elements;
- Linking the road network elements into a three-dimensional sequence.

2.2. Planning

2.2.1. Road hierarchy

Requirement:

- For new areas: Make sure each class of route reflects its role in the road hierarchy by its visual appearance and physical design and is distinct from established areas with a pre-existing road pattern;
- Functional classification: Routes differ in alignment and design according to the volume of traffic they are intended to carry, the desirable traffic speed, and other relevant factors. Most road authorities have developed a functional hierarchy.

2.2.2. Integrated design principles

Requirement: Integrate design principles in the development of the road network to improve operational efficiency, road safety and public amenity while minimizing environmental impacts of noise, vibration and pollution.

Requirement: Consider the following in integrated design planning:

- Transport and community needs;
- Integrate natural patterns and design in response to topography and landform;

- Design roads so that their appearance signifies their function and their intended speed posting;
- Improve the legibility;
- Provide a self-reliant and minimal maintenance natural landscape;
- Integrate noise control in road network design;
- Avoid adverse visual impacts.

Preparation for design: For design development inputs conform to Austroads AGRD08.

2.2.3. Acceptable vehicle speed

Requirement: Determine the acceptable vehicle speed for the particular section of road to Austroads AGRD03.

2.2.4. Intersection turning movements

Requirement: Minimise the number of turning movements at intersections or junctions that a driver is required to undertake to reach a particular property within the development.

2.2.5. Conformance with Development Control Plan

Pattern and width: Conform to any relevant Development Control Plan (DCP). In areas not covered by such a plan, pattern and width(s) are determined by Council.

2.2.6. Legibility

General: Design for clear legibility in conformance with the following:

- Differentiation: Reinforce legibility by providing sufficient differentiation between the road functions;
- Landmark features: Emphasise distinct landmark features such as watercourses, mature vegetation or ridge lines within the structural layout so as to enhance the legibility;
- Introduced features: Provide the necessary legibility by the inherent design and functional distinction of the road network in addition to introduced physical features, such as pavement and lighting details.

2.2.7. Environmental considerations

Requirement: Evaluate the environmental considerations including topography, existing public utility services, visual intrusion, noise, vibration and pollution in the road design to Austroads AGRD03 and AGRD06B.

Noise reduction: Consider vertical alignment adjacent to intersections and/or sensitive areas (e.g. schools, hospitals) to minimise braking noise.

2.2.8. Salinity prevention

Design constraints: For the design of roads through or adjacent to land known to be salt affected, take the following actions:

- Consultation: Consult with the relevant land and water resource authority;
- Early planning: consider adjustments in horizontal and vertical line to avoid detrimental interference to recharge of sub-surface water within or adjacent to the road reserve;
- Landscaping: Select appropriate native deep-rooted species for plantings associated with road reserve works. Provide for plantations of sufficient size and density, multiple row belts and relatively close spacings, to lower the ground water table.

2.2.9. Heritage considerations

Requirement: Heritage sites are recorded in the state heritage asset register. Some sites may contain archaeological sites relating to Aboriginal or non-Aboriginal occupation. Plan for the management of heritage assets.

2.3. Consultation

2.3.1. Council and other authorities

Council consultation: Before starting design and during preparation of the design, liaise with the Council's officer(s) for the following:

- Roadway layout and traffic management;
- Council's transport policy;
- Stormwater and subsurface drainage;
- Landscaping.

Other authorities: Consult with and seek approval for the development from the following government authorities where relevant, identifying specific areas of consultation in the design:

- State roads authority;
- State and local planning authorities;
- State and federal environmental agencies;
- Rail authorities if the proposed project crosses the rail network;
- Regional catchment management authority;

- Water authorities;
- Other utility authorities.

2.3.2. Public consultation

Requirements: Undertake public consultation with the community and the other stakeholders in conformance with the Council policy.

2.3.3. Utilities services plans

Existing services in the development area/precinct: Liaise with all relevant utility authorities affected by the scheme and obtain service plans from these authorities for the proposed development area for above ground and below ground services. Where required, carry out on-site investigation to determine the location of services. Plot these services on relevant drawings including the plan and cross-sectional views.

Requirements for utility services: To NSW Streets Opening Coordination Council's (SOCC) Guide to Codes and Practices for Streets Opening.

Utility services location: Contact DIAL BEFORE YOU DIG to identify the locations of underground utility services pipes and cables. Contact Council for underground council services and conduct on-site investigations to locate services where necessary.

3. Design

3.1. Design Criteria

3.1.1. General

Requirement: Adopt a design domain approach to Austroads AGRD01.

3.1.2. Location

Road network location: Urban/rural

3.1.3. Traffic volume and composition

Requirements: Determine the AADT to Austroads AGTM03.

3.2. Road Network Design Criteria

3.2.1. Routing

General: Provide routing as follows:

- Avoid through routes in the internal road system that are more convenient than the external road network in conformance with Austroads AGTM04 and AGTM08;
- Design and locate the external road network to provide routes that are more convenient for potential through traffic within the network;
- Provide access to major roads at intervals of no more than 1.5 km, of adequate capacity to accommodate through network movements.

3.2.2. Road links

General: Provide for road links as follows:

- Hierarchy: Except in exceptional circumstances, do not link one road with another that is more than two levels higher or lower in the hierarchy;
- Restriction: Avoid access from Access Streets or Local Streets to an access-controlled Arterial Road.

3.2.3. Traffic flow

Traffic flow and speeds: Make sure that the traffic design for flow and speeds on any road are compatible with the residential functions of that road.

Traffic management in activity centres: Conform to Austroads AGTM07.

Traffic Impact Assessment: Conform to Austroads AGTM12.

3.2.4. Transport provisions

Road layout: Conform to the requirements of the external road network and satisfy the transport provisions of an outline development plan.

Travel time: Minimise the time required for drivers to travel on all streets within the development.

Internal road connections: Provide intersections of internal roads as T-junctions or controlled by roundabouts.

Local Sub-Arterial Road: Minimise the length of Local Sub-Arterial Road within a development.

Access Street: Restrict the maximum length of an Access Street so that its status as a residential place is retained. Adopt design speed and volume to allow the integration of pedestrian, bicycle and vehicular movements without impairing residential convenience.

Pedestrian or bicycle network: Where Access Streets form part of a pedestrian or bicycle network, provide for access links with adjoining Access Streets or open space systems for functional efficiency of the pedestrian and bicycle network.

3.3. Design Parameters

3.3.1. Location

Road network location: Select urban or rural.

3.3.2. Traffic volume and composition

Requirements: Determine the following traffic characteristics to Austroads AGTM03.

- Traffic volume: Determine the volume of traffic to be carried by the road by conducting traffic studies and surveys;
- Roadway capacity;
- Level of service;
- Roadway conditions: Affect the roadway capacity and level of service depending on type of road and environment, traffic lane and shoulder widths, design speed, horizontal and vertical alignment;
- Terrain conditions: Generally classified as level, rolling and mountainous;
- Traffic composition: Generally classified as passenger cars, trucks and buses;
- Vehicle characteristics: Vehicle types and length or axle configurations.

Traffic lanes: Capacity analysis, level of service and design traffic volumes are used to determine the number of traffic lanes required.

3.3.3. Road classification

Requirement: Determine the functional road classification of the network to be designed in conformance with **Section 1.5 Hierarchical Road Network**.

3.3.4. Vulnerable road users

Pedestrians, cyclist and motorcyclists: Provide safe and convenient passage to vulnerable road users to Austroads AGRD03, AGRD04, AGRD04A, AGRD04B, and AGRD06A.

3.3.5. Design speed and operating speed

Requirement: Identify the operating speed for existing roads and select the design speed for both existing and planned lengths of the road.

3.3.6. Alignment controls

Requirement: Identify any mandatory and discretionary controls for the proposed alignment.

3.3.7. Design vehicle

Requirement: Determine the type of vehicles that will be operating on the road network to establish the traffic lane widths, road geometry and intersection layout.

3.3.8. Use of roads as emergency aircraft runway strip

Requirement: In an emergency in remote areas, roads may be designed to operate as emergency aircraft runway strips to Austroads AGRD03.

3.3.9. Environmental

Requirement: Evaluate the environmental considerations including topography, existing public utility services, visual intrusion, noise, vibration and pollution in the road design to Austroads AGRD03.

Noise reduction: Consider vertical alignment adjacent to intersections and/or sensitive areas (e.g. schools, hospitals) to minimize braking noise.

Salinity prevention: For the design of roads through or adjacent to land known to be salt affected, take the following actions:

- Consultation: Consult with the relevant land and water resource authority;
- Early planning: Consider adjustments in horizontal and vertical line to avoid detrimental interference to and recharge of subsurface water within or adjacent to the road reserve;
- Landscaping: Select appropriate native deep-rooted species for plantings in association with road reserve works. Provide for plantations of sufficient size and density, multiple row belts and relatively close spacings, to lower the groundwater table.

3.3.10. Heritage considerations

Requirement: Plan for the management of heritage assets. Heritage sites are recorded in the State heritage asset register. Some sites may contain archaeological sites relating to Aboriginal or non-Aboriginal occupation.

3.3.11. Access management

Requirement: Provide safe and appropriate access for the movement of traffic between the proposed road and the adjacent land.

3.3.12. Drainage

Drainage methods: Select the appropriate drainage methods to the 0043 Subsurface Drainage (Design) and 0074 Stormwater Drainage (Design) worksections.

3.3.13. Utility services

Location: Locate the utility services in the road reserves such that there are minimum service relocations in case of future upgrades or growth in or around the proposed development.

3.3.14. Topography

Site specific features: Design the road with the terrain rather than against it and carry out the geotechnical investigation of the site to Austroads AGRD01 Appendix B.

3.4. Design Speed

3.4.1. General

Design parameters: Use design speed as the basic parameter in road design as it is dependent on the functional classification of the road, topography, land use and abutting development and desired speed of drivers.

3.4.2. Operating speed model

Model: Determine the operating speed using the operating speed model to Austroads AGRD03.

3.4.3. Operating speed on urban roads

Consult with council for direction on the selection of an operating speed for proposed urban roads. Minimum design speeds shall be determined using the concept of a speed environment as outlined in Austroads AGRD03 following direction from council on appropriate operating speeds for the proposed road.

3.4.4. Operating speed on rural roads

Consult with council for direction on the selection of an operating speed for proposed rural roads. Minimum design speeds shall be determined using the concept of a speed environment as outlined in Austroads AGRD03 Section 3 following direction from council on appropriate operating speeds for the proposed road.

Restricted access to major roads: Design all rural subdivisions to control access to major roads. Limit access to one point on to Local, Collector, Local Sub-Arterial or Arterial road networks.

3.4.5. Operating speed model

Model: Determine the operating speed using the operating speed model to Austroads AGRD03 to predict the operating speed of cars along the length of the road.

3.4.6. Hazard reduction

Low speeds: Adopt a low design speed to discourage speeding. Avoid vertical or horizontal curves of low design speed located in otherwise high-speed sections to minimise the risk of creating a potentially dangerous section of road. Recognise that in low design speed roads, operating speeds may be in excess of posted speed limits.

Hazardous features: Make hazardous features visible to the driver. Adopt traffic engineering measures that help a driver avoid errors of judgement.

Road safety barriers: Assess and design road safety barriers to AS/NZS 3845.1.

3.5. Cross-Section

3.5.1. Road reserve characteristics

Cross section: Provide for all road functions including the following:

- Safe and efficient movement of all users (including emergency vehicles and operation of buses on connector streets);
- Provision for parked vehicles. Give particular attention to access for disabled persons in conformance with the AUS Gov Act No. 135 - Disability Discrimination Act 1992;
- Access to public transport;
- Buffer from traffic acoustic nuisance for residents;
- Provision of public utilities and WSUD devices;
- Streetscaping;
- Requirements of AUS Gov Act No. 135 - Disability Discrimination Act 1992.

Operational aspects: Conform to the following:

- Allow vehicles to proceed safely at the operating speed intended for that level of road in the network with only minor delays in the peak period;
- Take into consideration the restrictions caused by parked vehicles where it is intended or likely that this will occur on the carriageway;
- Vehicles include trucks, emergency vehicles and buses on some roads. (Refer to **Table 1: Bus Route Criteria** in clause 3.13.3 of this worksection).

Design life: To Austroads AGRD01 Table 4.5.

3.5.2. Type of cross-section

General: Determine the type of cross-section considering the following factors:

- Location: Urban/rural;
- Function of the road;
- Type of road;
- Traffic volume;
- Public transport;
- Environmental constraints;
- Availability of construction materials.

Pedestrians and cyclists: Provide for the safety of pedestrians and cyclists where it is intended they use the carriageway by providing sufficient width and control of landscaping to provide sight distances.

Access to allotments: The carriageway width must allow for unobstructed access to individual allotments. Provide for drivers to comfortably enter or reverse from an allotment in a single movement, taking into consideration the possibility of a vehicle being parked on the carriageway opposite the driveway.
Design life: To Austroads AGRD03 Table 4.1.

3.5.3. Traffic lanes

General: All roads shall be dual carriageway unless otherwise directed by council. The typical minimum width required for traffic lanes are given in the figures below but may vary depending upon traffic volume, presence of cyclists, available road reserve width and the side friction constrained by abutting access. Any variations to these figures must be first approved by council.

The typical minimum standard required for both urban and rural roads are given in **Figures 6 and 7** below.

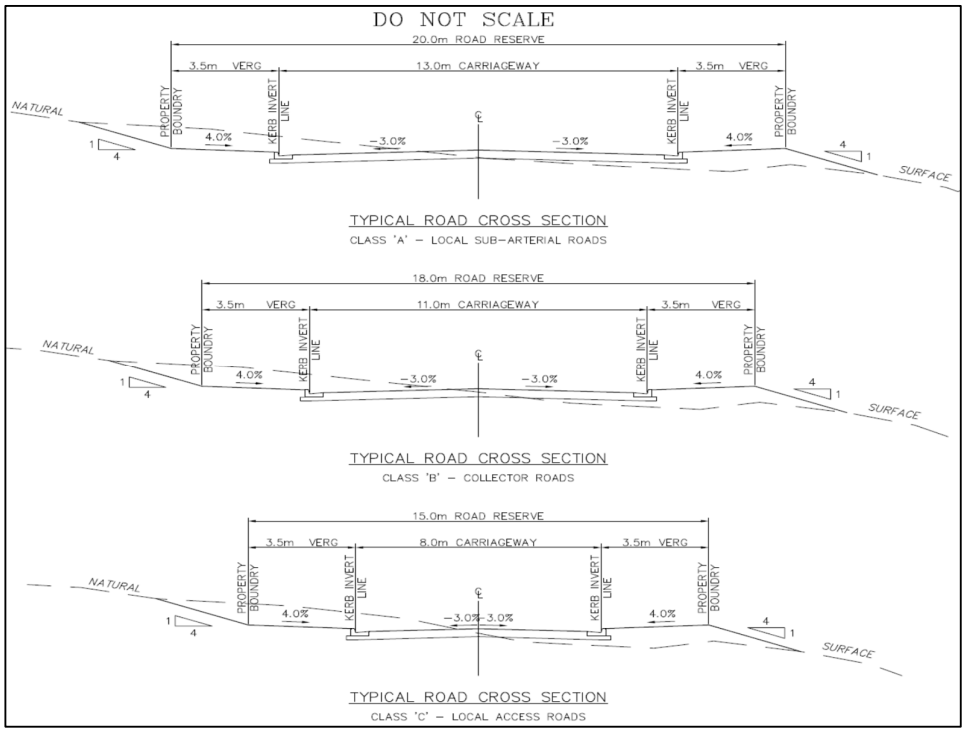

Figure 6: Typical Cross Section Requirements - Urban Roads

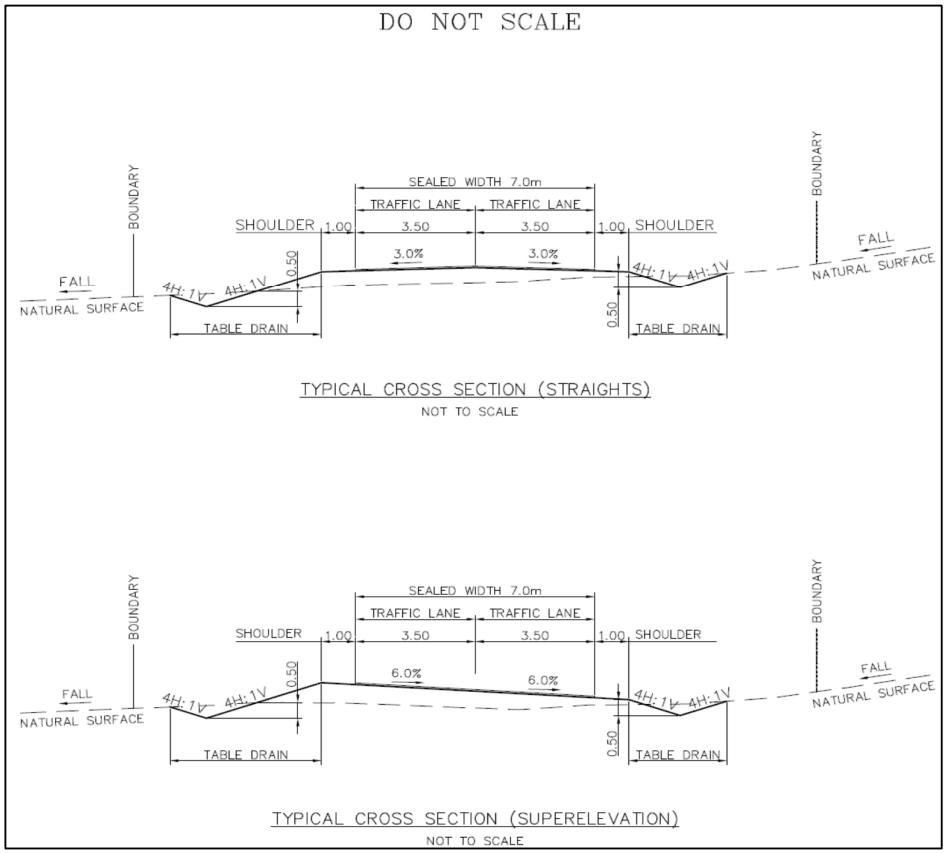

Figure 7: Typical Cross Section Requirements - Rural Roads

3.5.4. Plan transitions

Restrictions: In urban road design it is often impracticable to use plan transitions as kerb lines are fixed in plan and any shift requires carriageway widening. Widening on horizontal curves compensates for differential tracking of front and rear wheels of vehicles, overhang of vehicles and transition paths. If proposed roads are curved, consider the adequacy of the carriageway width.

Crossfall changes: To avoid causing discomfort and the creation of visible kinks in kerb lines, abrupt changes in crossfall shall be avoided. Conform with the following:

- The wider the pavement, the longer the transition;
- Use superelevation transitions at all changes in crossfall, not just for curves. Drainage problems can arise with superelevation transitions which may require extra gully pits and steeper gutter crossfalls;
- Where crossfalls change at intersections, draw profiles of the kerb line. Calculated points can be adjusted to present a smooth curve.

3.5.5. Crossfall

Pavement crossfalls: Crown the roads on centreline. Provide crossfall to drain the carriageway on straights and curves and to provide superelevation on horizontal curves.

Pavement crossfall on straights: To Austroads AGRD03 Table 4.2

Rate of change: Do not exceed the rate of change of crossfall in the following conditions:

- Through traffic: 6% per 30 m;
- Free flowing turning movements: 8% per 30 m;
- Turning movements for which all vehicles are required to stop: 12% per 30 m.

Precedence of crossfall over grade: Conform to the following:

- The crossfall on a collector street or local sub-arterial road will take precedence over the grade in local or access streets. Maintain the crossfall on the major road and adjust the local street levels to suit;
- A rate of change of grade of 2% in the kerb line of the side street relative to the centre line grading is a reasonable level.

3.5.6. Shoulders

Function: Design road shoulders to carry out the following functions:

- Structural: Provide lateral support to the road pavement layers;
- Traffic: Provide an initial recovery for an errant vehicle, emergency use, a refuge for stopped vehicles and space for cyclists where required.

Shoulder widths shall be minimum as per the standard cross sections shown for urban and rural roads. This should be taken as the minimum and may require variation for safety reasons. Consult with Council to confirm specific requirements for shoulder width in these cases.

Shoulder crossfall: Provide shoulder crossfall to Austroads AGRD03 clause 4.3.5.

3.5.7. Verge

General: Design the verge to perform the following functions:

- A traversable transition between the shoulder and the batter slopes;
- A firm surface for stopped vehicles;

- Space for installation of guideposts and road safety barriers;
- Reduce scouring due to stormwater run-off.

Minimum width: As per typical cross sections shown for urban roads.

Verge rounding: Provide verge and batter toe rounding to minimise rollover accidents to Austroads AGRD03 Table 4.10.

Verge slope: Provide verge slopes for local roads or behind kerb and channel in cut:

- Without rounding: 4%;
- With rounding: Initial slope same as abutting shoulder.

3.5.8. Verges and property access

Criteria: Design the verge with consideration of utility services, the footpath width, access to adjoining properties, likely pedestrian usage and preservation of trees.

Restriction: If normal crossfalls are impracticable adopt low level footpaths.

Crossfalls in footpath paving: < 2.5% to Austroads AGRD06A.

Longitudinal grade: Conform to the following:

- Parallel to the longitudinal grade of the road;
- Limit: May be steeper than 5%.

Driveway profile: Conform to the following:

- Provide a vehicular driveway centreline profile for the property access;
- Check the design using critical car templates, available from the Council;
- Design driveway profiles so that vehicles can use the driveway satisfactorily.

3.5.9. Batters

Requirement: Accommodate differences in level across the road between road reserve boundaries by the following measures used individually or combined:

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

- Battering at the boundary over half the verge width with the half against the kerb constructed at standard crossfall.

Batter slopes: Design the batter slopes considering the following factors:

- Recommendations of geotechnical investigations;
- Batter stability and safety;
- Available width of road reserve;
- Landscape requirements;
- Maintenance costs and accessibility requirements. Preferred maximum batter slope for a slasher is 4:1.

Batter slopes: To Austroads AGRD03 Table 4.11 or as directed by geotechnical engineer.

Benches: Provide benches for high batters > 10 m vertical height or batters on unstable ground. Provide benches as shown in Austroads AGRD03 Figure 4.14.

- Minimum width of bench: 3 m;
- Maximum crossfall: 10%;
- Preferred bench width for road safety, maintenance and drainage: 5 m.

3.5.10. Roadside drainage

General: Provide appropriate drains to remove water from the road and its surroundings and to maintain road safety and pavement strength to Austroads AGRD03 section 4.6.

- Table drain: Provide a dish drain or similar structure along the invert of table drains, seal the outer edges of the pavement, the shoulder verges and the drain lining where scour is likely to occur to Austroads AGRD03 Figure 4.16. Provide the following slopes:
    - Side slopes: < 4H:1V;
    - Desirable slope: 6H:1V.
- Catch drains: Provide catch drains to prevent overloading of the table drain and scour of the batter face at least 2 m from the edge of cuttings to minimise possible undercutting of the top of the batter;
- Median drains: Provide median drains with side slopes 10H:1V to reduce the chance of vehicle overturning. Provide a depressed median of minimum 10 m width. Place the invert of the median drain below subgrade level to facilitate drainage of pavement layers;
- Kerb and channel: Provide kerb and channel to perform the following:
    - Collect and convey surface drainage to a discharge point;
    - Delineate the edges of the carriageway;
    - Separate carriageways from areas dedicated to footpath users;

  - Support the edge of the base course of the pavement;
  - Reduce the width of cut by substituting an underground drainage system in place of table drains.
- Kerb type and placement: Shall be first confirmed by council but will generally conform to AGRD03 Section 4.6 and the following:
  - Provide barrier kerb for lightly trafficked local roads, adjacent to parking lanes and parking areas and bus bays to reduce the risk to pedestrians;
  - Provide layback kerb on minor roads to allow for off-road parking and for continuous access to property.
- Kerb location: Place kerb and channel with the minimum clearance between the face of the kerb and edge of the traffic lane to Austroads AGRD03 Table 4.14;
- Kerb and channel in rural roads: Provide kerb and channel on both sides of roads and piped drainage in all rural residential subdivisions.

3.5.11. Scour protection

Requirement: Provide scour protection of roadside drainage and table drains depending on the nature of the soils, road gradients and volume of stormwater runoff.

Protection of the works: Provide concrete lined channels, turfing, rock pitching, grass seeding, individually or in combination. Carry out geotechnical investigations to determine the level and extent of any protection works before proceeding to final design stage.

3.5.12. Medians

General: Provide medians to improve the safety and operation of urban and rural roads with multiple lanes.

Median type: Select raised or depressed type to Austroads AGRD03 Figure 4.21.

Median width: Minimum urban median width to Austroads AGRD03 Table 4.15.

Median slopes: Provide median slopes to Austroads AGRD03 Table 4.16.

Median transitions: Provide appropriate transition to safely merge and diverge vehicles to Austroads AGRD03 Figure 4.34.

3.5.13. Bicycle lanes

General: Consider provisions for cyclists in the road design to Austroads AGRD03 Section 4.9 and provide adequate space for cyclists to share the road safely and comfortably by providing on-road bicycle facilities in the form of the following:

- Separate bicycle lanes: Provide separation from other motor traffic with exclusive bicycle lane on the left side of the road by pavement markings and signs.
- Road shoulders.
- Widened lanes for joint use by bicycles and other vehicles.

Bicycle lane width: To Austroads AGRD03 Table 4.18.

Restriction: Provide a minimum bicycle width of 2 m in congested areas.
Minimum clearance with adjacent traffic on local roads: to AGRD03 Table 4.17.

3.5.14. High occupancy vehicle (HOV) lanes

General: If there are any public transport services proposed in the route, provide HOV priority lanes for public transport in conformance with the following:

- Shoulder width: 3.5 m;
- Intermittent bays: Provide bays with appropriate length tapers to provide safe movement of vehicles;
- Provide access to public transport in conformance with the AUS Gov Act No. 135 - Disability Discrimination Act 1992.

Bus lane width: On new roads, conform to the following:

- To Austroads AGRD03 Table 4.22;
- Minimum width between the kerbs:
    - If bicycle lanes are provided: 15 m;
    - If bicycle lanes are not provided: 11.6 m.
- Width of kerbside bus lanes incorporating bicycle lanes: To Austroads AGRD03 Table 4.23.

3.5.15. On-site parking

Requirement: Determine the demand for on-site parking to Austroads AGTM11.

Design criteria:

- Accommodate on-site parking requirements for normal levels of activity associated with any land use;
- Do not impede through traffic;
- Dimensions: Allow convenient and safe access and usage;
- Non-residential land uses:
    - Number of parking spaces: To parking standards as determined by the relevant authority. Refer to council for requirements;
    - Layout and access: To AS/NZS 2890.1;
    - Parking for people with disabilities: To AS/NZS 2890.6 and to the AUS Gov Act No. 135 - Disability Discrimination Act 1992.
- Residential land use: Number of parking spaces: Conform to the following:
    - Single dwelling allotment: Provide two car parking spaces (which may be in tandem);
    - Multi-unit residential developments: Provide three spaces on-site for each two dwelling units.
- Minimum dimension: Include one space for each residential unit within the allowable building area and with a minimum dimension of 5.0 m by 3.0 m.

3.5.16. On-street parking

Standards: To AS 2890.5, Austroads AGRD03 Section 4.11 and Austroads AGTM11.

Road reserve parking: Provide adequate parking within the road reserve for visitors, service vehicles and any excess resident parking.

Future spaces: On single lane carriageways, provide one space for each two allotments on the verge within 25 m of each allotment, with scope to provide one additional space for single dwelling allotments or for each two units in a multi-unit development if required at a future time.

Short term truck parking: On single lane carriageways, combine a number of verge spaces to provide for short term truck parking within 40 m of any allotment.

Verge and carriageway parking: On single lane access streets, provide parking spaces within the verge. Provide verge and carriageway parking in conformance with the following:

- Adequate dimensions;
- Convenient and safe to access;
- Well defined with traffic control devices;
- All-weather surface;
- No restriction to the safe passage of vehicular, disabled and pedestrian traffic.

Joint use: For non-residential land uses, provide the opportunity for maximum joint use of shared parking by a number of complementary uses.

On-street parking dimensions: Conform to the following:

- Single (car) space: As per AS2890.5;
- Combined spaces for two cars: 13.0 m x 2.5 m;
- Truck parking: 20 m x 2.8 m with adequate tapers at both ends to allow parking manoeuvres determined to Austroads AP-G34.

Material: Construct all verge spaces and indented parking areas of concrete, interlocking pavers, lawn pavers, bitumen with crushed rock or other suitable base material designed to withstand the loads and manoeuvring stresses of vehicles expected to use those spaces.

Angled parking: Provide angled parking as specified by Council in accordance with AS2890.5 Tables 3.2 and 3.3.

3.5.17. Off-street parking

Standards: To AS/NZS 2890.1, AS/NZS 2890.2, Austroads AGTM11 and Austroads AGRD06B.

3.5.18. Service roads and footpath

General: Provide service roads for access to the abutting property or control access to the arterial road from the abutting property.

Minimum service road lane width: To Austroads AGRD03 Table 4.26.

Access to allotments: Adopt a carriageway width to provide for unobstructed access to individual allotments. Provide for drivers to comfortably enter or reverse from an allotment in a single movement, taking into consideration the possibility of a vehicle being parked on the carriageway opposite the driveway.

Operating speed: 40 to 60 km/h.

Outer separator width: To Austroads AGRD03 Table 4.28.

Urban border: Consider urban borders comprising a pedestrian path and nature strip to Austroads AGRD03 clause 4.12.3.

Typical urban border slopes: Conform to the following:

- For footpaths:
  - Desirable: 1%;
  - Maximum: 2.5%.
- Nature strip:
  - Grassed soil: 4 to 10%.
- Determine minimum slope on urban borders by considering the drainage;
- Determine the maximum slope by considering the terrain and provision of access at driveways.

Footpaths: Provide footpaths either adjacent to the roadway or separated from it by a nature strip.

- Standard: To Austroads AGRD06A;
- Minimum desirable width: Confirm with Council but typically minimum 1.35 m or 2.5m where shared pathway required;
- Crossfall: Varies from flat to 2.5%.

3.5.19. Bus stops

New bus stops: In conformance with the requirements of the AUS Gov Act No. 135 - Disability Discrimination Act 1992 and other road authorities and transport agency disability standards which outline the requirements of the access paths, manoeuvring areas, ramps, waiting areas, surfaces and tactile ground surface indicators.

Urban bus stops: To Austroads AGRD03 clause 4.13.2.

Rural bus stops: Locate bus stops in the road shoulder between the carriageway and table drain.

Minimum shoulder width for a bus stopping area: 3 m.

Minimum length of bus stopping area: 15 m.

For intermediate speed environments provide a longer sealed distance: 30 to 50 m.

3.6. Sight Distance

3.6.1. General

Stopping and sight distance: Provide stopping and sight distance at all points on the road conforming to Austroads AGRD03 Section 5.

3.6.2. Sight distance parameters

General: To Austroads AGRD03 Table 5.1 and the following:

- Driver reaction time: Adopt reaction time of 2.5 seconds for all roads. If 1.5 seconds and 2 seconds reaction times are required, arrange approvals from the State Road Authority.

3.6.3. Stopping Sight Distance

General: Conform to the following:

- General: To Austroads AGRD03 Section 5.3, measured from an eye height of 1.1 m to an object height of 0.20 m;
- On sealed roads: Car stopping sight distance to Austroads AGRD03 Table 5.5.

3.6.4. Sight distance on horizontal curves

General: Conform to the following:

- On horizontal curves: To Austroads AGRD03 Figure 5.4 which shows the relationship between horizontal sight distance, curve radius and lateral clearance to the obstruction;
- On horizontal curves with roadside barriers: Provide minimum shoulder widths and manoeuvre times for sight distances as per Austroads AGRD03 Table 5.7.

Horizontal curve perception sight distance: Provide sufficient sight distance by adopting larger crests for a horizontal curve. Do not provide a horizontal curve starting over a crest. Check sufficient visibility is provided for the curve by providing:

- Clear driver eye height: 1.1 m;
- A zero-object height such that the driver can see the road surface in order to perceive the curvature;
- Driver visibility of a minimum of:
    - 5 degrees of arc;
    - 80 m of arc;
    - The whole curve.

3.7. Coordination of Horizontal and Vertical Alignment

3.7.1. Horizontal and vertical alignment coordination

General: Consider three-dimensional coordination of the horizontal and the vertical alignment of the road to increase efficiency and safety, encourage uniform speed, improve aesthetics and provide harmony with the landform and drainage.

Requirement: Conform to the following:

- Avoid the use of minimum radius horizontal curves with crest vertical curves;
- Contain the crest vertical curves within horizontal curves to enhance the appearance of the crest by reducing the three-dimensional rate of change of direction and to improve safety;
- Provide the same design speed of the road in both horizontal and vertical planes;
- Avoid sharp horizontal curves at or near the top of a crest vertical curve;
- Consider three dimensional combined horizontal and vertical stopping sight distance and minimum sight distance;
- Provide a horizontal curve to indicate the change in direction before introduction of a vertical curve in both directions of travel;
- Be aware that a short vertical curve on a long horizontal curve or a short tangent in the grade-line between sag curves may adversely affect the road's symmetry and appearance.

Aesthetic consideration: Conform to the following:

- Provide horizontal curves slightly longer than the vertical curve, so that the curves fit with the terrain and are coincident;
- Provide long horizontal curves in preference to short curves so that:
    - The overtaking opportunities are not reduced;
    - Small deflection angles avoid the appearance of a kink;
    - Best appearance is provided for deviations around obstructions;
    - The far tangent point is beyond the driver's point of concentrated vision for curves located at the end of long straights.

Drainage consideration: To ensure pavement drainage and to reduce the risk of aquaplaning, avoid very long crest and sag curves that result in long sections of flat grades at the top and the bottom of the curves.

3.8. Horizontal Alignment

3.8.1. General

Requirement: Provide horizontal alignment for safe and continuous vehicle operation at a uniform travel speed including the following:

- For low and intermediate speed rural roads and minor urban roads, where it is difficult to overcome the physical restrictions of curve radii, introduce curvature of a lower standard than the design speed of the project to Austroads AGRD03 Table 7.1;
- Provide tangents of suitable length as frequently as the terrain permits to facilitate overtaking manoeuvres;
- Determine the horizontal alignment from the design speeds for a particular street within the road hierarchy (see **Section 3.4 Design Speed**).

3.8.2. Horizontal curves

Types of horizontal curves: Conform to the following:

- Compound curves: Where possible, use a single curve in place of compound curves. Where the use of compound curves is unavoidable, provide a smaller curve preceding a larger curve. Avoid diminishing radii at steep downgrades;
- Broken back curves: May be necessary in certain terrain constrained locations however should be avoided wherever possible. Replace with a single curve or if absolutely necessary a compound curve;
- Reverse curves: Do not use reverse curves unless there is sufficient distance between the curves to introduce full superelevation of the two curves without exceeding the standard rate of change of crossfall for a particular design speed. Reverse curves should be avoided wherever possible;
- Transition curves: Introduce transition curves to join the straight and circular curves to provide smooth travel of vehicles within the traffic lane;
    - Transition the horizontal curves with the transition length based on the superelevation runoff length for the recommended combination of speed, radius and superelevation;
    - Avoid transition curves for large radius horizontal curves and where operating speed is less than 60 km/h;
    - Provide transition paths for trucks, where lane width is no more than 3.5 m.

3.8.3. Horizontal curves and tangent lengths

Speed/radius relation: Conform to the following:

- For a given design speed, utilise the minimum radius of curvature that drivers can safely negotiate;
- Avoid curves that progressively tighten (e.g. parabolic curves) and sudden reverse curves that drivers cannot anticipate as they have the potential to produce an uncomfortable sense of disorientation and alarm.

Speed restriction: Where speed restriction is provided by curves in a street, conform to the relationship between the radius of the curve and the desired vehicle speed.

Tangents: Determine appropriate lengths for tangents between speed restrictions, which may be curves, narrow sections or other obstructions.

Sight distance: Determine the sight distance on curves to Austroads AGRD03 Section 5.4.

3.8.4. Side friction and minimum curve size

Recommended side friction factors: To Austroads AGRD03 Table 7.5.

Minimum radii for horizontal curves based on superelevation and side friction: To Austroads AGRD03 Table 7.6.

Maximum allowable deflection angles without horizontal curves: To Austroads AGRD03 Table 7.7.

3.8.5. Superelevation

Criteria: Determine the superelevation by considering the following:

- Operating speed of the curve;
- Difference between the inner and outer formation levels in flat or urban areas;
- Stability of high laden vehicles when adverse crossfall is considered;
- Length available to introduce the necessary superelevation.

Minimum radius of curves: Determine from the following:

- Design speed;
- Minimum superelevation (or maximum adverse crossfall) at any point on the circular portion of the curve.

Low design speed and crowned pavement: Conform to the following:

- Access and Local streets: For design speeds of 50 km/h or less, and curves of 60 m radius or less, generally crown the pavement on a curve instead of superelevation.

Superelevation in rural roads: Design superelevation, widening and centreline shift and transitions in conformance with the Austroads AGRD03 Section 7.7.

High design speed: Conform to the following:

- Maximum superelevation for urban roads of higher design speeds: 6%;
- Maximum values of superelevation for different road types: To Austroads AGRD03 Table 7.8;
- Avoid any increase in the longitudinal grade leading to excessive crossfall at intersections;
- While it is desirable to superelevate all curves, limit adverse crossfall to 3%;

Length of superelevation development: Design superelevation development lengths to satisfy both rate of rotation and relative grade criteria to Austroads AGRD03 Table 7.11.

3.8.6. Plan transitions

Transitions: Conform to the following:

- Planning: Plan transitions on superelevated curves for appearance and to provide sufficient length in which to apply the superelevation;
- Urban roads: Superelevation may be applied to the road cross section by shifting the crown to 2 m from the outer kerb, as long as the road is not too wide;
- Access to adjacent properties: The axis of rotation of the cross section for urban roads is normally the kerb grading on either side which best allows access to adjacent properties and intersections;
- On the outside of superelevation, or where the longitudinal grade of the gutter is < 0.5%, adopt a crossfall of 63 mm in a 450 mm wide gutter.

Restrictions: In urban road design it is often impracticable to use plan transitions as kerb lines are fixed in plan and any shift requires carriageway widening. Widening on horizontal curves compensates for differential tracking of front and rear wheels of vehicles, overhang of vehicles, and transition paths. If proposed roads are curved, consider the adequacy of carriageway width.

Crossfall changes: Avoid abrupt changes in crossfall, which can cause discomfort in travel and create a visible kink in the kerb line. Conform to the following:

- The wider the pavement the longer the transition;
- Use superelevation transitions at all changes in crossfall, not just for curves. Drainage problems can arise with superelevation transitions which may require extra gully pits and steeper gutter crossfalls;
- Where crossfalls change at intersections, draw profiles of the kerb line. Calculated points can be adjusted to present a smooth curve.

3.8.7. Curves with adverse crossfall

General: Avoid adverse crossfall greater than 3% except for curves with an operating speed of no more than 70 km/h in constrained areas and for intersection turns and roundabouts.
Minimum radii with adverse crossfall: To Austroads AGRD03 Table 7.12.

Adverse superelevation: Common urban situations that may require the use of adverse superelevation are:

- Property access controls;
- Channel drainage controls;
- Grading restrictions;
- Intersections to maintain visibility of the road surface.

3.8.8. Pavement widening on horizontal curves

Widening: Provide pavement widening on curves to Austroads AGRD03 Table 7.13 to maintain lateral clearance between vehicles, taking into account the following factors:

- Radius of the curve;
- Width of lane on a straight road;
- Vehicle length and width;
- Vehicle clearance.

3.9. Vertical Alignment

3.9.1. General

Documentation: Show vertical alignment on a longitudinal section with a vertical scale of 5H:1V.

3.9.2. Vertical controls

Requirement: Consider the effect of the following features on the vertical geometric design:

- Existing topography;
- Geotechnical conditions;
- Existing intersections;
- Property entrances;
- Pedestrian access;
- Service utility assets;
- Median openings.

Minimum clearance above flood levels and water tables: As defined by the relevant road authority.

3.9.3. Vertical clearances

General: Provide minimum vertical clearances over roadways and pedestrian/cycle paths to Austroads AGRD03 Table 8.1.

Precedence: If there is a conflict, the following order takes precedence:

- Policies of the road owning authority, e.g. Council, State Road Authority;
- Requirements of the authority that owns the asset, e.g. rail authority.

3.9.4. Underground services

Clearance requirements: Consult the relevant authority to determine the minimum clearance requirements for:

- Gas mains;
- Water mains;
- Stormwater drains;
- Sewer outfall;
- Telecommunication cables;
- Underground electrical cables;
- Road authority assets, e.g. traffic signals and street lighting.

3.9.5. Longitudinal gradient

General: Provide grades as flat as possible, consistent with longitudinal drainage requirements so that all vehicles operate at the same speed. Conform to the following minimum grades:

- Road with kerb and channel:
    - Minimum desirable grade: 1%;
    - Absolute minimum grade: 0.5%.
- Roads in cut:
    - Unlined drains: 0.5%;
    - Lined drains: 0.3%.
- Roads without adequate kerb and channel and not in cut: 0%;
- Minimum constructable gradient of 0.5%;
- In very flat conditions: Reduce grade to 0.3%;
- If underground drainage with gully pits or other special works are used, consider near level grades. Provide variable crossfall to achieve the required grade in the gutter.

Maximum grade: To Austroads AGRD03 Table 8.3.

Intersections: Conform to the following:

- Longitudinal grade of the minor street on the approach to an intersection: < 4%;
- Design actual gradient dependent on the type of terrain;
- Interrelate the design of the road alignments and the grades used;
- Avoid a steep grade on a minor side street if vehicles have to stand waiting for traffic in the major road.

Maximum grade in cul-de-sacs and turning circles: < 5%.

3.9.6. Vertical curves

Criteria: Design vertical curves in conformance with the following:

- Provide vertical curves like simple parabolas on all changes of grade exceeding 1%;
- Desirable minimum design speed: 40 km/h;
- The length of the crest vertical curve for Stopping Sight Distance: To Austroads AGRD03 Table 8.7;
- Limit the length of crest curve with 0.3% to 0.5% grade: 30 to 50 m;

Sag curves: Provide the lengths of sag vertical curves to Austroads AGRD03 clause 8.6.4 and the following:

- For kerbed roads: Limit the maximum length of sag curves with less than 0.3% grade to 30 m;
- Maintain a minimum grade of 0.5% in the kerb and gutter by warping of road cross sections at sag points;
- Make provisions for draining both the road surface and the subgrade;

- To minimise discomfort due to rapid changes in vertical acceleration when passing from one grade to another, limit the vertical acceleration generated on the vertical curve to the following:
    - For desirable riding comfort: 0.05g;
    - For minimum riding comfort: 0.10g.

Where g is the acceleration due to gravity.

Sight distance on sag curves: To Austroads AGRD03 clause 8.6.5.

Side road intersections: Locate intersections of roads at a safe distance from a crest, determined by visibility from the side road. If it is proposed to locate intersections of a side road where a crest occurs, provide details with justifications.

3.10. Auxiliary Lanes

3.10.1. General

Requirement: Provide auxiliary lanes adjacent to the through traffic lanes to enhance traffic flow and maintain the required level of service where an Arterial Road meets with the Sub-Arterial, Collector or Local Roads.

3.10.2. Types of auxiliary lanes

Speed change lanes: Provide speed change (acceleration or deceleration) lanes at intersections or interchanges to allow an entering vehicle to access the traffic stream at a speed approaching or equal to 85th percentile speed of the through traffic.

Overtaking lanes/climbing lanes: Provide overtaking lane lengths to Austroads AGRD03 Table 9.2 and merge sight distance at the end of overtaking to Austroads AGRD03 Table 9.3.

Slow vehicle turnouts: Provide a short section of paved shoulder to allow vehicles to pull aside and be overtaken. Provide turnout lengths of 60–160 m for average approach speed of 30–90 km/h and a width of 3.7 m.

3.10.3. Cross-section

Auxiliary lane width: Provide auxiliary lane width not less than the normal width for that section of the road.

Shoulder width: 1 m.

Crossfall: Provide same crossfall of the auxiliary lane as the adjacent lane.

3.11. Intersections

3.11.1. Design criteria

Requirement: Consider the following factors in the location and design of intersections:

- Alignment and grade of approach road;
- Provision of drainage;
- Interference with public utilities;
- Property access;
- Topography;
- Natural and built environment.

Urban and rural intersections: To Austroads AGRD04 Table 4.2.

Road user considerations: To Austroads AGRD04 Table 3.1.

Design criteria: To Austroads AGTM06.

3.11.2. Intersection turning movements

Requirement: Minimise the number of turning movements at intersections or junctions that a driver is required to undertake to reach a particular property within the development.

3.11.3. Intersection types

Traffic management: Select the type of intersections for traffic management in conformance with Austroads AGTM06 clause 3.3.4.

The basic forms of an intersection may include the following:

- Signalised, unsignalised or a roundabout;
- Channelised (i.e. has traffic islands and/or medians) to develop specific types of intersections, or unchannelised;
- Flared, to provide additional through and/or turning lanes, or unflared;
- Due to different driver expectations for an urban or rural intersection, different design and traffic management guidelines will apply.

3.11.4. Location

Requirement: Locate intersections to Austroads AGRD04 Table 4.2 and the following:

- Streets intersection: Preferably at right-angles and not less than 70°;
- Landform: Allowing clear sight distance on each of the approach legs of the intersection;
- Minor street: Intersect the convex side of the major street;
- Vertical grade lines at the intersection: Conform to the following:
    - Provide a desirable grade of 3% with a maximum of 5%;
    - Allow for any direct surface drainage.
- For a left turn, where two minor side streets intersect a major street in a staggered pattern, provide a minimum centreline spacing of 40 m.

Traffic volumes: Design for all movements to occur safely without undue delay. Use projected traffic volumes in designing all intersections or junctions on Local sub-arterial roads.

State roads and national highways: Design intersections for the junction of Council's roads with existing state rural or urban roads and national highways to Austroads AGRD04.

Approval of State Road Authority: Design intersections with state roads or national highways in conformance with the requirements of the State Road Authority.

Sight distance: Provide adequate stopping and sight distances for horizontal and vertical curves at all intersections.

Parking: Where required, make appropriate provision for vehicles to park safely.

Drainage: Design the road reserve cross-section profile to satisfy the drainage function of the carriageway and/or road reserve.

Turning movements: Accommodate all vehicle turning movements in conformance with Austroads AP-G34 and the following:

- For intersection turning movements involving Local sub-arterial roads: Provide for the design semi-trailer with turning path radius 19.0 m;
- For intersection turning movements involving Local streets or Collector streets, but not Local sub-arterial roads: Provide for the design single unit bus with turning path radius 13 m;
- For intersection turning movements on access streets but not involving local sub-arterial roads, collector streets or local streets: Provide for the garbage collection vehicle used by the local authority;

- For turning movements at the head of cul-de-sac access streets: Provide for sufficient area for the design single unit truck to make a three-point turn or, if the length of the cul-de-sac is less than 60 m, for the design car to make a three-point turn. If driveway entrances are used for turning movements, design the required area to withstand the relevant loads;
- Rural roads and designated heavy vehicle routes: Design for the largest permissible heavy vehicle movement on the proposed route (confirm specifications with Narrabri Shire Council).

Turning radii at intersections or driveways on Local Sub-Arterial Road: Design for the intended movements within desired speeds to Austroads AGRD04 Table 5.1.

Bus facilities: Provide minimum length required for bus lane termination on the departure side of an intersection to Austroads AGRD04 Table 6.1.

3.11.5. Sight distance

Requirement: Provide adequate horizontal and vertical sight distance at intersections. Examine each intersection location for conformance with the criteria for Approach Sight Distance (ASD), Minimum Gap Sight Distance (MGSD) and Safe Intersection Sight Distance (SISD). Ensure ASD and SISD are achieved for all intersections, and MGSD where appropriate. Reposition an intersection if required to obtain conformance with the following sight distance criteria:

- ASD: To Austroads AGRD04A Table 3.1 and grade corrections to Austroads AGRD04A Table 3.4 for sealed roads;
- MGSD: To Austroads AGRD04A Table 3.6 for various speeds;
- SISD: Provide SISD for sealed roads to Austroads AGRD04A Table 3.2 and grade corrections to Austroads AGRD04A Table 3.4 for sealed roads.

3.11.6. Types of turn treatments

General: Provide the appropriate type of right-turn and left-turn treatments from the following:

- Basic turn treatment (Type BA): To Austroads AGTM06 clause 3.2.2 and AGRD04A.
- Auxiliary lane turn treatment (Type AU): Provide short lengths of auxiliary lane to improve safety on high speed roads where an arterial road meets with sub-arterial, collector or local roads to Austroads AGTM06 clause 3.2.3, AGRD04 Appendix A and AGRD04A.
- AUR right turn treatments: Generally, not as safe as a channelised treatment at unsignalised intersections. Do not use, unless approved by State Road Authority;
- Channelised turn treatment (Type CH): To Austroads AGTM06 clause 3.2.4, AGRD04 Appendix A and AGRD04A.

Staggered T-intersections: Rural staggered T intersections may be 'left to right' (preferred configuration) or 'right to left' type to Austroads AGTM06 clause 3.2.7. Consider traffic volumes and available width in design selection. Provide staggered T-intersections by:

- Setting out the alignment of the minor roads on new major roads to form a staggered T-intersection;
- Realigning one or both minor road legs of an existing intersection.

3.12. Roundabouts

3.12.1. General:

Design criteria: To Austroads AGRD04B and AGTM06 Section 4. If alternative criteria are proposed, submit alternative criteria for consideration.
Requirement: Provide the following:

- Functional design: To achieve safety of all users and traffic performance;
- Entry width: To provide adequate capacity;
- Adequate circulation width: Compatible with the entry widths and design vehicles (e.g. buses, trucks, cars);
- Central islands: To Austroads AGRD04B Table 4.1 with a size sufficient only to give drivers guidance on the manoeuvres expected;
- Deflection of traffic to the left on entry: To promote gyratory movement;
- Adequate deflection of crossing movements to ensure low traffic speeds;
- A simple, clear and conspicuous layout;
- Design so that the speed of all vehicles approaching the intersection will be less than 50 km/h;
- Landscape and street furniture: To Austroads AGRD04B Section 7 and AGRD06B.

Approval: Obtain approval of roundabouts from the Council and the relevant State Road Authority.

3.13. Traffic Calming

3.13.1. General

Design criteria: Calming devices (e.g. threshold treatments, slow points, road humps, kerb extensions and splitter islands) to AS 1742.13 and Austroads AGTM08.

LATM Type: Select the type of local area traffic management devices from Austroads AGTM08 Table 8.1.

Local area traffic management (LATM) devices: Conform to the following:

- Streetscape:
  - Reduce the linearity of the street by segmentation;
  - Avoid continuous long straight lines (e.g. kerb lines);
  - Enhance existing landscape character;
  - Maximise continuity between existing and new landscape areas.
- Location of devices/changes:
  - Other than at intersections, maintain consistency with streetscape requirements;
  - For compatibility with existing street lighting, drainage pits, driveways, and services;
  - Slowing devices optimally at spacings of 100 m to 150 m.
- Design vehicles:
  - Make sure emergency vehicles are able to reach all residences and properties;
  - Local streets with a feeding function between arterial roads and minor local streets may be designed to Austroads AP-G34 turning templates;
  - Bus routes: Allow buses to pass without mounting kerbs and with minimal discomfort to passengers;
  - Provide for building construction traffic in newly developing areas where street systems are being developed in line with LATM principles.
- Control of vehicle speeds:
  - Reduce speed using devices which shift vehicle paths laterally (slow points, roundabouts, corners) or vertically (humps, platform intersections, platform pedestrian/school/bicycle crossings).
- Create a visual environment conducive to lower speeds. This can be achieved by segmenting streets into relatively short lengths (less than 300 m), using appropriate devices, streetscapes, or street alignment to create short sight lines;
- Visibility requirements (sight distance):
  - Provide critical sight distances so that evasive action may be taken by either party in a potential conflict situation. Relate sight distances to likely operating speeds;
  - Consider sight distance to include those of and for drivers, pedestrians and cyclists;
  - Design for night time visibility of street features. Locate speed control devices near existing street lighting if practicable and delineate all street features/furniture for night time operation. Provide additional street lighting at proposed new speed control devices located away from existing street lighting.
- Safety: Provide roadside design that conforms with Austroads AGRD06 including:
  - Safety barriers;
  - Treatment options;
  - Steep down grades.

3.13.2. Critical dimensions

Dimensions: Conform to the following:

- Pavement narrowing:
  - Single lane between kerbs: 3.50 m;
  - Single lane between obstructions: 3.75 m;
  - Two lanes between kerbs: Minimum 5.50 m.
- Plateau or platform areas: 75 mm to 150 mm height maximum, with 1 in 15 ramp slope relative to road grade.
- Width of clear sight path through slowing devices: 1.0 m maximum (i.e. the width of the portion of carriageway which does not have its line of sight through the device blocked by streetscape materials, usually vegetation).
- Mountable areas required for the passage of large vehicles: To appropriate turning templates.

Approval: Obtain approval of traffic calming devices from the Council.

3.13.3. Bus routes

Criteria: Conform to the following:

- Design the road hierarchy to cater for buses on routes identified by the Council;
- Location of bus routes and bus stops: Arrange so that no more than 5% of residents have to walk in excess of 400 metres to catch a bus;
- Design roads above the Local Street level in the network hierarchy as bus routes.

Table 1: Bus Route Criteria

Road	Carriageway Width (min)	Stops (Spacing)	Bays
Collector*	9 m	400 m**	Single
Local Sub-Arterial	11 m	400 m	Shelters
Arterial	13 m	400 m	Shelters and bays
* Collector Roads not identified as bus routes may have 7 m carriageways. ** Loop roads with single entry/exit only require stops and bays on one side road. Shelters are subject to Council's requirements.			

4. Documentation

4.1. General

4.1.1. Design process

Design development process: Develop a flow chart to capture the design process, include processes such as the brief and scope development, investigative studies and analyses, consultation, selection of design parameters/design inputs, design reviews, major design decisions made or design outputs, approvals and critical dates.

Design review, verification and validation: Provide design documentation to Austroads AGRD01 Appendix A.

4.1.2. Related design documentation requirements

Drainage and run-off: To the 0074 Stormwater Drainage (Design) and 0043 Subsurface Drainage (Design) worksections.

Earthworks, contours, cut and fill: To the 0021 Site Regrading worksection.
Footpaths, pathways and cycleways: To the 0044 Pathways and Cycleways (Design) worksection.

Pavement structure: To the 0042 Pavement Design worksection.

4.1.3. Approvals

Requirement: Document any prerequisite for approval of the development advised by the following authorities:

- Council for:
  - Construction staging and traffic management;
  - Landscaping and verge design;
  - Access provisions;
  - Tree protection and vegetation clearing;
  - Stormwater drainage control.
- NSW Department of Planning, Industry and Environment / Water NSW / Heritage NSW: For general land use, salination prevention measures, existing water bodies that may be affected, and areas of heritage significance;
- The EPA: For other general environmental impact requirements;
- Utilities authority: For any public or private utility affected by the development;

- Rail transport authority: For crossings and rail conflicts.

Authority audits: Include first party, external or third-party audits, for design process or design products, required by the relevant authority.

4.2. Drawings

4.2.1. Drawing sheets

Requirement: Provide separate sheets for the following:

- Cover;
- Key/locality plan and legend;
- Plans;
- Longitudinal sections;
- Cross-sections;
- Structural details;
- Standard drawings.

Minimum requirements: Complete the relevant checklist in Annexure B of the 0010 Quality Requirements for Design worksection for the development. Make sure required items are included in the design documentation.

4.2.2. Drawing presentation

Plain English: Drawings form part of the permanent record and are legal documents. Keep terminology in plain English, so that drawings can be easily read and understood by those involved in the construction of the works.

Drawing size and format: Present drawings on A1 sheets unless otherwise authorised. Prepare clear and legible drawings with consistent lettering and style, and clearly referenced with notations and tables as appropriate.

Drawing scales: Conform to the following:

- Plans:
  - Generally: Minimum 1:500;
  - Rural plans: Minimum 1:1000.
- Longitudinal sections:
  - Horizontal: Minimum 1:500;
  - Vertical: Minimum 1:100.

- Cross-sections: 1:100.

Requirement: Provide the following drawings, describing the geometric road layout for the development:

- Survey(s): Showing contours, original and proposed terrain, locations of existing and new roads. If required, include finished grades on a digital terrain model;
- Plans: Showing alignments of existing and new roads, access treatments, drainage structures, edges of pavement, roadside barriers and flares, clearing and grubbing limits, critical dimensions, cut/fill toes, utility conflicts, objects/items that are to be relocated or removed, fencing, and limits of construction;
- Ground profiles: Showing proposed grades, vertical curve data, horizontal alignment schematic, superelevation, existing and proposed culvert locations, surcharge and preload areas, and original ground profile;
- Typical sections drawings: Showing lane and shoulder widths, clear zone requirements, excavation and embankment slopes, stripping, and special treatments;
- Laning and geometrics (vertical and horizontal): Showing access movements, intersection movements, design vehicles (and turning templates), design speed, approaches and transitions, vertical clearances, and critical laning dimensions;
- Signage and pavement marking drawings: Showing new sign locations, schedule of signs required, sign removals and relocations;
- Construction staging drawings: Showing detours if required, any required cross-sections;
- Utility relocation drawings;
- Landscaping drawings: Showing verge treatments;
- Environmental drawings: Showing sensitive zones, limits and setbacks from environmental features, erosion and sedimentation control plans and details;
- Supporting design documents.

4.2.3. Design reports

Requirement: Provide a report including the following:

- Geotechnical field data;
- Noise studies;
- Environmental, cultural and archaeological studies;
- Development connectivity: Include details of links and place functions;
- Strategies for achieving target operating speeds.

Environmental impact statement: Include details of potential impacts and measures adopted for minimising the impact.

4.2.4. Design calculations

Calculations: Provide results and details of software used for relevant distance or curvature calculations. If friction is a factor in layout/geometry, note the pavement type assumed for surface conditions and noise minimisation.

Assumptions: Include any data used in the design calculation.

4.2.5. Specifications

Construction documentation: Prepare technical specifications using the AUS-SPEC Construction worksection templates from the National Classification System workgroups 02, 03, 11, 13.

4.2.6. Design certification

Certificate: Provide a signed and dated design certificate as evidence that a suitably qualified professional has reviewed all the design documents, including program and plans for the development, and can verify that the geometric road layout requirements for the development meet the Council and statutory requirements.

4.3. Work as Executed

4.3.1. Work as Executed documents

Work as Executed drawings: Provide an additional set of final construction drawings for the purpose of recording the work completed by the Contractor.

Work as Executed drawing format: ACAD .dwg and pdf.

Digital drawing/data format: ACAD .dwg.

4.3.2. Final certification of completed works

Following final inspection and approval of works by relevant Narrabri Shire Council officer.

5. Annexure

5.1. Annexure – Referenced Documents

The following documents are incorporated into this worksection by reference:

AS 1742		Manual of uniform traffic control devices
AS 1742.13	2009	Local area traffic management
AS 2890		Parking facilities
AS/NZS 2890.1	2004	Off-street car parking
AS/NZS 2890.2	2018	Off-street commercial vehicle facilities
AS 2890.5	2020	On-street parking
AS/NZS 2890.6	2009	Off-street parking for people with disabilities
AS/NZS 3845		Road safety barrier systems and devices
AS/NZS 3845.1	2015	Road safety barrier systems
ATAP Guidelines		Australian Transport Assessment and Planning (ATAP) Guidelines
Austroads AGRD		Guide to Road Design
Austroads AGRD01	2021	Objectives of Road Design
Austroads AGRD03	2016	Geometric Design
Austroads AGRD04	2017	Intersections and Crossings - General
Austroads AGRD04A	2017	Unsignalised and Signalised Intersections
Austroads AGRD04B	2015	Roundabouts
Austroads AGRD06	2022	Roadside Design, Safety and Barriers
Austroads AGRD06A	2017	Pedestrian and Cyclist Paths
Austroads AGRD06B	2015	Roadside Environment
Austroads AGTM		Guide to traffic management
Austroads AGTM03	2020	Transport Study and Analysis Methods
Austroads AGTM04	2020	Network Management Strategies
Austroads AGTM05	2020	Link Management
Austroads AGTM06	2020	Intersections, Interchanges and Crossings Management
Austroads AGTM07	2020	Activity Centre Transport Management
Austroads AGTM08	2020	Local Street Management
Austroads AGTM11	2020	Parking Management Techniques

Austroads AGTM12	2020	Integrated Transport Assessments for Developments
Austroads AP-C87	2015	Austroads Glossary of Terms
Austroads AP-G34	2013	Austroads Design Vehicles and Turning Path Templates
AUS Gov Act No. 135	1992	Disability Discrimination Act
SOCC Guide	2018	Guide to Codes and Practices for Streets Opening