Auckland Transport
An Auckland Council Organisation

7 Road Layout and Geometric Design

7.1 Introduction

The purpose of this chapter is to provide some general commentary around the geometric design of roads and intersections based on the Auckland context. Geometric design in New Zealand is based on the current Austroads standards (Austroads: Guide to Road Design 2009) and the various other documents referenced in *ATCOP Chapter 1*. These documents should be used as the initial reference points in understanding the geometrics and layout of the road.

In certain situations, the standards may not be the best option and therefore deviations from the standards are allowed as long as they are clearly documented and follow the departure from standards section contained in *ATCOP Chapter 1*.

While this chapter does not intend to re-write the current standards it does provide limitations on certain aspects of design and these are contained in the various sections below.

7.2 Design Speed / Operating Speed

The design speed of a road is the maximum speed that a vehicle can safely travel on that road under perfect conditions. It is based on the road classification, the conditions of the road itself, and the conditions of the surrounding land. Other factors are also taken into consideration such as the maximum speed allowed by law.

While the design speed is created for safety, it is important to remember that this speed is only safe under perfect conditions. Heavy traffic and bad weather affect how fast a driver can safely travel along a given road.

When deciding on the design speed for a road, many factors must be taken into account besides the condition of the road itself. If the road tends to have a high volume of traffic, the speed is adjusted to take that into account. The actual operating speed of the road is also considered. Actual operating speed is how fast traffic generally drives, regardless of what the legal speed limit is for the road.

When considering the design speed for a road, the classification of the road is taken into consideration. AT's Road Classification is provided in *ATCOP Chapter 4*. Local roads are those travelled by the local traffic on a day-to-day basis and generally have a lower speed limit. Arterial roads have the fastest speed and are designed for drivers covering a long distance. Collector roads are designed to connect local roads with arterial roads and have a speed that falls somewhere in the middle.

Design speed does not cover all vehicles on the road. Cars, for example, can travel faster than tractor-trailers. Often signs state the maximum speed limit for cars and may list a slower speed for tractor-trailers. This is especially common in areas with steep hills or sharp curves and this should be taken into account when designing the road - so that slower, larger vehicles can be easily overtaken by faster, smaller vehicles without endangering other road users.

In order to determine the correct design speed for a road, it is a requirement that rigorous estimates of the 85th percentile vehicle operating speed for each section of the road are obtained. Such determination can be made by direct measurement of speeds on the existing road or as an estimate for new roads based upon the expected use of the road and its location within the existing network.

Roads need geometric consistency to allow for all sections of the road to tie in and for drivers to negotiate them safely. It is important to ensure that the 85th percentile operating speed of the road across all sections is less than or equal to the expected design speed of the road. However, if due to geographical constraints the combination of alignments and environment cause the operating speed to vary along the road, the design speed has to change in accordingly. These changes in speed (reduction or increase) need to be consistent with normal driver expectations and capability. It is unwise to have sudden adverse changes as drivers will not be able to react in time.

Section 3 of the Austroads 2010 Guide to Road Design Part 3: Geometric Design manual contains detailed design information on the assessment of the 85th percentile speeds and how it can be calculated for rural and urban environments, and gives further advice for high speed, medium speed and low speed roads within these environments.

It is important to undertake an assessment of the 85th percentile for all projects that incorporate safety schemes or local traffic management schemes.

It is critical that designers understand the interaction between operating speeds on a road and the requirements for visibility and stopping distances when proposing infrastructure that might interact with vehicles.

7.3 Safe Visibility & Sight Distances

The term 'Sight Distance' refers to the clear unobstructed distance measured from a driver to an obstacle or between two drivers in their respective lanes of travel.

Sight Distance is a calculable concept that is related to the geometry of the road, vehicle assumptions, driver behaviour and perceived hazards, most commonly other vehicles or objects that would cause a driver to consider making evasive manoeuvres.

7.3.1 Design Philosophy

Austroads 2010, Guide to Road Design Part 3: Geometric Design; Chapter 5 & Austroads 2010, Guide to Road Design Part 4A: Unsignalised and Signalised Intersections; Chapter 3 describes the various Sight Distances that are normally considered on any road. These Sight Distances are listed below:

- Stopping Sight Distance of cars and trucks;
- Sight distances on horizontal curves;
- Sight distances on horizontal curves with roadside obstructions;
- Overtaking sight distances;
- Manoeuvre sight distances;
- Intermediate sight distance;
- Headlight sight distance; and
- Horizontal curve perception sight distance.
- Approach Sight Distance;
- Safe Intersection Sight Distance;
- Minimum Sight Distance

It is important to realise that more than one of these principles will apply on any length of road and that the designer must exercise careful judgment in determining which of them are applicable in the given situation.

Safe and efficient operation of the road network is achieved by having sufficient and suitable sight distances to allow drivers to perceive and react to any change in condition on the road. Traditionally it was considered that a driver's sight line should be as long as possible to allow the driver time to react to events in a safe manner, however recent thinking has shown that in some cases it is desirable to reduce the visibility to reduce the prevailing speed (TRL Report 661, UK) and when combined with a reduced carriageway width this can promote a slower driving speed.

7.3.2 Sight Distance Design Parameters

The calculation of Sight Distances is carried out using the formulas described in Austroads Guide to Road Design Part 3: Geometric Design: Chapter 5. These formulas generate a sight distance that is based upon road surface friction and vehicle deceleration along with a perception-reaction time. It is important when considering the application of this formula that the road surface coefficient of friction has either been calculated and/or specified and that the correct design vehicle has been considered – as these two factors greatly influence the Sight Distance requirements.

It is important to note that designing the street geometry based upon braking in an emergency is not recommended.

7.3.3 Sight Distance Requirements

7.3.3.1 *Sight Distance at Priority Intersections*

The sight distance requirements for the approach to a priority junction are defined in Austroads Part 4A as the 'Approach Sight Distance' (ASD) on the minor arm and the 'Safe Intersection Sight Distance' (SISD) on 5.2.10.2 the major arm. ASD and SISD are derived from the same equations used to describe stopping sight distance with the exception that an observation time is built in to the perception–reaction section of the SISD formula.

Using the principle that the minor arm must give way to the major arm, we derive a visibility splay that extends an average of 5m into the minor arm (minimum 3m) from a distance of 44m (x distance) for a speed of 50kph. The x distance will vary depending on the approach speed of the road.

Areas within this visibility envelope are to be kept clear of obstructions and any vegetation is to be maintained at a height no greater than 600mm above ground level.

7.3.3.2 *Sight Distance at Signal Controlled Intersections*

ATCOP Section 7.11 Intersection Designs and Types has further information on intersection inter-visibility and signal head visibility.

7.4 Standard Road configuration

7.4.1 Road Reserve / Public Right of Way

The term 'ROAD' is the legal name given to the strip of publicly owned land between abutting property boundaries, specifically gazetted and vested for the purpose of becoming a road. It generally includes the carriageway, as well as footpaths and verges / berms.

Sometimes, however, a lane or shared path can be owned and maintained by the local road controlling authority but is not used by motor vehicles. In this instance, the route is generally considered to be a public right of way, with similar rules and controls as a standard road reserve. Any new designs for right of ways that are to be vested to Auckland Council shall be to the standards laid out in the Auckland Transport Code of Practice.

7.4.2 Road Reserve Cross Section

The road reserve is made up of a number of different elements that form the overall cross section. These elements include the following items: Berms (may include service trenches), footways and carriageways (split in to various lane configurations and might include a flush/solid median).

The road reserve width is the combined width of all the different elements and can often include additional unused width for future capacity upgrades.

If any proposed carriageway is less than 6.5 metres it will be deemed to be a narrow street. If the carriageway is narrower than 6.5 metres then parking may be restricted to only one side of the road at the judgement of Auckland Transport's traffic engineer where there are demonstrable operational or safety issues.

In the past different previous legacy councils had different minimum road reserve width requirements for different classes of roads. Auckland Transport is in the process of re-evaluating these with a view to a consistent approach to this across the Auckland region. Further details will be provided in due course.

Typical road cross sections are shown on Plan No's GD001 – GD004.

7.4.3 Lane Widths

Lane widths should be suitable for the road classification and expected traffic volumes and are generally between 2.7 – 4.0m in width. A regional arterial is likely to have a high movement function and therefore the lanes should be designed to allow for vehicles to move freely with increased safety while a local road is more focused on the residents and families that use the area to walk and play and so the lane configuration should ideally be one that creates a slower environment with the use of parked vehicles and smaller lane widths.

Table 16 Lane widths by Road Classification lists the ideal widths to be used in proposed designs; however it is down to the designer to be able to justify the width selected for the design.

Table 16: Lane Widths by Road Classification

Road classification	Lane Width	Notes
Primary Arterial	3.5m desirable 3.0m minimum	The minimum width shown can only be used when not on a bus or heavy freight route.
Secondary Arterial	3.5m desirable 3.0m minimum	The minimum width shown can only be used when not on a bus or heavy freight route.
Collector	3.0m desirable 4.0m maximum	The maximum lane width should only be specified when the collector road is used extensively by buses or for freight movement.
Local Roads	2.7m minimum 3.0m maximum	

Where the road is shown as a bus route in the Regional Public Transport Plan, these lane widths may be required to be larger to accommodate the movement of buses. Early discussions with AT's Operations Division must be undertaken to ensure that bus movements are understood and suitably provided for.

7.4.4 Special Vehicle Lanes

Special vehicle lanes are lanes that have a defined usage and accessibility to a limited number of vehicles. The special lanes that are currently in use in Auckland are described in more detail in *ATCOP Chapter 5 Special Routes and Road Elements*.

7.4.5 Cycle Facilities

The provision of suitable cycling facilities is an important design decision. When undertaking improvements on roads that are shown as cycle routes on the Auckland Cycle Network, suitable facilities should be included during the design stages to ensure that cyclists are catered for. This can be through the provision of cycle lanes, shared paths, cycling facilities or devices that promote a safe cycling environment.

Further cycling design guidance can be found in *ATCOP Chapter 5 Section 5.2 Cycle Routes and Chapter 13 Cycling Infrastructure Design*.

7.4.6 Parking

Kerb side parking can be provided within the road reserve in different configurations to suit the intended function of the parking and to provide side friction in slower speed environments. It is important that the allocated parking space is suitable for the average vehicle in Auckland.

Parking can either be parallel to the direction of travel or perpendicular to the kerb.

Parking standards applied to on-street car parks or Auckland Transport owned car parks are considered in more detail in *ATCOP Chapter 11 Parking* including turning tracks and the appropriate dimensions.

7.4.7 Traffic Islands

Traffic islands are a solid or painted object in the road that channelizes traffic, and can create safe zones for turning vehicles or crossing pedestrians. It can also be a narrow strip of island between roads that intersect at an acute angle. If the island uses road markings only, without raised kerbs or other physical obstructions, it is called a painted island. Traffic islands can be used to reduce the speed of cars driving through.

Some traffic islands may serve as refuge islands for pedestrians. Traffic islands are often used at partially blind intersections on back-streets to prevent cars from cutting a corner with potentially dangerous results, or to prevent some movements totally, for traffic safety or traffic calming reasons.

It is important that parking is restricted on the approaches and exits of traffic islands to ensure that the road space is not compromised by parked vehicles. "No Stopping At Any

Time" road markings should be marked on the road at least 4.6m before and after the island.

Kerbs used to create traffic islands must be keyed in to the road surface by 60mm in order that lateral shift on impact cannot occur.

Traffic islands must have directional arrows placed at either end and the kerbs must be painted with white reflective paint for visibility.

Standard details are shown on Plan No. GD007.

7.4.8 Medians

Flush medians are used to segregate traffic while still allowing vehicles the ability to turn right into side streets and properties without slowing the flow of vehicles. The drawback of flush medians is that they can often lead to higher speeds as the effect of side friction is no longer present and as such careful consideration of their use needs to be undertaken.

The width of a flush median is dependent on the environment in which it is to be used. Table 17 outlines when a flush median could be used.

Table 17: Flush Median Classifications

Road classification	Flush Median Width	Notes
Primary Arterial	2.5m minimum 3.0m desirable	Flush medians must be provided on all routes unless a raised median is merited.
Secondary Arterial	2.5m minimum 3.0m desirable	Flush medians should be designed for average width vehicles and should be wide enough to allow vehicles to wait without fear of being hit.
Collector	2.0m	Flush medians should be provided only in roads which have significant safety concerns or high volumes of through-traffic.
Local Roads	0.00m	Flush medians are not recommended for use on the local road network.

Where a flush median is being installed to assist with turning movements, a minimum width of 2.5m is required to safely accommodate the turning vehicle.

Raised medians are means of segregating opposing traffic lanes with the purpose of improving safety and increasing traffic flows. This is achieved by the removal of the ability for vehicles to turn right into or out of side roads/private access and restricting access to concentrated points along the route.

The minimum width of raised medians on Primary Arterials is 2.5m and the minimum width of raised medians on Secondary Arterials is 1.0m. Raised medians are not recommended on the Collector and Local Road Network.

A raised median can also be constructed within a flush median should additional protection be required.

Raised medians can also accommodate pedestrian crossing points but care must be taken to ensure that the width is appropriate for the expected volumes of pedestrians and the depth can accommodate prams and push chairs. Further design advice can be found in *ATCOP Section 12.13 Pedestrian Refuge Islands* when designing a raised median to allow for pedestrians to cross.

It is important to note that a raised median can also limit turning movements in situations where the turning vehicle might be crossing multiple lanes, although consideration must be given to alternative routes for those wanting to turn right.

7.4.9 Road Shoulders

The road shoulder is an extension of the carriageway of a minimum of 0.5m which provides structural support to the sealed road. It is generally insufficient to be used for drivers to regain control and is therefore often used in conjunction with a 'clear zone', especially those roads with higher speeds than in the urban environment.

Table 18 outlines the acceptable widths and the situations in which they can be used:

Table 18: Acceptable Road Shoulder Widths and Situations

Shoulder Width (m)	Situation
0.5 – 1.0	Only be used on low volume rural roads and pavement overlays / rehabilitations.
1.0m	The minimum width adjacent to a safety barrier and the desirable minimum for most situations.
1.5m	The normal width for a sealed shoulder
2.0 – 2.5m	For use on higher speed /volume roads, particularly where there is a need for vehicles to be able to stop outside of the running lanes.

It is important to note that in the urban environment road shoulders should not be provided on any road unless it can be demonstrated that there is a very good safety reason to provide it.

If parking is to be allowed in the shoulder, it should be designed such that the minimum safe zone clearances are still maintained outside of the parked vehicles.

7.4.10 Footpaths and berms

Footpaths should be provided on all roads in accordance with the Footpath and Walking Guidelines (PDF 119KB) available via the embedded hyperlink.

Footpaths must be designed in accordance with *ATCOP Chapter 12 Footpaths and Pedestrian Facilities*.

A berm (or verge) may be provided on adjacent to footpaths on roads outside town centres. The purpose of the berm is to provide an easily accessible area adjacent to the carriageway to carry the utility services.

Typical details of the common berm make up and the position of utilities within the berm area are shown in Plan No.GD005 and should be planted in accordance with *ATCOP Chapter 14 Landscaping.*

A berm should not be provided where there is significant pedestrian movement, instead the total width between the carriageway and road reserve should be allocated to increased footpath widths.

7.4.11 Clear Zones

Clear Zones are an area designed to allow errant vehicles (driver error, vehicle failure or environmental conditions) to attempt to regain control if they leave the carriageway. It is an area kept free of obstacles unless they are frangible and can break or collapse on impact.

Clear Zones are measured from the outside edge of the lane and includes any verges, batters, footpaths adjacent to it. The required width is related to site specific conditions and is set out in the NZTA State Highway Geometric Design Manual Part 6, section 6.5 The Clear Zone.

It is a requirement that all rural roads have a clear zone in accordance with the NZTA State Highway Design Manual.

Whilst most urban roads do not require a clear zone, in some circumstances where there are high volumes, higher speeds or a history of accidents and vehicles leaving the carriageway it is recommended that a clear zone be investigated as part of any improvements to the road, however the implementation of such a zone should be a last resort and only considered if there are no other practical alternatives.

7.5 Geometric Alignment

7.5.1 Introduction

The geometric alignment of a road is a critical component of the overall design of a road. The geometric alignment should allow for the safe and economic passage of vehicles and pedestrians within context of the intended use. The use of roads varies significantly from Motorways (providing a strategic movement function) to shared surfaces (facilitating more of an access and 'place' function).

At a national level there are two main documents which are used in the geometric design of roads, Austroads Guide to Road Design – Part 3: Geometric Design, which defines the general principles of the geometric design of roads and NZS4404:2010 "Land Development and Subdivision Infrastructure", which takes a more holistic view where a greater emphasis is placed on land use.

This section of the ATCOP draws heavily on these two reference documents, and departs from their principles only when there are specific needs determined by local conditions, experience or policies.

Table 19 shows how these two main reference documents relate to Road Category and Classification:

Table 19: Road Category and Classification

Category	Road Classification	Function in Road Network	Reference document
A	Arterials: Motorways Strategic Primary Secondary	Strategic Movement	Austroads "Guide to Road Design–Part 3: Geometric design"
B	Non Arterials: Collectors Local Streets Cul-de-sacs Lanes/Service Lanes Shared Zones/Spaces	Access and Place	NZS4404:2010 "Land Development and Subdivision Infrastructure"

Arterials have an important strategic movement function and focus. Collectors and Local Streets have a combined movement/access function. Lanes/Service Lanes and Shared Zones/Spaces have an access/place emphasis. These classifications, however, are not prescriptive. For example, it is not unusual to find some roads classified as Arterials to have extensive frontage development.

7.5.2 Design Vehicles & Swept Path Analysis

Design vehicles and guidance for running tracking curves should be taken from RTS 18, New Zealand on-road tracking curves for heavy motor vehicles.

Swept path analyses are to be run using a design speed appropriate to the manoeuvre, and it is not acceptable to use the setting that permits steering whilst the vehicle is stationary.

The following road classifications / design vehicles must be used at all times, unless it can be demonstrated that a different swept path will work:

- The standard design car for swept path analysis must be the 85%ile car as described in Plan No.GD022. This applies for all roads classifications, on street car parking and off street car parking;
- All arterial road / intersections must be designed to accommodate an 18.0m semi-trailer or articulated truck;
- All urban collector roads / intersections must be designed to accommodate a 12.6m tour coach;
- All rural collector roads / intersections must be designed to accommodate an 18.0m semi-trailer or articulated truck; and
- All local streets must be designed to accommodate 8.0m medium rigid trucks.

Where the road or route is used as a bus route, Auckland Transport's Operations Division must be contacted to confirm the appropriate maximum bus size for swept path analysis.

7.5.3 Vertical Alignment

For Roads in Category A, the design of the Vertical Alignment must be in accordance with Austroads Guide to Road Design – Part 3: Geometric Design.

For Roads in Category B, the design of the Vertical Alignment must be in accordance with NZS4404:2010. Where traffic calming measures are required to achieve the Target Speed - see ATCOP Chapter 6 Traffic Calming and NZS4404:2010 Section 3.5 for details.

Departure from the above design approach is subject to approval as per the Engineering approval and departure from standard process as defined in *ATCOP Chapter 1*.

7.5.4 Horizontal Alignment

For Category A Roads, the design of the Horizontal Alignment must be in accordance with the Austroads Guide to Road Design – Part 3: Geometric Design.Horizontal curves in 50 kph zones may be circular, with a minimum centreline radius of 80m for all industrial and collector roads.

For local roads of less than 2,000 vehicles per day the radius may be reduced progressively to a minimum of 15m on roads with less than 300 vehicles per day (vpd).

On roads which may have a higher speed limit in the future, and subject to the agreement of Auckland Transport, the Designer may introduce transition curves applicable to the higher speed limit.

Transition curves must be calculated in accordance with the Austroads Guide to Road Design – Part 3: Geometric Design. Transition curves will not normally be required for local roads apart from the aforementioned situation.

For Category B Roads, in addition to the above design approach, the horizontal alignment may form part of the traffic calming measures used to achieve the target speed. See *ATCOP Chapter 8* and NZS4404:2010 Section 3.5 for details.

7.5.5 Cul-de-sac Geometry

Cul-de-sacs should be avoided when designing for the road network. In situations where cul-de-sacs are to be included, pedestrian and cyclist access ways shall be considered and included where possible to improve the permeability of the transport network.

If cul-de-sacs are required then they must be provided in accordance with Plan No.GD006 and must provide for landscaping and car parking as required by any resource consent. All cul-de-sac heads require a detailed design showing levels and dimensions and must include pedestrian and cyclist access ways.

7.5.6 Longitudinal Gradients

The volume and extent of earthworks in developments is influenced by the maximum and minimum gradients adopted.

The minimum acceptable longitudinal gradient is based on acceptable road drainage criteria – refer to *ATCOP Chapter 17 Road Drainage*.

For Category A Roads, gradients should not be steeper than 12.5%.

For Category A Roads fronting on Industrial or Commercial Zones the maximum gradient should not be above 8%.

For Category B Roads the requirements are prescribed in NZS 4404:2010 Land Development and Subdivision Infrastructure Table 3.2.

Departure from the above design approach is subject to the approval of Auckland Transport

7.6 Camber, Cross-fall and Super-elevation

7.6.1 Introduction

In addition to longitudinal fall, transverse fall is also used to carry rainfall from the road surface to the edge or edges of the road. Without this, standing water can cause aquaplaning problems and in colder climates the formation of ice on the road surface.

The terms cross-fall and camber are used to describe the application of fall across the width of a road for the purpose of removing water from the surface of the road. Cross-fall is used to describe the situation where the surface water is conveyed to one side of the road and, camber is used to describe where surface water is conveyed from the centre of the road to the edge of the road. A road with camber is often referred to as having a “balanced carriageway”. Camber is not a straight fall but rather an upward curve from the edge of a road towards the centre, and this shape aids the formation of a smooth surface when rolling during construction of the pavement. The construction of cross-fall follows the same principle. The term transverse gradient is commonly used to specify the transverse fall used in forming a camber or cross-fall. The amount of upward curvature is rarely specified and most geometric modelling software has no provision for doing so.

The term super-elevation is often incorrectly used to describe cross-fall, and the term should only be used to describe the application of transverse fall for the purposed of safety and passenger comfort when incorporated in the design to assist vehicular passage through bends in the horizontal alignment, by converting some of the sideways centrifugal forces in to a vertical component. The incorporation of super-elevation should always be accompanied by transition curves, before and after the section of super-elevation.

7.6.2 Design Considerations

7.6.2.1 *Cambers and Cross-falls*

Because of Auckland’s higher than average rainfall – minimum transverse gradients of 3% towards the outer edge of the road should normally be used on all sealed roads. However, where existing features mean that this cannot be attained, the camber or cross-fall may vary between 2% and 4%.

Similarly, minimum transverse gradients of 4% towards the outer edge of the road should normally be used on all unsealed roads.

The corresponding maximum transverse gradients are 5% for sealed roads and 6% for unsealed roads respectively.

The use of transverse gradients in excess of the above may only be considered with the approval of Auckland Transport.

At intersections, the camber of the major road should take priority and the minor road should be designed so that it grades in to the channel line of the major road.

The use of adverse camber or adverse cross-fall is not to be permitted under any circumstances.

7.6.2.2 *Super-elevation*

Super-elevation must be applied in accordance with the Austroads guide to Road Design Part 3: Geometric Design Section 7.7 Super-elevation.

The maximum super-elevation should be limited to 5% in areas where pedestrian movements are prevalent.

Super-elevation on curves is required where the longitudinal gradient is steeper than 8% to achieve the design speed for the road unless otherwise indicated by Auckland Transport.

7.7 Kerb & Channel

7.7.1 Purpose of the Kerb and channel

The primary purpose of a kerb and channel is to provide:

- Storm water control;
- An edge restraint for the pavement;
- A visual definition of the edge of the carriageway; and
- A barrier to prevent vehicles crossing onto the footpath or berm.

Any alternatives to kerbs and channels will need to meet the above criteria.

AT Kerb and Channel Guidelines

It is essential that the *AT Kerb and Channel Guidelines* (PDF 71KB) are read via the embedded hyperlink before reading the rest of this section.

7.7.2 Design Requirements

7.7.2.1 *Urban Roads*

Kerbs and channels/stubs must be provided on both sides of the full length of all urban carriageways in accordance with the *AT Kerb and Channel Guidelines* and the appropriate standard details for the function of the road contained in Plan No's. GD007 to GD015.

At pram crossings, the kerb must form a V-shaped channel with raked sections at either side. A flush transition with no lip must be provided between the footpath and the channel. The detailing of pram crossings is dealt with in more detail in *ATCOP Chapter 12 Footpaths and Pedestrian Facilities.*

7.7.2.2 Kerb Extensions and Indentations

Kerbs will be parallel to the centreline of the road unless where the road width changes, during which there will be a transitional angle that is not parallel. However kerb extensions and bays may be formed to provide:

- pedestrian crossing points;
- local area traffic management;
- parking bays;
- amenity planting areas;
- bus kerb extensions & inset bays; or
- swales or other storm water control devices.

Care needs to be taken in the design of kerb extensions so that they do not cause hazards for road users and particularly for cyclists. Particular attention must be paid to road marking, signage and lighting.

7.7.2.3 Rural Roads

In accordance with the AT Governing Principle on Kerb and Channel, kerbs and channels will generally only be required in rural areas in the following situations:

- where grades are steeper than 1 in 8;
- in cuttings to minimise earthworks;
- in areas of potential instability;
- to direct water to suitable discharge points; or
- at signed or marked bus stops to provide a platform to assist bus passengers to board or alight from a bus.

7.8 Vehicle Crossings

This section is subject to changes pending Auckland Unitary Plan outcomes.

Vehicle crossings are the way in which motor vehicles can enter and exit land adjacent to the road boundary and are located between the edge of the carriageway and the road boundary and cross any footpaths or berms in that location.

Vehicle crossings may be required as part of a resource consent approval or due to alterations to the existing road network.

Vehicle crossings should be located such that drivers entering and leaving have adequate sight distances along the adjacent road and that turning radii should be optimized to produce the minimum turning speeds and swept paths that are appropriate for the road environment. For example, in local roads the swept paths should be as tight as possible to reduce vehicle entry speeds.

The appropriate urban driveway designs are shown in Plan No's. GD017, GD018 and GD019 and the rural driveway design is shown in Plan No. GD020. The naming and details have been matched with the Unitary Plan to allow for easy reference. Any departures from these standards should be in accordance with the design process laid out in *ATCOP Chapter 1*.

Whilst the drawing indicate minimum and maximum values, it is important that a driveway crossing is no wider at the boundary that it needs to be, for example a two way driveway in a residential zone that is 4.0m wide will require the crossing to be 4.0m at the boundary but a 3.0m one way access in a central/mixed use zone may only need to be 3.0m wide.

The vehicle crossing and driveway must be considered to be subservient to the pedestrian through route, where the pedestrian path is continuous in grade, cross-fall, colour and texture across the driveway, with no tactile warning indicators.

Where the vehicle crossing is in a rural environment no silt, gravel or debris of any kind shall be able to run from the property on to the roadway or into drains.

The driveway should ramp down from the footpath across the kerb line to the channel lip with a free board of 200mm (i.e. height above the channel) to contain storm water within the road.

If a vehicle crossover is made redundant by the alteration to land adjacent to the road boundary, it should be requested that the property owner give up the licence or permit associated to the crossover and that it be replaced to match the existing footpaths and kerbs.

Driveway designs should take all reasonable measures to reduce the requirement for retaining structures or level adjustments, however should this be considered too onerous then any proposed structure shall be subject to an encroachment notice and all future maintenance, renewal, removal costs etc. are borne by the property owner and places as an encumbrance on the property file.

Vehicle crossings shall not compromise the design criteria for footpaths, either existing or proposed. Consideration shall also be given to the grade of the driveway to help prevent vehicles scraping and stormwater entering in the driveway. Plan No.GD021 gives a template that might be used to ensure most but not necessarily all vehicles will be able to use a crossing safely.

Any private driveways are to be detailed in accordance with Unitary Plan requirements which further details on the appropriate grades for private driveways.

Where grassed swales or Bio filtration strips are used for stormwater control in the road, grated channels or pipe culverts may be constructed across the driveways to cross Swales/Bio filtration strips. The driveway crossing shall have edge protection to prevent drivers from going over the edge of the channel / culvert. A concrete edging shall be provided on the edge of seal and an appropriate surface to allow all weather access to the property. Minimum width of grated channel and the minimum diameter of the pipe shall be 150mm and 200mm respectively. Site specific design for the crossing of Swale / Biofiltration strips and driveway should be provided considering storm water management issues and site conditions.

Development or redevelopment of a vehicle crossing must not result in changing the flow of surface water in the roadway, unless alternative drainage is provided. Care should be taken to avoid flow from the roadway discharging into property where it does not currently do so, or from adjoining land into the roadway. Where surface water discharges form the roadway onto adjoining land as overland flow, this must not be reduced or redirected to another property.

7.9 Designing for pedestrian access

7.9.1 Pedestrian Access ways

A pedestrian connection will generally be required where it would provide a significantly shorter walking route between roads or from a road to a reserve, shopping centre, community facility or a bus route.

Pedestrian connections should generally be provided within roads; that is, as part of a full road connection. Where a road connection would not be entirely necessary for traffic circulation, it will often still be required where a pedestrian connection is necessary.

7.9.2 Access way Locations

Pedestrian facilities should generally be an integral part of a road. Pedestrian access ways provide links where there is no road and should be considered at:

- cul-de-sac heads to provide a link to an adjacent road;
- parks and reserves where part of that reserve has no road frontage;
- schools and other community facilities where part of that facility has no road frontage; and
- Any other location where the trip by road would be considerably longer than ‘as the crow flies’.

Where a road connection would not be entirely necessary for traffic circulation, a pedestrian and cycle connection will often still be required to provide access for these active modes. Acceptance of a pedestrian and cycle only connection may be approved where AT concludes that provision of a road is not reasonable or cannot physically be constructed.

Where a pedestrian access way has been determined as being required, the design should provide sufficient signage opposite the entrance to the access way, for example, attached to a street light column or on a separate sign post.

Examples of appropriate signing of a pedestrian access way are shown in the above photos

Refer to *ATCOP Section 5.4 Pedestrian Access Ways* for more details.

7.10 Designing for Town Centres / Low Speed Environments

One of the key design approaches outlined within *ATCOP Chapters 1 and 2* is the concept of creating streets which respond well to their context – the whole idea of designing for both place and movement. When designing streets within town centres and low speed environments we must seek to respond to the fact that the role of place is equally and, in some cases, more important than designing our streets solely for the movement of vehicles. Therefore we must begin to design our streets by using the full width of the street from building boundary to building boundary instead of simply designing between the kerbs. While it is essential to consider standard engineering and safety principles, the whole idea of place-making must also be given the important consideration it deserves in the development/redevelopment of our street environments. Utilising the Urban Design principles contained in *ATCOP Chapter 2 Integrated Transport Planning* and the amenity functions of the road described in *ATCOP Chapter 6 Streetscape Amenities,* we will now examine a set of principles which seek to further refine the concepts of making streets for people and not just for vehicles.

7.10.1 Place-making

The whole concept of place-making ensures that any new project must respond to its surroundings by attempting to incorporate planning, design and management of public spaces with the goal of creating places which prioritise the movement of people over vehicles. Place-making is of particular importance at the key entry and exit points of a town/village centre and also around intersections as well. The purpose of this approach is to try and create places along our vast network of streets and roads to help better define the proposal within its' surroundings and to assist in creating places that promote people's health, happiness, and well-being.

7.10.2 Low Speed Design

Traffic speed is without a doubt the single most important factor when it comes to the interaction of pedestrians, places and traffic. Within the boundaries of a town centre, the design speed should be such that the integration of pedestrian flows and other activities can be safely incorporated. This should be achieved through road and street designs that are self-enforcing by being easy to read by all users. Low speed design is of particular importance in shared spaces where there is a greater risk of pedestrian / vehicle interactions.

7.10.3 Gateways and Entry Points

A clear indicator of a change of priority can be presented through the use of gateway / entry features at the limits of the town centre. These features can be used to emphasise the change of priority and location and also the context of the higher speed roads with the lower speed environment of the town centre. Changes in physical dimensions, materials, lighting and street details can be combined to enhance the visibility of the gateway and to reinforce it to the users.

7.10.4 Street Furniture Clutter

The modern road environment is awash with a multitude of signs, poles and road markings. A successful town centre and slow speed environment is one that approaches street furniture with a view to minimising the installation of them. This often goes against the grain of traffic engineers but research is starting to show that simplicity, legibility and an easily maintainable urban environment encourages users to think and make rational and correct decisions.

7.10.5 Accessibility

Streetscapes should aim to provide simple and unobtrusive guidance and navigational clues to the users to maximise accessibility, particularly for those users that are elderly or vulnerable. Barrier-free designs should be the norm for town centres, with direct desire lines that avoid convoluted detours and diversions.

7.10.6 Lighting

An important component to the urban realm in any town centre is the use of quality night-time lighting. Lighting designs should aim to emphasise the place, with pedestrian-friendly white light and lower level pedestrian light fittings. Lighting should be used to enhance the streetscape, provide a safe and friendly environment in which to congregate and to enhance any particular buildings or landmarks. Refer to *ATCOP Chapter 19 Street Lighting* for further details.

7.10.7 Simplicity and Future-proofing

The town centre streetscape should attempt to develop a simple palette of durable materials that can be adapted and used to create an identity for the place. Street designs should address the future needs of the environment and avoid complex kerb build-outs and road alignments. Street furniture should remain simple but robust.

7.10.8 Local Area Traffic Management

Raised tables and intersections can be used to create informal crossing points, reinforce the slower speed of the place and to break up the monotony of the road. They can be used to create large quantities of safe crossing points, connecting pedestrians to both sides of the road with ease.

Not all of the principles may apply in all situations but they should provide enough steer that a suitable design can be developed.

Further design details for the implementation of Local Area Traffic Management can be found in *ATCOP Chapter 8 Traffic Calming Devices and LATM.*

7.11 Intersection Design & Types

Good intersection design is based on sound geometric design and traffic criteria with safety a primary consideration. The Austroads Guides provide a comprehensive set of design guidelines for all types of intersections and these shall be adhered to.

Of particular relevance are the:

- Guide to Road Design – Part 4, Intersections and Crossings
- Guide to Road Design – Part 3, Geometric Design
- Guide to Traffic Management – Part 6, Intersections, Interchanges and Crossings

Legislation for intersections in New Zealand is covered by the Land Transport Rule: Traffic Control Devices 2004 (TCD Rule). Further requirements for signs and markings are provided in the TCD Manual (and relevant parts of MOTSAM contained in it).

7.11.1 General Principles

7.11.1.1 Design Approval

The designer must provide evidence supporting that the design will meet capacity, safety and turning movements of intended vehicles.

Traffic modelling must show that the design can mitigate the effects of traffic generation due to the development. Where applicable, consideration should be given for future network growth and development, with an appropriate design year or growth factor to be approved by Auckland Transport. The assessment could include intersection modelling using software such as SIDRA.

7.11.1.2 Kerb Radii

Kerb radii should be kept to a minimum (whist catering for an appropriate design vehicle), with a view to minimising vehicle speeds and pedestrian crossing distances.

7.11.1.3 Pram Crossings

Pram crossings must be provided at each kerb-line at all intersections in accordance with *ATCOP Section 12.8. Pram crossings* and RTS 14, and must be located to ensure adequate sight distances for both pedestrians and drivers. Pram crossings should generally be located to provide the shortest crossing distance, but also in a location where visibility is not restricted by buildings, walls or vegetation – to allow pedestrians to assess gaps in traffic and not diminish a driver's ability to stop safely if required. Tactile indicators must be provided at all pram crossings that lead to signal-controlled or 'Zebra' crossings.

7.11.1.4 Left Turn Slip Lanes

In an urban location left turn slip lanes should only be provided where there is clear traffic and/or safety justification, and should preferably be avoided in situations where there are high pedestrian volumes. If provided, a left turn slip lane must be designed with due consideration of pedestrian safety and convenience, and particular consideration should be given to provision of a zebra crossing to give priority to pedestrians. A raised table may be provided to emphasise the crossing and manage vehicle speeds.

7.11.1.5 Selection of Intersection Control

Each new or upgraded intersection should be evaluated in order to determine the most appropriate form of intersection control, as each site is unique. The type of control proposed for an intersection must be justified. When weighing up options for major intersections a robust assessment of all options is necessary, giving due consideration to effects on the wider road network.

Designers are referred to the Austroads Guide to Traffic Management Part 6 – Intersections, Interchanges and Crossings, which provides guidance relating to the factors that need to be considered in the selection of an appropriate type of intersection and in the functional design of intersections.

7.11.2 Priority Controlled Intersections

Priority controlled intersections must be designed in accordance with Austroads Guide to Road Design Part 4A: Unsignalised and Signalised Intersections.

7.11.2.1 Geometry

Sight distance at intersections must be to Austroads standards.

Intersections shall be sited such that the side road enters the through road at preferably 90° and generally no less than 80° at a location with adequate sight distance in both directions on the through road.

T-intersections must be offset, centreline to centreline, by at least 15m. Crossroad intersections on high speed roads are discouraged.

Intersections on curves, particularly where the side road is on the inside of the curve, should be avoided.

7.11.2.2 Sign Control

The requirements of the TCD Rule must be adhered under all circumstances. The design guidance of the TCD Manual, which currently includes the Manual of Traffic Signs and Markings

(MOTSAM) must be adhered to for priority intersections. Stop control must be provided where required and as directed in the above mentioned documents.

All intersections must be controlled by Stop or Give Way signs and markings as a minimum, with the following exception (note, this does not apply to rural situations);

- Where the priority road has less than 2000 vehicles per day and
- Where the adjoining road has less than 500 vehicles per day and
- Where the approach visibility meets Austroads safe intersection sight distance standards.

All crossroad intersections must have a Stop or Give Way control as a minimum.

7.11.3 Roundabouts

Roundabouts must be designed in accordance with;

- Austroads Guide to Road Design Part 4B: Roundabouts,
- NZTA Guidelines for marking multi-lane roundabouts http://www.nzta.govt.nz/resources/guidelines-marking-multi-roundabouts/index.html, and
- NZTA Manual of Traffic Signs and Markings.

Generally speaking, a well-designed roundabout is safer than other forms of intersection. This is particularly true in high speed environments, as roundabouts can be designed to ensure vehicle speeds are lowered through the intersection. However, cyclist safety and pedestrian amenity can be compromised at multi-lane roundabouts and these users demand special consideration. When designing roundabouts, extra care must be taken to ensure vehicle speeds are at or below 30km/h. If well implemented, roundabouts can be an appropriate form of control at urban arterial intersections, but a robust assessment of all options is necessary.

An appropriate design speed is critical to ensure safe operation of a roundabout. Current Austroads guidelines advise lowering entering speeds to match circulating speeds. Speed on the approach and exit of a roundabout is typically controlled by horizontal deflection, but in certain circumstances vertical deflection can be considered appropriate. Determination of the appropriate form of speed control is to be evaluated for each site.

The size of a roundabout has a significant role in capacity performance. Generally larger roundabout provide greater capacity. Roundabouts can be signalised or metered, to aid management of traffic flow, however, it may not be possible to retrospectively signalise some smaller roundabouts.

In town centre environments or near schools particular attention should be made to ensure crossing points are conservatively designed to take into account elderly, young and mobility and visually impaired users. These pedestrians may be less mobile and / or less able to judge traffic speed and driver intentions crossing points need to take these factors into consideration. Options for pedestrian crossing facilities at roundabout include;

- Pedestrian refuges
- Zebra crossings, if pedestrian demand warrants this treatment
- Signalised crossings
- Raised table crossing points. These help to minimise vehicle speeds and reduce the risk of crashes. Particular consideration should be given to providing raised table on multi-lane approaches and exits.

7.11.4 Traffic Signal Requirements

7.11.4.1 Design Approval

AT Traffic Systems Team in Road Corridor Operations has a role in guiding, reviewing and approving designs. The process for design, review and approval of a traffic signals design is documented in the Auckland TMU Traffic Signal Design Review Guidelines (PDF 317KB).

Any proposal for a signalised intersection must be provided for approval by the Manager Road Corridor Operations.

7.11.4.2 Key Reference Documents

The Auckland Transport Traffic Signal Specification covers the requirements of all signal equipment including; local signal controller and cabinet, detectors, lanterns, target boards, visors, poles and push button assemblies. This specification also covers the installation and commissioning of traffic signals, ducting and associated equipment including the supply of all materials, tools, plant, labour and supervision for the works in accordance with the contract specification and any relevant basis of payment.

Traffic signal controlled intersections must be designed in accordance with;

- Austroads Guide to Road Design Part 4A: Unsignalised and Signalised Intersections, and
- NZTA Manual of Traffic Signs and Markings, and
- National Traffic Signal Specification dated 1 September 2005; Revision 2 (PDF 65KB).

7.11.4.3 Auckland Transport Specification

In addition to the above key reference documents, Auckland Transport's specific requirements are currently based on the TMU Traffic Signal Design Guidelines dated August 2010 Version *3.0* (PDF 1MB).

with the following variations:

- Overhead Lanterns must be 300mm in diameter.
- Tactile indicators must be of yellow concrete tile construction.
- Warranty for new LED lanterns must be 5 years.
- Lantern Bodies can be of Aluminium or Polycarbonate construction.
- All new Traffic Signal Controllers must be RMS specification TSC4 compliant.
- All new traffic signals are to be provided with a communications link to SCATS.
- All new traffic signal controlled intersections will require a CCTV camera and associated equipment to connect to the Joint Traffic Operations Centre (JTOC).
- All new traffic signal controlled intersections will require an ADSL/VDSL connection to the Joint Traffic Operations Centre.
- All traffic signal poles must be painted, not powder coated.
- Finial Caps: metal construction is not acceptable.
- Finial Caps must be fastened so that they cannot be removed if fastening bolts are loose.
- Alignment is important and intersections must be sited such that the side road enters the through road preferably at 90° and generally no less than 80°.
- Pedestrian crossing facilities must be provided on each leg of intersections located in town centres, and should be provided on each leg in other situations.
- Pedestrian Countdown Timer lanterns are to be used at all Signalised mid-block crossings and any intersection operating an Exclusive or Barnes Dance pedestrian phase.

7.11.4.4 Guarantee Period

Any new equipment supplied and installed by the Contractor must be guaranteed by the Contractor against defective materials and workmanship for a period of 12 months from the date of installation, apart from LED Modules of Vehicle and Pedestrian Lanterns which must be guaranteed for a period of 5 years. The Guarantee must also cover the installation of the equipment supplied.

During the Guarantee period, the Contractor is responsible for making good any defects at no charge to Auckland Transport. Auckland Transport is entitled to recover from the Contractor any costs it incurs in rectifying faulty equipment, materials or installation during the Guarantee period.

The Contractor's Guarantee must not become invalid as a result of an alternative Contractor servicing the equipment supplied.

7.11.5 Grade Separation

Any proposal for a grade separated intersection shall be provided for approval by the Manager Investigation and Design as well as the Manager Road Corridor Operations.

Grade separated intersections shall be designed in accordance with Austroads Guide to Road Design Part 4C: Interchanges.

Grade separated intersections are occasionally necessary to provide adequate capacity at major intersections. This form of intersection provides maximum vehicle throughput and minimises vehicle delays, however, this can be at the expense of pedestrian and cyclist amenity.

7.11.6 References / Guidelines

- Austroads Guide to Road Design, in particular the following parts;
  - Guide to Road Design Part 3: Geometric Design
  - Guide to Road Design: Part 4 Intersections and Crossings – General
  - Guide to Road Design Part 4A: Unsignalised and Signalised Intersections
  - Guide to Road Design Part 4B: Roundabouts
- Austroads Guide to Traffic Management Part 6: Intersections, Interchanges and Crossings
- NZTA Manual of Traffic Signs and Markings (MOTSAM)
- NZTA Traffic Control Devices Manual (TCD Manual)
- NZTA Road and Traffic Standards Series parts;
  RTS 1 Control at Crossroads
  RTS 14 Guidelines for facilities for blind and - NZ Transport Agency
  RTS 18 New Zealand on-road tracking curves for heavy vehicles
- TMU Traffic Signal Design Guidelines dated August 2010 Version 3.0 (PDF 1MB) or later revision
- National Traffic Signal Specification (PDF 665KB), which is available via the embedded hyperlink.
- Transfund Road Safety Audit Procedures for Projects