SC6.4.4 Design specification and standard drawings

SC6.4.4.1 Geometric road design

SC6.4.4.1.1 Introduction

(1) Purpose

(a) This sub-section sets out the specifications developed specifically for the design of roads using principles of street design to ensure safety and improved amenity and to reduce pedestrian/vehicular conflicts.

(b) A fundamental requirement of the design process is for designers to determine the vehicle speed which is deemed acceptable for a particular subdivision or section of road.

(c) All relevant design principles must be integrated in the development of the road network, recognising the primary role of roads for transport function.

(d) The objective of road design is to recognise the carrying of through traffic.

(e) The objectives of street design are to recognise improving safety and security, increase vitality and interaction, reduce private motor vehicle dependence, improve development efficiency, provide valuable community space and retain economic activity in communities.

(2) Scope

(a) This specification must be read in conjunction with the IPWEAQ publication *Complete Streets: Guidelines for Urban Street Design*, with limited adoption in Townsville as follows:

(i) in areas with close nexus to CBD, and in areas where higher densities are encouraged and it can be demonstrated that there is high access and potential use of public transport, then a full adoption of *Complete Streets* while tying into existing road and street networks. For infill development and upgrades in these areas, development is to be in line with *Complete Streets* principles of pedestrian and cyclist friendly environments, encouraging developments that engage with active street frontages;

(ii) new, large, master planned developments are to adopt *Complete Streets*, although they will be required to recognise the particular role of public transport as an alternative to moving people between these sites and other areas of Townsville. Designs should emphasise pedestrian and cyclist movements, and allow for retrofitting of public transport options in the future, if and when they become viable;

(iii) other developments are to adopt updated cross-sections and road hierarchy, and apply priorities in line with *Complete Streets*, but layout is to be adapted to tie into existing road and street networks, recognising high car dependence, and lack of containment opportunities, where commercial centres, schools and retail facilities are not proposed within the development; and

(iv) curvilinear street designs are to be avoided wherever practical, with a focus on the grid structure in accordance with *Complete Streets and requirements of the Townsville City Plan.*

(3) Aims

A road system within a subdivision is to be designed so as to achieve the following aims:

(a) to provide convenient and safe access to all allotments for pedestrians, vehicles and cyclists;

(b) to provide safe, logical and hierarchical transport linkages with existing street system, including consideration of crime prevention in streets, bikeways and pathways;

(c) to provide appropriate access for buses, emergency and service vehicles;

(d) to provide both a permeable and legible street network;

(e) to provide for a quality product that minimises maintenance costs;

(f) to allow for public utilities;

(g) to provide an opportunity for visual amenity, e.g. street landscaping;

(h) to provide convenient parking for visitors;

(i) to provide connecting streets and places through permeable networks without any corresponding increase in vehicle speeds or "rat-runs"; and

(j) to have appropriate regard for the climate, geology and topography of the area.

(4) Terminology

For the purpose of this sub-section the definition of terms used to define the components of the road reserve must be in accordance with these AS 1348 terms.

Carriageway	that portion of the road or bridge devoted particularly to the use of vehicles, inclusive of shoulders and auxiliary lanes.
Footpath	the paved section of a pathway (verge).
Pathway	a public way reserved for the movement of pedestrians and of manually propelled vehicles.
Pavement	that portion of a carriageway placed above the subgrade for the support of, and to form a running surface for, vehicular traffic.
Shoulder	the portion of the carriageway beyond the traffic lanes and contiguous and flush with the surface of the pavement.
Verge	that part of the road reserve between the carriageway and the road reserve boundary. It may accommodate public utilities, footpaths, stormwater flows, street lighting poles and plantings.

(5) Reference and source documents

(a) Council specifications and drawings:
SC6.4 Development manual planning scheme policy - all specifications and drawings for design and construction.
SC6.4.3.13 Townsville road hierarchy

(b) Australian Standards, in particular:
AS 1348 - *Road and traffic engineering – Glossary of terms, Road design and construction*.
AS 1428 - *Design for access and mobility.*
AS 1742 - *Manual of uniform traffic control devices*.
AS 2890 - *Parking facilities.*
AS/NZS 3845 - *Road safety barrier systems.*

(c) QLD State Authorities:
Department of Transport and Main Roads *Accessible Regional Bus Stops Guidelines, 2008*
Department of Local Government and Planning, *Queensland Residential Design Guidelines, 1998*
Department of Transport and Main Roads, *Queensland Manual of Uniform Traffic Control Devices*,
Department of Transport and Main Roads, *Road Planning and Design Manual*
Department of Transport and Main Roads, *Queensland Transport's Interest in Planning Schemes, 2008*
Queensland Health (2006) *Issue Guidelines for Natural and Built Determinants of Health*

(d) Austroads:
Road Design – *Guide to Road Design*
Design vehicles and turning path templates
Traffic management: *Guide to Traffic Management*

(e) Other
Queensland Government, *Active Healthy Communities*
Queensland Government, *Crime Prevention through Environmental Design,*
Institute of Public Works Engineering Australia, Qld Division, *Complete Streets: Guidelines for Urban Street Design, 2010*

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

SC6.4.4.1.2 Consultation and planning

(1) Consultation

(a) Designers are encouraged to consult with the council and other relevant authorities prior to and during the preparation of the design. Designers should, in addition to requirements of this sub-section, ascertain the specific requirements of these authorities as they relate to the designs in hand.

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

(2) Planning concepts

(a) In new areas (as distinct from established areas with a pre-existing road pattern) each class of route should reflect its role in the street and road hierarchy by its visual appearance and related physical design standards. Routes should differ in alignment and design standard according to the volume of traffic they are intended to carry, the required traffic speed, adjoining land-uses, and other factors. All higher order road networks under Townsville City Council jurisdiction must comply with SC6.4.3.13 Townsville road hierarchy.

(b) The road network for residential developments should have clear legibility for all road users, particularly pedestrians and cyclists.

(c) The road network should reinforce legibility by providing sufficient differentiation between the road functions.

(d) Distinct existing landmark features such as watercourses, mature vegetation or ridge lines should be emphasised within the structural layout so as to enhance their legibility.

(e) Whilst legibility can be enhanced by introduced physical features such as pavement and lighting details, the road network should by its inherent design and functional distinction provide the necessary legibility and place making.

(f) The road network should provide for shortest reasonable access from any lot to the major road system for all pedestrian cyclists and vehicles.

(g) Speed regulation should be built in to the street geometry, to create an environment where drivers are actively discouraged from driving above the legislated/design speed. Speed control devices, often known as Local Area Traffic Management (LATM), are considered unnecessary for appropriately designed new streets and should only be used where no other solution is viable, due both to their capital and maintenance costs and possible intrusive nature. Side friction may be considered to assist with speed regulation where appropriate.

(h) Provide convenient and safe access to all allotments for all road users including pedestrians, cyclists, public transport users, garbage trucks and motorists. Priority of consideration in streets should be as per *Complete Streets.*

(i) Include adequate network considerations in the placement and design of safe pedestrian crossing facilities especially across roads and high volume streets.

SC6.4.4.1.3 Urban design criteria

(1) Road and street hierarchy

(a) A hierarchical road network is essential to maximise road safety, residential amenity and legibility. Each class of road in the network serves a distinct set of functions and is designed accordingly. The design should convey to motorists the predominant function of the road.

(b) Transport routes are divided into two distinct levels (refer to SC6.4.4.8 Standard drawings):

(i) streets; and

(ii) roads

(c) The lowest order of transport route (streets) have as their primary function to facilitate public interaction and movement through a place, village, town or city.

(i) Streets should be designed in accordance with the adjoining land uses.

(d) The highest order of transport route (Roads) should have as its main function the convenient and safe distribution of traffic and should be designed in accordance with the SC6.4.3.13 Townsville Road Hierarchy, Austroads and Department of Transport and Main Roads standards.

(2) Road network

(a) The design features of each type of road or street convey to the driver its primary functions and encourage appropriate driver behaviour.

(b) Traffic volumes and speeds on any road or street should be compatible with its adjoining land uses and function.

(c) The maximum length of a residential street should ensure its status as a residential place is retained, where the traffic, in terms of speed and volume will enable the integration of pedestrian, bicycle and vehicular movements. This length will also ensure that residential convenience is not unduly impaired as a result of speed restraints.

(d) The distance required for pedestrians, cyclists and drivers to travel between two points within the development should be minimised.

(e) Where local streets form part of a pedestrian or bicycle network, access links should provide suitable connectivity with adjoining local streets or open space systems so as to ensure such pedestrian and bicycle network are functionally efficient and safe.

(f) The road network should ensure that no road intersects with another road which is more than two levels higher or lower in the hierarchy. In exceptional circumstances roads may intersect with others that are more than two levels apart with council approval, however, no local street should have direct connection to an access-controlled arterial road.

(g) The road and street layout should conform to the requirements of the external road network and satisfy the transport provisions of an outline development plan.

(h) The external road network should be designed and located to provide routes which are more convenient for potential through traffic within the network. Major roads should be provided at intervals of no more than 1.5 km and should be complete and of adequate capacity to accommodate through network movements. The internal road system should not provide through routes that are more convenient than the external road network.

(i) The design of sub-arterial roads should achieve a context sensitive design by providing an acceptable balance between the level of service, safety, whole of life costs, flexibility for future upgrading or rehabilitation and environmental impact. Consequently, sub-arterial roads should provide a higher level of efficiency and safety with space for public transport, bicycle lanes and pedestrian facilities.

(j) Operations on sub-arterial roads must be in accordance with Austroads' *Guide to Road Design Part 2: Design Considerations,* taking into account:

(i) intersection spacing and control;

(ii) lane changing;

(iii) weaving;

(iv) merging;

(v) spacing of median openings;

(vi) reverse flow/tidal traffic control;

(vii) pedestrians;

(viii) cyclists;

(ix) parking (if permitted);

(x) transit lanes for buses and high occupancy vehicles (HOV);

(xi) provision for B-doubles and multi-combination vehicles;

(xii) provision for intelligent transport systems (ITS);

(xiii) bus stops;

(xiv) service roads;

(xv) driveway spacing and their distances from intersections (if permitted); and

(xvi) signage and line marking in accordance with Main Roads' *Manual of Uniform Traffic Control Devices* (MUTCD) and *Traffic and Road Use Management Manual* (TRUM).

(3) Design speed

(a) Design speed is generally used as the basic parameter in the specification of design standards, determining the minimum design value for other elements and is the 85th percentile maximum speed of traffic within the street. This is similar to the "Speed Environment" used in Austroads *Guide to Road Design*. Vehicular speeds are also limited by road intersections as well as changes in horizontal and vertical alignment.

(b) Adoption of a low design speed discourages speeding, however, where vertical or horizontal curves of low design speed are located in otherwise high speed sections (tangents) the result is a potentially dangerous section of road. Attention should be given to ensuring that potentially hazardous features are visible to the driver and adopting traffic engineering measures which will help a driver avoid errors of judgement.

(c) Design speed should allow for road characteristics such as:

(i) traffic volume;

(ii) width of carriageway;

(iii) grades; intersections;

(iv) the presence and spacing of consolidated property access;

(v) traffic characteristics; and

(vi) traffic composition (pedestrians, cyclists, public transport, passenger vehicles, heavy vehicles).

(d) The need for road safety barriers must be assessed and designed in accordance with SC6.4.6.25 Non-rigid road safety barrier system and AS/NZS 3845.

(4) Longitudinal gradient

(a) A general minimum gradient of 0.5 % should be adopted. In very flat conditions it may be reduced to 0.3% with council approval. Where underground drainage with gully pits or other special works are used it is preferable to allow near level grades rather than reverting to introduction of artificial undulations. Variable crossfall may be necessary to produce the required grade in the kerb and channel. The maximum longitudinal grade on any street should not exceed 12%, from consideration of pedestrian walking convenience.

(b) Grades over 8% must provide additional considerations for pedestrians, cyclists, public transport and heavy vehicles (e.g. garbage trucks, furniture vehicles) where appropriate. Exceptionally steep terrain may be allowed for very short lengths on steep streets of up to 16%. In these exceptional circumstances, the developer must demonstrate that alternate routes for pedestrians, bicycles and heavy vehicles are available.

(c) The longitudinal grade of the minor street on the approach to an intersection should not exceed 4% with sufficient length to accommodate a stationary single unit truck. Design of the road alignment and the grades used are interrelated. A steep grade on a minor side street is not acceptable if vehicles have to stand waiting for traffic in the major road.

(d) Turning circles in cul-de-sacs on steep grades should have grades less than 5%.

(5) Horizontal curves and tangent lengths

(a) The horizontal alignment of a road or street is normally in a series of tangents (straights) and curves which may be connected by transition curves. The choice of the horizontal alignment should be determined from the design speeds for a particular street, in particular the expected operating speeds and constraints of the developments adjacent to the road in accordance with Austroads' *Guide to Road*

Design Part 3: Geometric Design. Designers should ensure that, for a given design speed, the minimum radius of curvature utilised is such that drivers of all vehicles can safely negotiate the curve. Curves which progressively tighten and sudden reverse curves must be avoided.

(b) While horizontal alignment is one means of limiting vehicle speed, the greater of the following requirements must be complied with:

(i) minimum curve radius for a street - 10 m; or

(ii) minimum curve radius for a road in accordance with DTMR design standards.

(c) Carriageway widening applies to all standard carriageway widths. Widening should be applied to the inside kerb line of the carriageway, in accordance with Austroads' *Guide to Road Design.*

(d) The minimum horizontal sight distance required at any point along the street is the general minimum sight distance for the spot speed relevant at that point. The sight distance is measure along the vehicle path, which may be assumed as the carriageway centreline for streets.

(6) Vertical curves

(a) The design of vertical alignment must reflect the expected operating speeds and constraints of the developments adjacent to the road in accordance with Austroads' *Guide to Road Design Part 3: Geometric Design.*

(b) Vertical curves will be simple parabolas and should be used on all changes of grade exceeding 1%. The length of the crest vertical curve for stopping sight distance is based on speed and should conform with Austroads' *Guide to Road Design Part 3: Geometric Design.*

(c) In addition to the above general minimum sight distance, which is required to be provided at all points along the street, at locations where there may be channelisation or line marking, such as intersections or pedestrian crossings, the driver must be able to see such indications within the stopping distance, i.e. sight distance from 1.15m eye height to zero is not less than single-vehicle stopping distance.

(d) For adequate riding comfort, lengths of sag vertical curves should conform with Austroads' *Guide to Road Design Part 3: Geometric Design.*

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

(f) Drainage poses a practical limit to the length of sag curves and a maximum length (in metres) of 15 times the algebraic sum of the intersecting vertical grades (expressed as a percentage) is suggested. To avoid water ponding in excessively flat sections of kerb and gutter, a minimum grade of 0.3% must be maintained in the kerb and channel.

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

(i) the design speed of the road in both horizontal and vertical planes should be of the same order; and

(ii) combined horizontal and vertical stopping sight distance and minimum sight distance should be considered three dimensionally.

(h) Horizontal curves should not be introduced at or near the crest of a vertical curve.

(7) Superelevation

(a) The use of superelevation in association with horizontal curves is an essential aspect of geometric design of roads with design speeds in excess of 60km/h. Streets which are designed for speeds of 40km/h or less and with curves of 60m radius or less generally have the pavement crowned on a curve instead of superelevation.

(b) The maximum superelevation for urban roads of higher design speeds should be 5%. Any increase in the longitudinal grade leading to excessive crossfall at intersections should be considered with caution. While all curves should be superelevated, negative crossfall should be limited to 3%.

(c) In general, curve radii larger than the minimum and superelevation rates less than the maximum should be used where possible. The minimum radius of curves is determined by the design speed, the minimum superelevation (or maximum adverse crossfall) at any point on the circular portion of the curve, and the maximum coefficient of side friction which allows safe lane changing. Refer to the *Road Planning and Design Manual* Table 11.1.

(d) Recommendations for minimum curve radii (in metres) on major urban roads under varying superelevation/crossfall are as per Austroads' *Guide to Road Design.*

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

(f) Rate of Rotation for superelevation refer Austroads' *Guide to Road Design Part 3: Geometric Design* (Section 7.7).

(8) Road reserve characteristics

(a) The cross section of the road reserve must provide for all functions that the road is expected to fulfil, including the safe and efficient movement of all users, provision for parked vehicles, acting as a buffer from traffic nuisance for residents, the provision of public utilities and street scaping. Road reserve widths will depend on verge widths, service roads and pathway requirements, and sub-arterial and arterial roads must also allow for future upgrading.

(b) The carriageway width must allow vehicles to proceed safely at the operating speed intended for that level of road in the network and with only minor delays in the peak period. This must take into consideration the restrictions caused by parked vehicles where it is intended or likely that this will occur on the carriageway. Vehicles include trucks, emergency vehicles and, on some roads, buses. Excessive carriageway widths can be detrimental to safety, amenity, user convenience, capital expenditure and maintenance costs.

For example, for urban residential streets:

(i) narrower urban residential carriageways in accordance with Urban Type A of Standard Drawing SD-001 are allowable for shorter street lengths, with low parking demand, and serving standard residential allotments. This carriageway does not allow for any buses, bike lanes, or indented parking. Frequent staggered parking may occur on both sides of the street where there are less than 150 vehicles per day, otherwise on street parking should be infrequent or along one side of the street only. Generally leg lengths should be kept to a maximum length of 150m. These streets may not function as a through route, and must carry a low traffic volume;

(ii) standard urban residential carriageways in accordance with Urban Type B of Standard Drawing SD-001 are allowable where there is relatively frequent parking on both sides of the street with traffic volumes generally less than 750 vehicles per day;

(iii) wider urban residential carriageways in accordance with Urban Type C of Standard Drawing SD-001 are required where there is a higher density residential area with higher parking demand or higher volume of traffic (less than 3000 vehicles per day in accordance with SC6.4.3.13) and possible bus routes. Indented bus bays may be required, on advice from council;

(c) the safety of pedestrians and cyclists where it is intended they use the carriageway must also be assured by providing sufficient width;

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

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

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

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

(h) stopping sight distances and junction or intersection sight distances, provided by the verge, should be based on the intended speeds for each road type;

(i) safe intersection stopping distance envelopes must be provided to ensure sight distances are achieved in the street layout; and

(j) industrial roads and streets must be designed to allow access for larger vehicles including B-doubles and multi-combination vehicles into these areas, including safe turning manoeuvres at intersections and to and from allotments.

(9) Crossfall

(a) Roads should be crowned in the centre. Typical pavement crossfalls on straight roads are:

Pavement Type	**Crossfall**
Bituminous seal coat	3%
Bituminous concrete pavement	3%
Cement concrete pavement	3%

Source: Austroads*, Guide to Road Design*

(b) There are many factors affecting levels in urban areas which force departures from these crossfalls. Differences in level between road alignments can be taken up by offsetting crown lines or adopting one way crossfalls. Sustained crossfalls should not exceed 4%, although up to 6% may be used where unavoidable with council approval. The rate of change of crossfall should not exceed those adopted in SC6.4.4.1.3(7) Superelevation.

(c) The use of one way crossfalls should be limited taking into consideration overland drainage and the impact on open space, public footpaths and private properties.

(d) The crossfall on a higher order transport route should take precedence over the grade in minor side streets. Standard practice is to maintain the crossfall on the major road and adjust the minor side street levels to suit. The crossfall in side streets should be warped quickly either to a crown or a uniform crossfall depending on the configuration of the side street. A maximum change of grade of 2% in the kerb line of the side street relative to the centre line grading is acceptable.

(10) Verges and property access

(a) A suitable design for the verge will depend on utility services, the width of footpath, access to adjoining properties, likely pedestrian usage and preservation of trees. Low level footpaths may only be used if normal crossfalls are impracticable. Crossfalls in footpath paving should not exceed 2.5%, in accordance with Austroads' *Guide to Road Design - Part 6A: Pedestrian and Cyclist Paths*. Longitudinal grade usually parallels that of the road and this may be steeper than 5%.

(b) Differences in level across the road between road reserve boundaries may be accommodated by:

(i) cutting at the boundary on the high side and providing the verge at normal level and crossfall;

(ii) battering at the boundary over half the verge width with the other half against the kerb constructed at standard crossfall;

(iii) a uniform crossfall across the carriageway; and

(iv) the lower verge being depressed below the gutter level.

(c) The above measures can be used singularly or combined. The verge formation should extend with a 0.5m berm beyond the road reserve boundary.

(d) The designer must design a vehicular driveway centreline profile for the property access and check this design using critical car templates, to ensure that vehicles can use the driveway satisfactorily.

(e) Where commuter pedestrians and cyclist paths are proposed, appropriate shading and rain protection should be provided. An approved landscaping master plan must be provided for approval.

(11) Intersections

(a) The design of intersections or junctions should allow all movements to occur safely without undue delay. Projected traffic volumes should be used in designing all intersections or junctions on major collector streets.

(b) Intersection design for the junction of subdivision roads and streets with existing state rural or urban roads and national highways should generally be in accordance with the publication Austroads' *Guide to Road Design – Part 4, Intersections and Crossings.*

(c) Intersections with state roads or national highways are to be designed, approved and constructed in accordance with the requirements of the Queensland Department of Transport and Main Roads.

(d) Where major intersections are required to serve a development complete reconstruction of the existing road pavements may be necessary.

(e) Intersections should be generally located in such a way that:

- (i) the streets intersect preferably at right-angles and not less than 70º;
- (ii) the landform allows clear sight distance on each of the approach legs of the intersection;
- (iii) the minor street intersects the convex side of the major street;
- (iv) the vertical grade lines at the intersection do not impose undue driving difficulties;
- (v) the vertical grade lines at the intersection will allow for any direct surface drainage;
- (vi) two minor side streets intersecting a major street in a left-right staggered pattern must have a minimum centre-line spacing of 50m to provide for a possible right-turn auxiliary lane on the major street; and
- (vii) a right-left manoeuvre between the staggered streets is preferable, avoiding the possibility of queuing in the major street, but only where staggered streets cannot be avoided.

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

(g) Appropriate provision should be made for vehicles to park safely, where required.

(h) Safe intersection sight distance - refer clause SC6.4.4.1.3(8)(i).

(i) The drainage function of the carriageway and/or road reserve must be satisfied by the road reserve cross-section profile.

(j) All vehicle turning movements are accommodated utilising *Design Vehicles and Turning Templates*, as follows:

- (i) for intersection turning movements involving low order roads, the "design semi-trailer" with turning path radius 15 m;
- (ii) for intersection turning movements involving streets, the "design single unit" bus with turning path radius 13 m; and
- (iii) for turning movements at the head of cul-de-sac local streets sufficient area is provided for the "design single unit" truck to make a three-point turn Driveway entrances are not to be used for turning movements. The minimum cul-de-sac head radius is 9m to kerb lip.

(k) Turning radii at intersections or driveways on major collector streets accommodate the intended movements without allowing desired speeds to be exceeded.

(l) On bus routes 3-centred curves with radii 15m, 10m, 30m are to be used at junctions and intersections.

(m) Un-signalised intersections on sub-arterial roads at grade should have a median width of at least five metres to allow for a two stage crossing from the side street.

(n) Design of traffic signals in sub-arterial roads must be in accordance with the Department of Transport and Main Roads' *Road Planning and Design Manual* (RPDM), Chapter 18. Council approval is required for use of equipment that is uniquely associated with traffic signals.

(o) Barrier kerb and channel must be used at intersection kerb turnouts extending to the tangent point. A one metre kerb transition must be used to connect barrier kerb and channel turnout with adjacent layback kerb and channel.

(12) Roundabouts

(a) Roundabouts are to be approved by council.

(b) Roundabouts should generally be designed in accordance with the requirements of *Austroads Guide to Road Design - Part 4B - Roundabouts.* Designs adopting alternative criteria will be considered on their merits. Roundabout design should generally comply with the following:

(i) safe provision for pedestrians, cyclists and public transport movements;

(ii) entry width to provide adequate capacity;

(iii) adequate circulation width, compatible with the entry widths and design vehicles e.g. buses, trucks, cars;

(iv) central islands of diameter sufficient only to give drivers guidance on the manoeuvres expected;

(v) deflection of the traffic to the left on entry to promote gyratory movement;

(vi) adequate deflection of crossing movements to ensure low traffic speeds;

(vii) a simple, clear and conspicuous layout; and

(viii) design to ensure that the speed of all vehicles approaching the intersection will be less than 40 km/h.

(13) Local area traffic management

(a) Local area traffic management (LATM) devices are unnecessary for appropriately designed new streets, but may be used to address speed and safety issues in existing streets, and must be approved by council.

(b) Calming devices such as thresholds, slow points, speed humps, chicanes and splitter islands should be designed in accordance with the requirements of the publication *Guide to Traffic Management Part 8: Local Area Traffic Management (LATM)* and the *Manual of Uniform Traffic Control Devices*. Device designs should generally comply with the following.

(i) Streetscape:

(A) reduce the linearity of the street by segmentation;

(B) avoid continuous long straight lines (e.g. kerb lines);

(C) short straights and short distances between intersections;

(D) enhance existing landscape character;

(E) maximise continuity between existing and new landscape areas;

(F) on-street parking; and

(G) mixed activity precincts.

(ii) Location of devices/changes:

(A) devices other than at intersections should be located to be consistent with streetscape requirements;

(B) existing street lighting, drainage pits, driveways, and services may decide the exact location of devices; and

(C) slowing devices are optimally located at spacings of 100-150m.

(iii) Design vehicles:

(A) emergency vehicles, garbage trucks and furniture vehicles must be able to reach all residences and properties;

(B) local streets with a “feeding” function between arterial roads and streets must be designed for an Austroads Design Single Unit Truck/Bus;

(C) where bus routes are involved, buses should be able to pass without mounting kerbs and with minimised discomfort to passengers; and

(D) in newly developing areas where street systems are being developed in line with LATM principles, building construction traffic must be provided for.

(iv) Control of vehicle speeds:

(A) maximum vehicle speeds can only be reduced by deviation of the travelled path. Pavement narrowings have only minor effects on average speeds, and usually little or no effect on maximum speeds;

(B) speed reduction can be achieved using devices which shift vehicle paths laterally (slow points, roundabouts, corners) or vertically (humps, platform intersections, platform pedestrian/school/bicycle crossings); and

(C) speed reduction can be helped by creating a visual environment conducive to lower speeds. This can be achieved by "segmenting" streets into relatively short lengths (less than 300 m), using appropriate devices, streetscapes, or street alignment to create short sight lines and by inducing in drivers a feeling of constriction through the introduction of side friction.

(v) Visibility requirements (sight distance):

(A) adequate critical sight distances should be provided such that evasive action may be taken by either party in a potential conflict situation. Sight distances should relate to likely operating speeds;

(B) sight distance to be considered include those of and for pedestrians and cyclists, as well as for drivers; and

(C) night time visibility of street features must be adequate. Speed control devices particularly should be located near existing street lighting if practicable, and all street features/furniture should be delineated for night time operation. Additional street lighting must be provided by the developer at proposed new speed control devices located away from existing street lighting.

(vi) Critical dimensions

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

(A) pavement narrowings in accordance with *Guide to Traffic Management;*

(B) bicycle lanes (including adjacent to pavement narrowings) – 1.5m minimum, 1.2m absolute minimum with council approval (in accordance with *Guide to Traffic Management*, and *Guide to Road Design);*

(C) plateau or platform areas;

(D) 75 mm to 100 mm height maximum, with 1 in 15 ramp slope;

(E) width of clear sight path through slowing devices;

(F) The width of the portion of carriageway which does not have its line of sight through the device blocked by streetscape materials, (usually vegetation);

(G) dimensions of mountable areas required for the passage of large vehicles to be determined by appropriate turning templates; and

(H) on bus routes, devices must allow the full-length of the bus to be contained between ramps.

(14) Road safety audits

(a) Road safety audits (RSA) should be carried out on sub-arterial road projects in accordance with *Guide to Road Safety Part 6: Road Safety Audit*. Confirmation from council is to be sought on which project stages require an RSA. The following stages of the project should be considered for an RSA, as appropriate:

(i) feasibility design;

(ii) completion of design development;

(iii) completion of final design;

(iv) during construction, where temporary traffic management measures are proposed;

(v) two weeks prior to opening to traffic; and

(vi) within one week of opening to traffic.

(15) Parking

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

(b) All on-site parking should be located and of dimensions that allow convenient and safe access and usage. All designs must account for a B99 (AS 2890) vehicle as the minimum requirement.

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

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

(e) On single lane local streets parking spaces should be provided within the verge. Such parking should be well defined and an all-weather surface provided. Such parking may not restrict the safe passage of vehicular and pedestrian traffic.

(f) Parking spaces provided on the verge or carriageway should be of adequate dimensions, convenient and safe to access.

(g) For non-residential land uses the opportunity for joint use of parking should be maximised by being shared by a number of complementing uses.

(h) On single lane carriageways a number of verge spaces are combined to provide for short term truck parking within 40m of any allotment.

(i) All verge spaces and indented parking areas are constructed of concrete, interlocking pavers, bitumen with crushed rock or other council approved base material and are designed to withstand the loads and manoeuvring stresses of vehicles expected to use those spaces.

(j) Right-angled kerbside parking is provided only on streets where posted speeds do not exceed 40 km/h.

(16) Bus routes

(a) It is important that the road hierarchy adequately caters for buses. The main criteria in determining the location of bus routes is that no more than 5% of residents should have to walk in excess of 5 minutes to catch a bus. Sub-section SC6.4.3.5 Car parking and public transport facilities guidelines details minimum criteria for bus route design, though local conditions, including climate and topography should be taken into consideration to demonstrate that bus routes are readily accessible to the majority of residents.

(b) Carriageway widths must comply with sub-sections SC6.4.4.8 Standard drawings, and SC6.4.3.13 Townsville road hierarchy. For indented bus bays on streets identified as bus routes, refer to SC6.4.4.8 Standard drawings. Shelters are subject to council's requirements.

SC6.4.4.1.4 Rural design criteria

(1) General

(a) In addition to the above, SC6.4.4.1.4 specifically applies to all those sites identified as being suited to rural subdivisions inclusive of rural home sites and hobby farms types of developments.

(b) Design speed is to be generally used as the basic parameter of design standards and the determination of the minimum design value for other elements in rural subdivisions is to be based on the concept of a "speed environment" as outlined in *Guide to Road Design.*

(c) Superelevation, widening and centreline shift and their associated transitions are to comply with Austroads Guides, where appropriate.

(d) Where the table drain is likely to scour, a stone pitched or suitably lined dish drain is to be constructed along the invert. For grades of less than 0.5%, the inverts of the drain are to be lined to prevent siltation. Drains with a minimum gradient of 0.25% are to be concrete lined.

(e) All rural subdivisions should be designed to restrict access to major roads.

(f) Access should be limited to one point on to street, major collector or arterial road networks.

(2) Sight distances

(a) Stopping sight distance should be provided at all points on the road.

(b) Stopping sight distance is the sum of the braking distance and the distance the vehicle travels during a reaction time of 2.5 seconds.

(3) Horizontal and vertical alignment

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

(4) Intersections

(a) Intersections should generally be designed in accordance with the publication *Guide to Road Design Part 4: Intersections and Crossings and Guide to Traffic Management Part 6: Intersections, Interchanges and Crossings.* The type of intersection required will depend on existing and planned connecting roads.

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

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

(ii) ESD relates to the driver entering the intersection from a minor road and ability to observe the roadway layout and assess traffic gaps. SISD relates to an overall check that vehicles utilising the intersection have sufficient visibility to allow reaction and deceleration so as to provide adequate stopping distance in potential collision situations.

(iii) Tabulated speed/sight distance requirements together with detailed explanations for each of the sight distance criteria are given in the relevant sections of the *Austroads Guide to Road Design*. Repositioning of an intersection may be required to obtain conformance with the sight distance criteria.

(iv) Stopping distance envelopes must be provided to ensure sight distances are achieved in the street layout.

(c) Staggered-T arrangements proposed for rural cross-intersections should preferably be of the “right to left” type. This arrangement eliminates traffic queuing in the major road, the need for additional pavement for right turn lanes and greater stagger length associated with “left to right” T-intersections. Figures and discussion on staggered-T treatments are given in the *Austroads Guide to Road Design.*

(5) Carriageways

Carriageway widths for rural roads should generally be as per SC6.4.4.8 Standard drawings SD-010 Typical Road Cross Sections – Rural Roads.

(6) Superelevation

Use of maximum superelevation will be considered where the radius of the curve in approaching the minimum speed environment. Reference should be made to *Austroads Guide to Road Design* for superelevation calculation. At low and intermediate ranges of design speed (i.e. below 80 km/h) all curves should be superelevated to at least a value equal the normal crossfall of straights.

(7) Table drains

Table drains to rural roads must comply with *Guide to Road Design Part 3: Geometric Design*. Minimum longitudinal grade of table drains is 0.50%. Refer to *Guide to Road Design Part 6: Roadside Design, Safety and Barriers for capacity of drains.*

(8) Scour protection

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

SC6.4.4.2 Pavement design

SC6.4.4.2.1 Introduction

(1) Objectives

The objective in the design of the road pavement is to select appropriate pavement and surfacing materials, types, layer thicknesses and configurations to ensure that the pavement performs to its design functions and requires minimal maintenance under the anticipated traffic loading for the design life adopted.

The objective in the design of the subsurface drainage system is to control moisture content fluctuations in the pavement and/or subgrade to within the limits assumed in the pavement design. In areas with a history of salinity problems, subsurface drainage may be prescribed to keep the groundwater table lower in the strata so as to avoid progressive deterioration of the health of topsoil and upper layers due to salinity levels increased by rising and/or fluctuating groundwater tables.

(2) Scope

(a) This sub-section covers the design guidelines for road pavement to meet the required design life, based on the subgrade strength, traffic loading and environmental factors, and including the selection of appropriate materials for select subgrade, subbase, base and wearing surface, and the design of the subsurface drainage system for the road pavement and/or subgrade.

The sub-section contains guidance in the design of the following forms of surfaced road pavement construction types:

(i) flexible pavements consisting of unbound granular materials;

(ii) flexible pavements that contain one or more bound layers, including pavements containing asphalt layers other than thin asphalt wearing surfaces;

(iii) rigid pavements (i.e. cement concrete pavements); and

(iv) concrete or clay segmental pavements.

(b) This sub-section generally sets out procedures in determining the following design criteria:

(i) design traffic;

(ii) design CBR of pavement subgrade (including method of sampling and testing);

(iii) determination of required subgrade treatments;

(iv) design methods for rigid and flexible pavement (pavement thickness);

(v) subsoil and foundation drains;

(i) sub-pavement drains; and

(ii) Te drainage mats, including Type A and Type B mats.

(3) rminology

Foundation drains	are intended for the drainage of seepage, springs and wet areas within and adjacent to the foundations of the road formation.
Sub-pavement drains	are intended for the drainage of the base and subbase pavement layers in flexible pavements. They may also function to drain seepage or groundwater from the subgrade.
Subsoil drains	are intended for the drainage of ground water or seepage from the subgrade and/or the subbase in cuttings and fill areas.
Type A drainage mats	are intended to ensure continuity of a sheet flow of water under fills, to collect seepage from a wet seepage area, or for protection of vegetation or habitat downstream of the road reserve where a fill would otherwise cut the flow of water.

Type B drainage mats are constructed to intercept water which would otherwise enter pavements by capillary action or by other means on fills and to intercept and control seepage water and springs in the floors of cuttings.

(4) Reference and source documents

(a) Development manual planning scheme policy sub-section to be read and applied in conjunction with this sub-section are as follows:

SC6.4.4.1 - Geometric road design
SC6.4.6.8 - Drainage mats
SC6.4.6.12 - Flexible pavements
SC6.4.6.13 - Asphaltic concrete
SC6.4.6.14 - Mass concrete sub base
SC6.4.6.15 - Plain and reinforced concrete base
SC6.4.6.16 - Sprayed bituminous surfacing
SC6.4.6.17 - Bituminous microsurfacing
SC6.4.6.18 - Segmental paving
SC6.4.6.20 - Subsoil, foundation and pavement drains
SC6.4.6.21 - Subsurface drainage

(b) Australian Standards

AS 1289 – *Methods of testing soils for engineering purposes*
AS 1289.4.2.1 - *Methods of testing soils for engineering purposes - Soil chemical tests - Determination of the sulfate content of a natural soil and the sulfate content of the groundwater - Normal method*
AS 2439.1 - *Perforated drainage pipe and associated fittings.*
AS/NZS 1477 - *PVC pipes and fittings for pressure applications.*

(c) Department of Transport and Main Roads

Pavement Design Manual – Supplemental to 'Part 2: Pavement Structural Design' of the *Austroads Guide to Pavement Technology.*
MRTS05 - Unbound Pavements
MRTS11 - Sprayed Bituminous Surfacing (Excluding Emulsion)
MRTS12 - Sprayed Bituminous Emulsion Surfacing
MRTS31 - Heavy Duty Asphalt
MRTS08 – Plant-Mixed Stabilised Pavements using Cement or Cementitious Blends
MRTS13 – Bituminous Slurry Surfacing
MRTS17 - Bitumen
MRTS18 – Polymer Modified Binder
MRTS20 – Cutback Bitumen
MRTS21 – Bituminous Emulsion
MRTS30 – Asphalt Pavements
MRTS35 – Recycled Materials for Pavements
MRTS38 – Pavement Drains
MRTS39 – Lean Mix Concrete sub-base for Pavements
MRTS40 – Concrete Base in Pavements Jointed Unreinforced, Jointed Reinforced, Continuously Reinforced and Steel Fibre Reinforced Pavements

(d) Other

Austroads, *Guide to Pavement Technology (all parts).*
Austroads, *Guide to Road Design – Geotechnical Investigation and Design.*
Concrete Masonry Association of Australia:

CMAA – MA57 - Concrete Segmental and Flag Pavements – Guide to Specifying, 2010
CMAA - T45 - Concrete Segmental Pavements - Design Guide for Residential Access Ways and Roads
CMAA - T46 - Concrete Segmental Pavements - Detailing Guide.

Clay Brick and Paver Institute, *Design Manual 1 - Clay Segmental Pavements, A Design and Construction Guide for Sites Subjected to Vehicular and Pedestrian Traffic.*

SC6.4.4.2.2 Pavement design criteria

(1) The design traffic loading must be calculated based on the following minimum design lives of pavement:

Table SC6.4.4.2.1 Design ESAs

Road or street type	Minimum design life
Urban streets and roads	20 years
Rural streets and roads	20 years
Rigid (concrete)	40 years
Segmental block	25 years

Design traffic loading for urban areas must be calculated in equivalent standard axles (ESAs) for the applicable design life of the pavement, taking into account present and predicted commercial traffic volumes, axle loadings and configurations, commercial traffic growth and street capacity.

For new subdivisions, the design traffic loading must take account of the construction traffic associated with the subdivision development, and the in-service traffic for the subdivision and any future developments linked to that subdivision.

When designing staged developments, the number of vehicle trips must take into consideration the ultimate development that will eventually access each segment of the road under consideration with appropriate allowances for bus, garbage, construction and in-service traffic.

For interlocking concrete segmental pavements, the simplification of replacing ESAs with the number of commercial vehicles exceeding 3 tonne gross contained in CMAA-T45 is acceptable up to a design traffic of 10^6ESAs. Beyond this, ESAs should be calculated.

The pavement design must include all traffic data and/or assumptions made in the calculation of the design traffic. The estimated design traffic must generally be made in accordance with G*uide to Pavement Technology* – in particular *Part 2 Pavement Structural Design* for the calculation of design traffic volumes up to and exceeding 10^6ESAs.

In the absence of other traffic data, the following traffic values (in ESAs) may be taken as a guide to the minimum design traffic, but are subject to variation depending on the circumstances for the particular development.

Table 6.4.4.2.2 Design ESAs

Street Type	Design ESAs - 20 year design life (minimum)
Urban Residential	
- Type A	2×10^4
- Type B	1×10^5
- Type C	1×10^6
Major Collector	2×10^6
Commercial and Industrial	5×10^6
Rural Roads	1×10^6

Traffic volume and annual growth rate can be obtained upon request to council as guidance in determining the design traffic loading to be used for pavement design. For roads, the design traffic loading must be determined using a design life as per SC6.4.4.2.2.(1), however, a practical design strategy to allow extensions of the pavement life to 35 years (minimum) must also be submitted.

For new residential developments where traffic data is not readily and accurately available, the design may consider the following data to determine the design traffic loading:

(a) traffic generation – 10 vehicles per day/allotment plus 20 ESAs per equivalent allotment for consideration of construction traffic;

(b) traffic growth rates – 0.5% – 2% for streets. Annual traffic growth rates for roads are subject to confirmation by council and will be based on available traffic data;

(c) commercial vehicles – 3%-7% for streets. Commercial vehicle percentages for roads are subject to confirmation by council and will be based on available traffic data;

(d) ESA per heavy vehicle (ESA/HVAG) - Urban 0.7, Rural 0.9; and

(e) axle group per heavy vehicle (NHVAG) – Urban 2.5, Rural 2.8.

(2) The calculation of design traffic loading for rural area must adopt a similar approach to the urban areas while the design for industrial roads will require a detailed assessment addressing the following factors and must be designed using a mechanistic approach:

(a) traffic generation, including peak hour traffic volumes and truck volumes;

(b) details of the types of heavy vehicles that are expected to utilise the road; and

(c) predicted route patterns (heavy vehicles).

(3) The calculation of design traffic loading for industrial development must include the following factors:

(a) traffic generation of the proposed industrial development (including peak hour traffic volumes). Refer to *Guide to Pavement Technology Part 2* for the method of calculating load factors for each type of heavy vehicles;

(b) to Austroads Guide to Pavement Technology Part 2 for the method of calculating load factors for each type of heavy vehicles;

(c) details of types of trucks that will utilise the proposed road network with consideration to the proportion of heavy vehicles that will have full load; and

(d) predicted truck usage patterns with consideration to expected land use.

SC6.4.4.2.3 Geotechnical evaluation

(1) General

The designer must arrange a detailed geotechnical investigation of the naturally occurring material along the alignment of the proposed roads. The extent of any areas of filling and cutting must be determined including the strength of the underlying materials and considered in the overall pavement design.

The geotechnical investigation, including both field and laboratory testing must be undertaken in accordance with all relevant Australian Standards (e.g. AS 1289) and *Guide to Road Design* in particular *Part 7 Geotechnical Investigation and Design.*

(2) Subgrade testing

(a) Except where a mechanistic design approach is employed using Austroads *Guide to Pavement Technology Part 2: Pavement Structural Design*, the measure of subgrade support must be the California Bearing Ratio (CBR). Where a mechanistic design approach using linear elastic theory is employed for flexible pavements, the measure of subgrade support must be in terms of the elastic parameters (modulus, Poisson’s ratio), e.g. for use in CIRCLY computerised pavement design methods.
In conducting subgrade tests, the following approach must be adopted for new roads:

(i) test pits/holes along the alignment of the road must have a spacing between 60m and 120m as appropriate for each urban residential and industrial street or a minimum of three test locations per street in a stage, whichever is greater;

(ii) test pits/holes along the alignment of a rural area must have a spacing of up to 300m or a minimum of 3 test locations per road whichever is greater;

(iii) test holes must be excavated to a minimum depth of 1 m and must extend a minimum 500mm below the proposed subgrade level;

(iv) if the depth of fill material over the natural subgrade is more than 500mm, then the fill material is considered to be the new subgrade and it must be assessed; and

(v) if the depth of fill is less than 500mm, investigation must assess the natural ground conditions and also the properties of the proposed fill material.

(b) The following factors must be considered in determining the design strength/stiffness of the subgrade:

(i) sequence of earthworks construction;

(ii) the compaction moisture content and field density specified for construction;

(iii) moisture changes during service life;

(iv) subgrade variability; and

(v) the presence or otherwise of weak layers below the design subgrade level.

(3) California Bearing Ratio (CBR)

(a) Notwithstanding the requirements of AS1289.6.1.1, this document specifies additional or differing requirements, including:

(i) CBR tests must be carried out with a maximum of 4.5kg surcharge; and

(ii) maximum correction allowable to the applied force is 0.5mm along the horizontal axis of the penetration curve.

(b) The calculation of the Design CBR must be based on either soaked or unsoaked conditions as appropriate.

(i) For boxed in pavements soaked conditions must be adopted for the calculation of Design CBR and must be based on a minimum of three 4-day soaked CBR laboratory samples for each subgrade area compacted to 97% of maximum dry density, standard compaction at optimum moisture content (OMC).

(ii) If it can be demonstrated that the subgrade is well drained and not less than 300mm above natural surface or table drain, e.g. Rural formation, in free draining material and not influenced by spring/seepage conditions then the unsoaked condition will be considered for design by council. When unsoaked conditions are to be adopted the calculation of Design CBR must be based on a minimum of three laboratory samples for each subgrade area compacted to 97% maximum dry density standard compaction at OMC and corrected to allow for the effects of subsurface drainage (or lack of), climatic zone and soil type if appropriate (as per the guidelines in Austroads *Guide to Pavement Technology Part 2: Pavement Structural Design*) to give an estimate of equilibrium in-situ CBR.

(iii) The Design CBR for each subgrade area is computed by using the appropriate formula as follows:

Design CBR = Least of estimated CBRs, for less than five results

or

Design CBR = 10th percentile of all estimated CBRs, for five or more results

Where practicable, the Design CBR obtained from laboratory testing should be confirmed by testing performed on existing road pavements near to the job site under equivalent conditions and displaying similar subgrades.

The pavement design must include a summary of all laboratory and field test results and assumptions and/or calculations made in the assessment of Design CBR.

(4) Environment

The environmental factors which significantly affect pavement performance are moisture and temperature. Both of these factors must be considered at the design stage of the pavement. Reference should be made to Austroads *Guide to Pavement Technology Part 2: Pavement Structural Design.*

The following factors relating to moisture environment must be considered in determining the design subgrade strength/stiffness and in the choice of pavement and surfacing materials:

(a) rainfall/evaporation pattern;

(b) permeability of wearing surface;

(c) depth of water table and salinity problems;

(d) relative permeability of pavement layers;

(e) whether shoulders are sealed or not; and

(f) pavement type (boxed or full width).

The effect of changes in moisture content on the strength/stiffness of the subgrade must be taken into account by evaluating the design subgrade strength parameters (i.e. CBR or modulus) at the highest moisture content likely to occur during the design life, i.e. the design moisture content. The provision of subsurface drainage may, under certain circumstances, allow a lower design moisture content, and hence generally higher design CBR.

The effect of changes in temperature environment must be considered in the design of pavements with asphalt wearing surfaces, particularly if traffic loading occurs at night when temperatures are low, thus causing a potential reduction in the fatigue life of thin asphalt surfacing. The effect of changes in temperature environment should also be considered for bound or concrete layers.

The pavement design must include all considerations for environmental factors, and any assumptions made that would reduce or increase design subgrade strength, or affect the choice of pavement and surfacing materials.

(5) Expansive soils

Highly expansive materials are classified as highly reactive with high plasticity. Refer to the classification in Table SC6.4.4.2.1 Guide to classification of expansive soils, with prominence give to classification based on the CBR swell. Expansive soilds have the potential to exhibit significant volume changes with the variation in moisture content leading to possible loss of pavement shape and longitudinal cracking in the future pavement. For this reason, if test results indicate highly expansive materials (classified as "High" or "Very High"), the design CBR must be 3% or less. Materials having a measured CBR swell ≥2.5% must incorporate a low permeability treatment layer to minimise significant moisture changes in the underlying subgrade.

Table SC6.4.4.2.3 Guide to classification of highly expansive soils

Expansive Nature	Liquid Limit (%)	Plastic Index	PI x % <0.425mm	Potential Swell (%)*
Very High	>70	>45	>3200	>5.0
High	>70	>45	2200-3200	2.5-5.0
Moderate	50-70	25-45	1200-2200	0.5-2.5
Low	<50	<25	<1200	<0.5

*Swell OMC and 97% MDD using Standard compactive effort; 4 day soak based on 4.5kg surcharge.
(Source: Guide to Pavement Technology – Part 2).

SC6.4.4.2.4 Subgrade treatment

(1) General

Subgrade treatment may be required subject to ground conditions defined in Table SC6.4.4.2.4 Ground conditions for subgrade treatment.

Table SC6.4.4.2.4 Ground conditions for subgrade treatment

Category	Condition	Definition	Treatment Type
A	Excessively wet subgrade anticipated prior to construction and/or excessively wet subgrade encountered once construction commences	“Wet” subgrade	Working Platform
B	Low Design Subgrade Strength *	Soaked CBR ≤ 3%	Capping Layer
C	Highly or very highly expansive subgrade soil #	Swell ≥ 2.5%	Pavement Cover
D	Ground beneath pavement will be exposed to water (due to the effect of capillary rise and/or positive head)	“Water Exposure”	Drainage Layer

* CBR swell at OMC and 97% MDD using Standard Compactive effort; 4 day soak based on 4.5kg surcharge. (Source: Austroads Guide to Pavement Technology – Part 2)

Swell measured in CBR test described in SC6.4.4.2.3 (5)

Design subgrade CBR = 3% must be adopted into the pavement design if the subgrade soaked CBR is > 3% but with CBR swell of ≥ 2.5% (classified as highly or very highly expansive).

This specification does not provide direct criteria for determining the required depth of subgrade treatment in highly or very highly expansive soils (Category C). However, as Category C subgrade will need to be designed with CBR of ≤ 3%, the subgrade treatment of Category B (low design subgrade strength) will ensure that the total “Pavement Cover” is adequate to meet the cover requirements for an expansive subgrade soil. It is noted that the type of subgrade treatment that is acceptable will be depend on the expansive nature of the soil. A subgrade with CBR swell of ≥ 2.5% will require capping material to include a low permeability layer.

Subgrade Treatment selection is outlined in flowchart Figure SC6.4.4.2.1 Guide to determine subgrade treatment. Details for subgrade “Treatment Layer” is described in Table SC6.4.4.2.5 Selection of subgrade treatment type. Subgrade treatment may comprise one or a combination of the alternatives listed.

(2) Subgrade treatment types

- (a) In-situ lime stabilisation of the subgrade;
- (b) Plant mixed cement stabilised gravel;
- (c) Unbound gravel;
- (d) Select fill;
- (e) Rock fill (geofabric wrapped) + min. 150mm select fill;
- (f) Drainage layer material + min. 150mm select fill; and
- (g) Geofabric separation layer.

The acceptable types and combinations of treatment are as outlined in SC6.4.4.2.4 (3).

(3) Selection criteria for subgrade treatment type
Figure SC6.4.4.2.1 Guide to determine subgrade treatment outlines subgrade treatment layers, denoted as Treatment L1 to L11. Table SC6.4.4.2.5 Selection of subgrade treatment type details which subgrade treatment options are acceptable for each condition.

Table SC6.4.4.2.6 Thickness of treatment layer outlines procedure for determination of the required thickness of the treatment layer under the pavement. Note that no prescription is given to the required thickness of Working Platform, as this will depend on the specific conditions encountered and the treatment layer selected.

(4) Required thickness of treatment layer
Table SC6.4.4.2.6 Thickness of treatment layer outlines procedure for determination of the required thickness of the treatment layer under the pavement. Note that no prescription is given to the required thickness of Working Platform, as this will depend on the specific conditions encountered and the treatment layer selected.

(5) Working platform
A working platform could comprise of any of the treatment type *(a)* to *(g)* as defined in Table SC6.4.4.2.5 Selection of subgrade treatment type.

- (a) Except for treatment type (g) – geofabric separation layer, the working platform is required to meet the following minimum standards necessary for it to function when it becomes part of the subgrade for the operating service life of the pavement structure:
  - (i) at least 150mm compacted thickness, and as thick as necessary to provide support required;
  - (ii) have a surface maintained with a geometric tolerance of ± 10mm of the specified height and a maximum deviation from a 3m straight edge of 8mm at all points on the surface; and
  - (iii) where a treatment type (b) – plant mixed cement stabilised gravel is used, gravel must be of a standard no less than Type 2.3 with a minimum UCS of 0.8 MPa and a maximum UCS of 3.5 MPa at 28 days.
- (b) The working platform must be designed by the Contractor to meet the particular requirements of the project including, but not limited to, the following considerations:
  - (i) the characteristics of the underlying subgrade materials;
  - (ii) the Contractor’s construction traffic and equipment the Contractor intends to use to construct the

pavements and other works;

(iii) the full operating life of the working platform including, but not limited to:

- actual period during which the working platform will be required to provide access for construction traffic;
- actual periods during which the working platform will be required to provide a platform for construction traffic and equipment, including for construction of the pavement layers; and
- actual periods during which it is not in use prior to the construction of the overlying pavement;

(iv) provide protection to the underlying layers, including protection from water and stress;

(v) provide a platform for the construction of the overlying pavement;

(vi) suitability for the Contractor's construction program; and

(vii) be sufficiently stiff to enable the placement and compaction of the overlying pavement layers in accordance with their specified requirements.

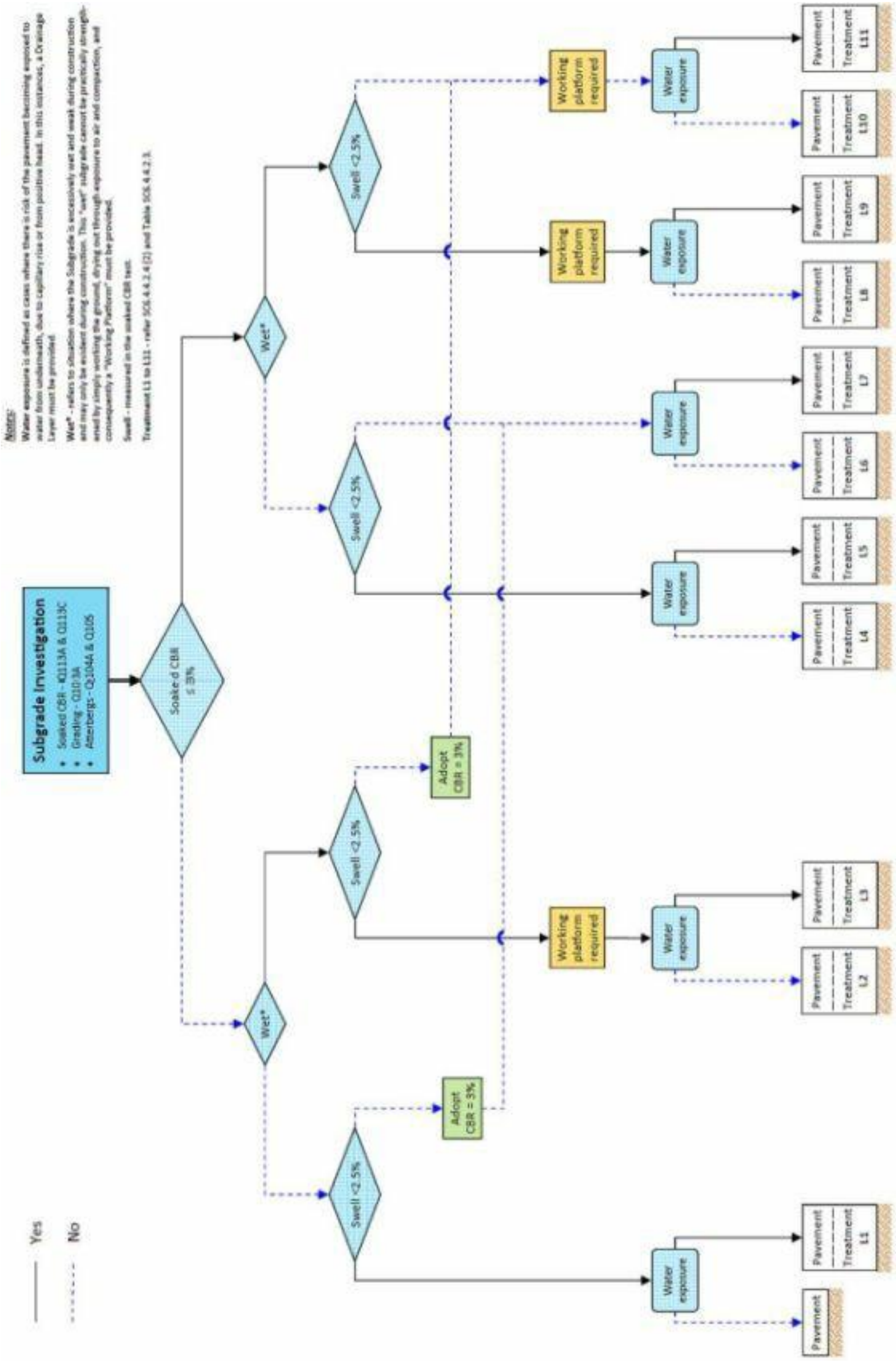

Figure SC6.4.4.2.1 Guide to determine subgrade treatment

Table SC6.4.4.2.5 Selection of subgrade treatment type

Treatment	Soaked CBR ≤ 3%	Wet at construction	Swell < 2.5%	Water Exposure	Acceptable Treatment Types	Treatment Name
-	X	X	✓	X	No treatment required	-
L1	X	X	✓	✓	(e) or *(f)*	Drainage layer
L2	X	✓	✓	X	If "Wet" layer entirely removed & replaced: (b) to (e) & (g)*. If not: (a), (b), (e) or *(g)*.*	Working platform
L3	X	✓	✓	✓	(e)	Drainage layer & working platform
L4	✓	X	✓	X	(a) to (d)	Capping layer
L5	✓	X	✓	✓	(e) or (f)	Capping layer & drainage layer
L6	✓	X	X	X	(a), (b) or (d)	Capping layer & pavement cover
L7	✓	X	X	✓	(e) or (f)	Capping layer, pavement cover & drainage layer
L8	✓	✓	✓	X	If "Wet" layer entirely removed and replaced: (b) to (e). If not: (a), (b) or (e)	Capping layer & working platform
L9	✓	✓	✓	✓	(e)	Capping layer, drainage layer & working platform
L10	✓	✓	X	X	(a), (b) or (e)	Capping layer, pavement cover & working platform
L11	✓	✓	X	✓	(e)	Capping layer, pavement cover, drainage layer & working platform

* (g) – geofabric layer may or may not provide adequate as a working platform upon which pavement construction can proceed. This can only be determined by trial and error. If it proves insufficient support, other acceptable treatments will be required.

(6) Capping layer

Capping layer must be provided where the in-situ untreated subgrade has a design CBR ≤ 3%. Treatment types that are suitable for use as a capping layer and a reference to the quality requirements are as follows:

(a) in-situ lime stabilisation of the subgrade – refer SC6.4.4.2.4 (8);

(b) plant mixed cement stabilised gravel – refer SC6.4.6.12 Flexible pavements;

(c) unbound gravel – refer SC6.4.6.12 Flexible pavements;

(d) select fill – refer SC6.4.4.2.4 (7);

(e) rock fill (geofabric wrapped) + min. 150mm *(b)* or *(d)* – refer SC6.4.4.2.4 (9); and

(f) drainage layer material + min. 150mm *(b)* or *(d)* – refer SC6.4.4.2.4 (10).

(7) Select fill

Select fill can be used as part of a subgrade treatment solution when a "capping layer" and/or "pavement cover" is required, and could also be used as a "working platform" to replace a wet layer. Select fill may comprise a naturally occurring material from on site or imported to site, or may comprise a natural material that has its properties improved by addition of cement or lime. The natural material or improved product must meet the minimum requirements in Table SC6.4.4.2.7 Material properties for select fill.

Table SC6.4.4.2.6 Determining thickness of treatment layer

Treatment	Thickness of treatment	Treatment name
L1	Refer SC6.4.6.8 Drainage mats	Drainage layer
L2	Excluding *(g)* “geofabric layer”, thickness is as required to successfully achieve compaction on top of the working platform, min. 150mm	Working platform
L3	Refer SC6.4.6.8 Drainage mats. A minimum 150mm thick layer of type *(d)* must be provided on top of the drainage layer	Drainage layer & working platform
L4	Refer SC6.4.4.2.7 (1) and (2)	Capping layer
L5	Refer SC6.4.4.2.7 (1) and (2) and SC6.4.6.8 Drainage mats. A minimum 150mm thick layer of type *(d)* must be provided on top of the drainage layer	Capping layer & drainage layer
L6	Refer SC6.4.4.2.7 (1) and (2)	Capping layer & pavement cover
L7	Refer SC6.4.4.2.7 (1) and (2) and SC6.4.6.8 Drainage mats. A minimum 150mm thick layer of type *(d)* must be provided on top of the drainage layer	Capping layer, pavement cover & drainage layer
L8	Refer SC6.4.4.2.7 (1) and (2). Greater thickness may be required to achieve an adequate working platform	Capping layer & working platform
L9	Refer SC6.4.4.2.7 (1) and (2) and SC6.4.6.8 Drainage mats. A minimum 150mm thick layer of type *(d)* must be provided on top of the drainage layer. Greater thickness may be required to achieve an adequate working platform	Capping layer, drainage layer & working platform
L10	Refer SC6.4.4.2.7 (1) and (2). Only types *(a), (b)* or a combination of a minimum 150mm of *(d)* on top of *(e)*, are acceptable due to expansive subgrade. Greater thickness may be required to achieve an adequate working platform	Capping layer, pavement cover & working platform
L11	150mm of *(d)* is required on *(e).* Thickness of *(e)* determined from SC6.4.6.8 Drainage mats. Combined thickness must also satisfy SC6.4.4.2.7 (1) and (2). Greater thickness may be required to achieve an adequate working platform	Capping layer, pavement cover, drainage layer & working platform

Table SC6.4.4.2.7 Material properties for select fill and treated material

Property	**Depth below Working Platform** [1]	
	≤ 150 mm	**> 150 mm**
Laboratory CBR (%) [1]	≥ 10	≥ 10
Maximum aggregate size (mm)	75	75
Plasticity index	≥7	≥7
Weighted plasticity index (WPI)	< 1200	< 2200
Swell (%) [2]	≤ 0.5	≤ 2.5
% passing 0.075 mm	15–30 inclusive	4–30 inclusive

Note—

(1) material may be chosen with a minimum CBR greater than specified above, ift his is considered to provide a better overall design solution. However, for design purposes, the layer may not be modelled with CBR of greater than1 5%. CBR to be tested in accordance with Q113C (97.0% MDD, OMC, standard compactive effort), 4.5kg surcharge and soaked for a period of four days.

(2) swell determined from CBR test described above.

(8) In-situ lime stabilised subgrade

In-situ lime stabilisation of the subgrade soil is the preferred means of satisfying “Capping Layer” and “Pavement Cover” requirements when the subgrade comprises plastic clay soils.

In-situ treatment of clay subgrades using lime involves mixing lime, which has been either previously hydrated or hydrated on site by adding water (slaking), into a subgrade to increase subgrade strengths. This may be done to modify the subgrade (i.e. usually achieve a temporary strength gain) or it may be added to stabilise it (i.e. achieve a permanent increase in strength). In the case of the latter sufficient lime must be added to ensure that these strength gains are permanent. It is essential that the purpose of the treatment is clearly identified and clear to all concerned.

No design benefit can be adopted if stabilisation is only for the purpose of "modifying" the subgrade soil properties. To qualify for use as a "Capping Layer" and/or "Pavement Cover", full stabilisation as outlined below is required.

Subgrade soil not suitable for lime stabilisation must include:

(a) unbound material with:

(i) a plasticity index less than 10%; or

(ii) less than 25% passing the 0.425 mm sieve; or

(iii) Soluble sulphate > 0.2%

(b) any patch which may include:

(i) concrete; or

(ii) cement treated material; or

(iii) asphalt.

Lime stabilisation of subgrade material must be carried out as a 2 day operation to a minimum depth of 250mm, except for natural subgrades with a representative strength of CBR 0.5% where stabilisation depth must be a minimum of 300mm. The required process is detailed in SC6.4.6.12 Flexible pavements.

(9) Rock fill (geofabric wrapped) + min. 150mm of *(b)* or *(d)*

Rock fill (geofabric wrapped) can be utilised in combination with treatment types *(b)* or *(d)* for application within a capping layer, a working platform and a Drainage Layer.

Rock fill must meet the quality requirements for rock Fill in TMR Specification MRTS04 and the Geofabric must be selected in accordance with TMR Specification MRTS27.

The minimum rock fill layer thickness must be twice the maximum particle size, but not less than 300mm. If a working platform is also required, the thickness must be sufficient to bridge the natural subgrade and provide solid support for the *(b)* or *(d)* overlying layer.

(10) Drainage layer + min. 150mm of *(b)* or *(d)*

A drainage layer must be provided where water exposure occurs, or is likely to occur, from beneath the pavement (due to the effect of capillary rise and/or positive head). The drainage layer must be a minimum 300mm thick (refer SC6.4.6.8 Drainage mats) and covered by a minimum 150mm of type *(b)* or *(d)*.

Treatment type *(f)* must not be used for situation where a working platform is also required due to the insitu material being wet and of low strength (which can be assessed by in situ dynamic cone penetrometer testing), and only treatment type *(e)* is acceptable.

(11) Equivalent subgrade CBR for design

Section SC6.4.4.2.4 (1) to (10) outlines the requirements of subgrade treatment and treatment type options acceptable by Council. Once subgrade treatment has been identified, the equivalent subgrade CBR value for pavement design calculation or modelling must be adopted as per Table SC6.4.4.2.8 Equivalent subgrade CBR.

As a capping layer is compulsory for treatment L4 to L11, there are two design conditions to determine the thickness requirement and equivalent subgrade CBR strength for the capping layer.

(a) Capping layer comprises in-situ lime stabilised subgrade or plant mixed cement stabilised gravel

The pavement above an in-situ lime stabilised subgrade or plant mixed cement stabilised gravel must be designed for an equivalent CBR derived from the natural subgrade CBR and the design traffic load (ESA's) as shown in Figure SC6.4.4.2.2 Design chart: Subgrade CBR equivalent to lime stabilised layer + natural subgrade (M. Matheson).

The capping layer depth required must be 250mm for natural subgrade CBR of > 0.5%, otherwise depth must be 300mm.

(b) Capping layer comprises unbound material

As detailed in section SC6.4.4.2.4 (6), unbound material that are acceptable to be used as capping layer include:

- unbound gravel;
- select fill;
- rock fill (geofabric wrapped) + min. 150mm select fill; and
- drainage layer material + min. 150mm select fill.

The required capping thickness is given in Table SC6.4.4.2.9 Capping thickness for unbound materials. However, for natural subgrade CBR ≤ 1.0%, a specific assessment is required.

Table SC6.4.4.2.8 Equivalent subgrade CBR

Treatment	Natural ground subgrade CBR (%)	Treatment type	Equivalent subgrade CBR
-	> 3	Nil	Use natural ground subgrade CBR
L1	> 3	*(e)* or *(f)*	CBR = 10%
L2	> 3	*(b), (c), (d), (e)* or *(g)**	If wet layer is removed and replaced: Use natural ground subgrade CBR
		(b), (e) or *(g)**	If wet layer remains: CBR = 3%
L3	> 3	*(e)*	CBR = 3%
L4	≤ 3	*(a)* or *(b)*	Refer SC6.4.4.2.4 (11A)
		(c) or *(d)*	CBR = 3%. Refer SC6.4.4.2.4 (11B)
L5	≤ 3	*(e)* or *(f)*	CBR = 3%. Refer SC6.4.4.2.4 (11B)
L6	≤ 3	*(a)* or *(b)*	Refer SC6.4.4.2.4 (11A)
		(d)	CBR = 3%. Refer SC6.4.4.2.4 (11B)
L7	≤ 3	*(e)* or *(f)*	CBR = 3%. Refer SC6.4.4.2.4 (11B)
L8	≤ 3	*(a)* or *(b)*	Refer SC6.4.4.2.4 (11A)
		(e)	CBR = 3%. Refer SC6.4.4.2.4 (11B)
L9	≤ 3	*(e)*	CBR = 3%. Refer SC6.4.4.2.4 (11B)
L10	≤ 3	*(a)* or *(b)*	Refer SC6.4.4.2.4 (11A)
		(e)	CBR = 3%. Refer SC6.4.4.2.4 (11B)
L11	≤ 3	*(e)*	CBR = 3%. Refer SC6.4.4.2.4 (11B)

* (g) – geofabric layer may or may not provide adequate as a working platform upon which pavement construction can proceed. This can only be determined by trial and error. If it proves insufficient support, other acceptable treatments will be required.

Table SC6.4.4.2.9 Capping thickness for unbound material

Natural subgrade CBR	Minimum capping layer thickness (mm)
≥ 2.5% to ≤ 3.0%	150
≥ 2.0% to < 2.5%	200
≥ 1.5% to < 2.0%	300
≥ 1.0% to < 1.5%	400

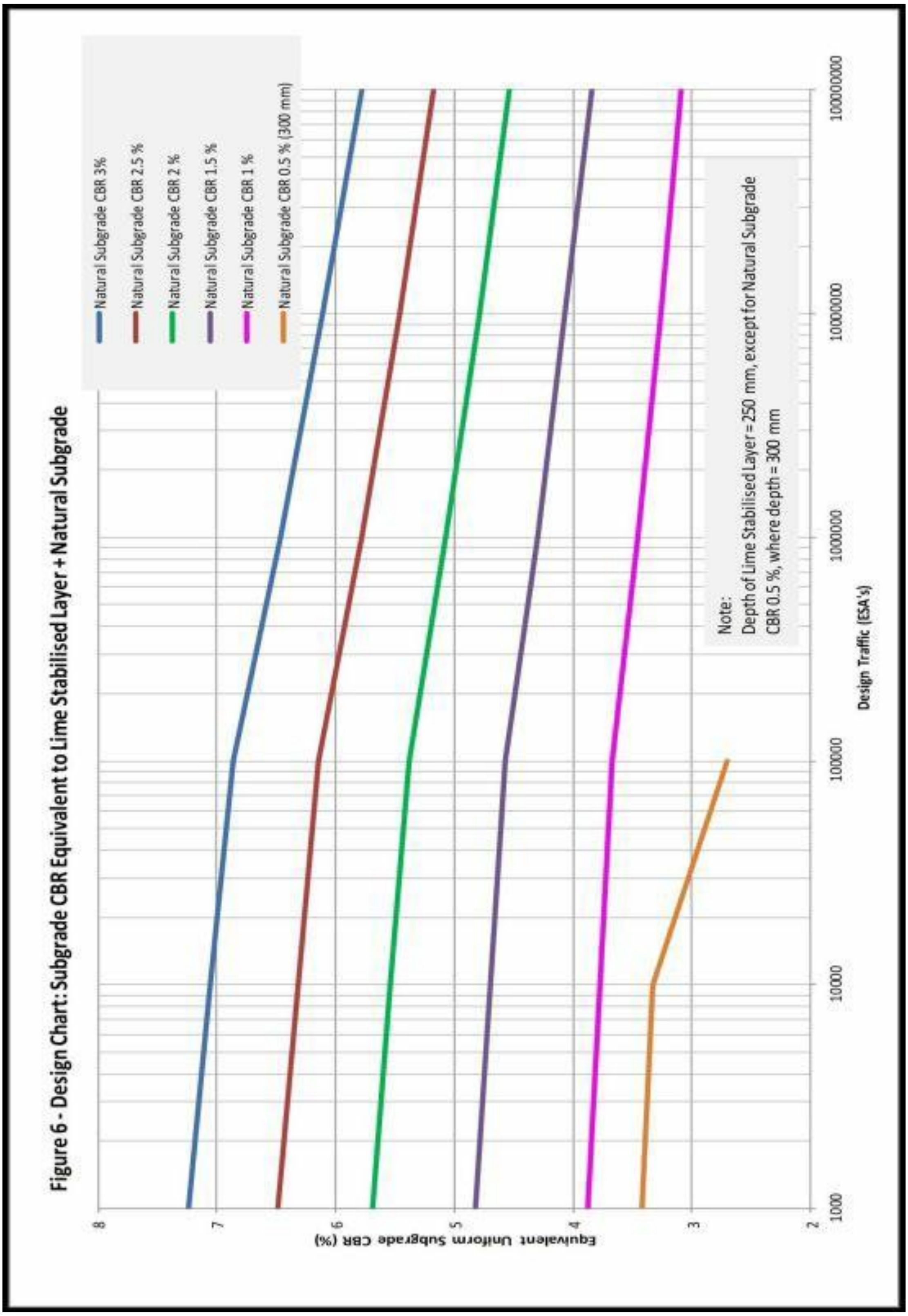

Figure SC6.4.4.2.2 Design chart: subgrade CBR equivalent to lime stabilised layer + natural subgrade (M. Matheson)

SC6.4.4.2.5 Pavement and surfacing materials

(1) Pavement materials can be classified into the following categories according to their fundamental behaviour under the effects of applied loadings:

- unbound granular materials;
- cement modified granular materials, also known as cement modified (0.8 MPa < UCS < 1.5 MPa);
- bound (cemented) granular materials, also known as cement treated (UCS >1.5MPa);
- asphaltic concrete;
- cement concrete; and
- heavy duty asphalt (deep lift asphalt).

(2) Surfacing materials can also be classified into essentially five categories or types:

- sprayed bituminous seals (flush seals);
- asphaltic concrete;
- cement concrete;
- concrete segmental pavers; and
- clay segmental pavers.

(3) Unbound granular materials, including modified granular materials, must satisfy the requirements of SC6.4.6.12 Flexible pavements.

(4) Bound (cemented) granular materials must satisfy the requirements of SC6.4.6.12 Flexible Pavements.

(5) Asphaltic concrete must satisfy the requirements of SC6.4.6.13 Asphaltic concrete.

(6) Cement concrete must satisfy the requirements of SC6.4.6.14 Mass concrete subbase, SC6.4.6.15 Plain and reinforced concrete base, as appropriate.

(7) Sprayed bituminous seals must satisfy the requirements of SC6.4.6.16 Sprayed bitumen surfacing.

(8) Concrete and clay segmental pavers must satisfy the requirements of SC6.4.6.18 Segmental paving.

(9) Heavy duty asphalt pavements must satisfy the requirements of MRTS31.

SC6.4.4.2.6 Construction and maintenance considerations

The type of pavement, choice of base and subbase materials, and the type of surfacing adopted should involve consideration of various construction and maintenance factors as follows:

(1) extent and type of drainage;

(2) use of boxed or full width construction;

(3) available equipment of the Contractor;

(4) use of stabilisation;

(5) aesthetic, environmental and safety requirements;

(6) social considerations;

(7) construction under traffic;

(8) use of staged construction; and

(9) ongoing and long-term maintenance costs

These factors are further discussed in Austroads *Guide to Pavement Technology Part 2: Pavement Structural Design.*

SC6.4.4.2.7 Pavement design

Pavement design must be in accordance with Austroads *Guide to Pavement Technology Part 2: Pavement Structural Design* unless otherwise stated in this document.

(1) Pavement Thickness

Notwithstanding subgrade testing and subsequent pavement thickness design, the minimum pavement thickness on local streets must not be less than 250 mm. This is necessary to ensure that council has sufficient thickness for future insitu stabilisation of pavements (without the risk of mixing the subgrade into the pavement during the process). Additionally, individual compacted layer thickness must be chosen to suit construction process and must be no less than 125 mm nor greater than 250 mm for optimal compaction and to avoid lamination of layers.

(2) Design subgrade CBR

The subgrade Design CBR adopted for the pavement design must consider the effect of moisture changes in the pavement and subgrade during the service life, and hence consideration must be given to the provision of subsurface drainage in the estimation of equilibrium in-situ CBRs, and hence in the design of the pavement structure.

Design CBR of untreated subgrade must be no greater than 3% unless otherwise approved by council who reserves the rights to carryout independent 3rd party geotechnical investigations to confirm adopted design CBR's and respective pavement designs.

Warrants for the provision of subsurface drainage are given in SC6.4.6.21 Subsurface drainage. If subsurface drainage is not provided, then the Design CBR adopted must allow for a greater variability in subgrade moisture content during the service life of the pavement, and hence a design moisture content above the optimum moisture content (OMC).

Subgrade treatment must be carried out in accordance with this document on all natural subgrade CBRs ≤ 3% (97% maximum dry density standard compaction at OMC). The equivalent design subgrade CBR of the treated subgrade must be determined in accordance with this document. Pavement design over treated subgrades may adopt the equivalent CBR determined in accordance with this document.

(3) Pavement structure - general

Unbound granular materials used must comply with the requirements of MRTS05. Bound layers must comply with the requirements under MRTS08.

The subbase layer must extend a minimum of 150 mm behind the rear face of any kerbing and/or guttering. The base and surfacing must extend to the face of any kerbing and/or guttering. Where the top surface of the subbase layer is below the level of the underside of the kerbing and/or guttering, the base layer must also extend a minimum of 150 mm behind the rear face of the kerbing and/or guttering.

For unkerbed roads, the subbase and base layers must extend for the full width of the formation.

The pavement designer must make specific allowance for traffic load concentrations within car park areas (e.g. entrances/exits).

The pavement designer must make provision for pavement layer drainage on the assumption that during the service life of the pavement ingress of water will occur. Compaction of the subbase, including 150mm behind the rear face of the kerb and channel, must be carried out before trenching of the subsoil behind the kerb.

(4) Unbound granular flexible pavements (bituminous surfaced)

Unbound granular flexible pavements with thin bituminous surfacings, including those with cement or lime modified granular materials, with design traffic up to 1×10^6 ESAs must be designed in accordance with Austroads *Guide to Pavement Technology Part 2: Pavement Structural Design*.

Residential streets and rural roads with non-fixed level construction (future overlay possible) must be designed in accordance with Austroads Guide to Pavement Technology Part 2: Pavement Structural Design.

For design traffic above 1×10^6 ESAs, the design must be in accordance with Austroads *Guide to Pavement Technology Part 2: Pavement Structural Design.*

An unsealed gravel pavement may be acceptable for assigned traffic volumes of less than 100vpd on lightly trafficked roads in rural areas. Where the connecting road to a reconfiguration is also unsealed, it must be upgraded to at least the gravel pavement standard, and, if the assigned traffic volume equals or exceeds 100vpd, it must be fully sealed, from its connection with an existing sealed road to a threshold point where the assigned traffic volume on the connecting road falls below 100vpd. Where an existing rural road is specified as upgraded to gravel pavement standard, the minimum pavement thickness is 100mm.

(5) Flexible pavements containing bound layers (bituminous surfaced)

Flexible pavements containing one or more bound layers, including cement stabilised layers or asphaltic concrete layers other than non-structural asphalt surfacings, must be designed in accordance with Austroads *Guide to Pavement Technology Part 2: Pavement Structural Design.*

(6) Rigid pavements

Rigid (concrete) pavements, with design traffic up to 1 x 10^6 ESAs must be designed in accordance with either CACA -T51 or Austroads *Guide to Pavement Technology Part 2: Pavement Structural Design.*

Rigid (concrete) pavements for design traffic above 1 x 10^6 ESAs, the design must be in accordance with Austroads *Guide to Pavement Technology Part 2: Pavement Structural Design.*

(7) Concrete segmental pavements

Concrete segmental pavements with design traffic up to 1 x 10^6 estimated commercial vehicles exceeding 3T gross must be designed in accordance with CMAA T45.

For design traffic above 1 x 10^6 ERAs estimated commercial vehicles exceeding 3T gross the design must be in accordance with Austroads *Guide to Pavement Technology Part 2: Pavement Structural Design*, with the calculation of design traffic in terms of ESAs.

(8) Clay segmental pavements

Clay segmental pavements with design traffic up to 1 x 10^6 ESAs must be designed in accordance withAustroads *Design Manual 1 - Clay Segmental Pavements.*

For design traffic above 1 x 10^6 ESAs and up to 1 x 10^7 ESAs the design must involve consideration of both *Design Manual 1 - Clay Segmental Pavements* and Austroads *Guide to Pavement Technology Part 2: Pavement Structural Design,* with the thicker and more conservative design of each of the two methods adopted.

For design traffic above 1 x 10^7 ESAs, the pavement must be designed in accordance with *Guide to Pavement Technology Part 2: Pavement Structural Design.*

SC6.4.4.2.8 Surfacing design

(1) Choice of surface type

Except where the pavement is designed for concrete or segmental paver surfacing, the wearing surface must be a bituminous wearing surface as follows:

(a) urban residential streets – urban Type A, B and C, major collector, sub-arterial and arterial roads—prime, plus one coat flush seal, plus asphalt;

(b) rural residential streets—access roads, collector roads, sub-arterial and arterial roads—prime, plus two coats flush seal; and

(c) commercial and industrial streets—prime and one coat flush seal plus asphalt;

In cases where it is required for the road to be opened to traffic upon completion of work, primerseal may be used with prior approval from council.

At intersection approaches and cul-de-sac turning circles on residential streets with flush seals, asphalt surfacing must be provided within the vehicle braking and turning zones.

Variations to these requirements may be approved by council in special circumstances.

(2) Sprayed bituminous seals (flush seals)

The design of sprayed bituminous (flush) seals, including primer seals, must be in accordance with the *Guide to Pavement Technology Part 3: Pavement Surfacings.*

7mm primer seals or prime and seals must be indicated on the Drawings below all flush seals, and asphalt surfacings. Where a 7 mm primer seal is impractical, a 10mm primer seal must be indicated in lieu.

Two-coat flush seals must be double-double seals, comprising a minimum of two coats of binder and two coats of aggregate. The preferred seal types are:

(a) 1st coat 14 mm; and

(b) 2nd coat 10 mm.

Single coat flush seals may be allowable if asphaltic concrete is to be applied as the finished surface. The preferred seal type is either 14mm or 10mm.

(3) Asphaltic concrete

In urban residential roads, medium to heavily trafficked commercial streets and in all industrial roads, the asphalt mix design must be a dense graded mix in accordance with the MRTS 30 06/09.

Asphaltic concrete surfacings must be designed to provide a nominal compacted layer thickness of not less than 30 mm (AC10) on light to medium trafficked residential streets, and 50 mm (AC14) minimum on medium to heavily trafficked residential, commercial roads and on all industrial and classified roads including all roundabouts and all cul-de-sac heads.

As a minimum, a 10mm primer seal or prime and seal must be indicated on the Drawings below the asphalt surfacing. Tack coat is to be used where the asphalt is used as an overlay.

Polymer Modified Bitumen in accordance with MRTS18 must be used in the asphalt in areas of heavy traffic where braking, turning, acceleration is to be experienced.

(4) Segmental pavers

Pavements must be sealed with a minimum of 10 mm primerseal prior to laying segmental pavers. Concrete segmental pavers must be 80mm thick, shape Type A, and designed to be paved in a herringbone pattern.

Clay segmental pavers must be 65mm thick, Class 4, and designed to be paved in a herringbone pattern. The edges of all paving must be designed to be constrained by either kerbing and/or guttering, or by concrete edge strips.

SC6.4.4.2.9 Documentation – pavement design criteria and calculations

All considerations, assumptions, subgrade test results, and calculations and other documentation required under this design specification must be submitted with the pavement design for approval by council.

The Drawings must clearly indicate the structure, material types and layer thicknesses of the proposed pavement and surfacing.

Pavement design criteria must be shown on the pavement drawings and include the ESA, CBR and expected design life.

SC6.4.4.2.10 Subsurface drainage design

(1) Subsoil and sub-pavement drains

(a) Warrants for use

(i) Subsoil drains are designed to drain groundwater or seepage from the subgrade and/or subbase in cuttings and fill areas.

(ii) Sub-pavement drains are designed to drain water from base and subbase pavement layers in flexible pavements, and to drain seepage or groundwater from the subgrade.

(iii) Subsoil or sub-pavement drains must be provided on both sides of the formation in the following locations, unless the geotechnical report indicates the absence of subsurface moisture at the time of investigation and the likelihood that changes in the subsurface moisture environment will not occur within the design life of the pavement and/or the pavement has been specifically designed to allow for likely variations in subgrade and pavement moisture contents:

(A) cut formations where the depth to finished subgrade level is equal to or greater than 400mm below the natural surface level;

(B) locations of known hillside seepage, high water table, isolated springs or salt affected areas;

(C) irrigated, flood-prone or other poorly drained areas;

(D) highly moisture susceptible subgrades, i.e. commonly displaying high plasticity or low soaked CBRs;

(E) use of moisture susceptible pavement materials;

(F) existing pavements with similar subgrade conditions displaying distress due to excess subsurface moisture; and

(G) at cut to fill transitions.

Where only one side of the formation is in cut, and the other side in fill, it may be sufficient to provide subsoil or sub-pavement drains only along the edge of the formation in cut.

(iv) The need for subsoil and sub-pavement drains may otherwise become apparent during the construction process, due to changes in site moisture conditions or to areas of poorer subgrade being uncovered that were not identified in the geotechnical investigation. The Design Drawings must be suitably annotated to the potential need for subsoil or sub-pavement drains in addition to those shown on the Drawings.

(2) Layout, alignment and grade

Typical cross sections of subsoil drains are shown in SC6.4.4.8 Standard drawing SD-080 – Subsoil Drain. In kerbed roads, the only acceptable location for the line of the trench is directly behind the kerbline. Pavement layers must extend to at least the line of the rear of the trench.

In unkerbed roads, subsoil and sub-pavement drains must be located within the shoulder, preferably at the edge of the pavement layers.

The minimum desirable longitudinal design grade is 1.0%. For non-corrugated pipes, an absolute minimum grade of 0.5% is acceptable.

Trench widths must be a minimum of 300 mm for a 100mm diameter slotted pipe or a minimum of 100mm for strip drains, Outlets must be spaced at maximum intervals of 150m into gully pits or outlet headwalls. As a salinity prevention measure and where practical, discharge must be on the downhill side of the embankment or in the cut-fill area to reduce the risk of recharge to the subsurface water table. Unless otherwise authorised, where subsurface drains outlet through fill batters, unslotted plastic pipe of the same diameter as the main run must be specified. A small precast concrete headwall must be installed at the drain outlet with a marker post to assist maintenance and protect the end of the pipe.

Cleanouts must be provided at the commencement of each run of drain, and at intervals not exceeding 80m. Cleanouts must generally be located directly at the rear of kerb or at the edge of shoulder, as applicable.

In salinity affected areas, the Designer should consider providing a separate drainage system for subsurface drains to discharge to a basin where controlled release or desiccation treatment and removal can be facilitated as a maintenance operation. Saline subsurface drainage should not be routinely discharged directly into natural watercourses. Reference to water quality targets for downstream watercourses is essential and the Designer must provide advice on discharge operations and maintenance compatible with water quality targets and the requirements of the relevant land and water resource or environmental protection authority.

SC6.4.4.2.11 Foundation drains

(1) Warrants for use

Foundation drains are designed to drain excessive ground water areas within the foundation of an embankment or the base of cutting, or to intercept water from entering these areas.

The need to provide foundation drains may be apparent from the results of the geotechnical survey along the proposed road formation alignment, and in this case the location must be shown on the Drawings. However, more commonly, the need to provide foundation drains is determined during construction, and hence in this situation requirements and locations cannot be ascertained at the design stage.

Where the road formation traverses known swampy, flood-prone, salt affected areas or watercharged strata, the Drawings must be suitably annotated for the potential need for foundation drains at various locations, in addition to those shown on the Drawings.

(2) Layout, alignment and grade

Typical cross-sections of foundation drains are shown below in Figure SC6.4.4.2.3.

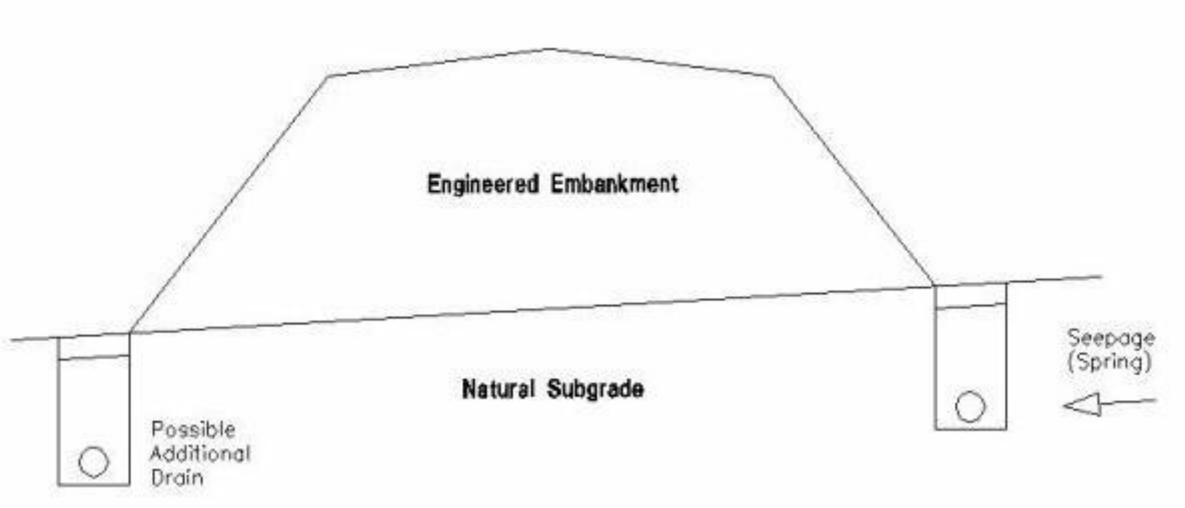

Figure SC6.4.4.2.3 Foundation drains

The minimum desirable design grade is 1%. For non-corrugated pipes an absolute minimum grade of 0.5% is acceptable.

Foundation drains must have a minimum trench width of 300 mm, with a variable trench depth to suit the application and ground conditions on site.

Outlets must be spaced at maximum intervals of 150m.

Where practicable, cleanouts must be provided at the commencement of each run of foundation drain and at intervals not exceeding 60 m. Where not practicable to provide intermediate cleanouts, outlets must be spaced at maximum intervals of 100m.

SC6.4.4.2.12 Drainage mats (blankets)

(1) Warrants for use

Type A drainage mats are designed where there is a need to ensure continuity of a sheet flow of water under fills, to collect surface seepage from a wet seepage area, or for protection of vegetation or habitat downstream of the road reserve where a fill would otherwise cut the flow of water. Type A drainage mats are constructed after the site has been cleared and grubbed and before commencement of embankment construction.

Type B drainage mats are designed where there is a need to intercept water which would otherwise enter pavements by capillary action or by other means on fills and to intercept and control seepage water and springs in the floors of cuttings. Type B drainage mats must be constructed after completion of the subgrade construction and before construction of the pavement.

The need to design for the provision of drainage mats should be apparent from the result of the geotechnical survey along the proposed road formation alignment.

SC6.4.4.2.13 Materials

(1) Subsoil and sub-pavement drain pipe

Pipes designated for subsoil, foundation and sub-pavement drains must be 100mm dia. slotted pipe.

Corrugated plastic pipe must conform with the requirements of AS 2439.1. The appropriate class of pipe must be selected on the basis of expected live loading at the surface. Joints, couplings, elbows, tees and caps must also comply with AS 2439.1.

Slotted rigid UPVC pipe must be of a type and class approved by council.

All pipe must be slotted, and fitted with a suitable geotextile filter tube, except for cleanouts and outlets through fill batters which must be unslotted pipe.

(2) Intra pavement drain pipe

Pipes designated for intra pavement drains with crushed rock subbases having layer thicknesses neither less than 150mm nor more than 200mm must be slotted thick walled UPVC pressure pipe complying with AS/NZS 1477.

Pipes designated for intra pavement drains with crushed rock subbases having layer thicknesses exceeding 200 mm must be slotted pipe of a type and class approved by council.

Pipes for use in Type B drainage mats must be slotted thick walled UPVC pressure pipe complying with AS/NZS 1477.

(3) Filter material

The types of filter material covered by this sub-section must include:

(a) Type A filter material for use in subsoil, foundation, and sub-pavement (trench) drains and for Type B drainage mats;

(b) Type B filter material for use in subsoil, foundation and sub-pavement (trench) drains;

(c) Type C filter material comprising crushed rock for use in Type A drainage mats; and

(d) Type D filter material comprising uncrushed river gravel for use in Type A drainage mats.

Material requirements and gradings for each type of filter material are included in the construction sub-section SC6.4.6.21 Subsurface drainage.

The type of filter material specified to backfill the sub-surface drainage trenches (subsoil, foundation and sub-pavement drains) depends on the permeability of the pavement layers and/or subgrade and the expected flow rate. Generally, Type A filter material is used for the drainage of highly permeable subgrade or pavement layers such as crushed rock or coarse sands, while Type B filter material is used for the drainage of subgrade and pavement layers of lower permeability such as clays, silts or dense graded gravels. Further guidance to the selection of appropriate filter material is contained in *Guide to Pavement Technology.*

(4) Geotextile

To provide separation (i.e. prevent infiltration of fines) between the filter material in the trench and the subgrade or pavement material, geotextile must be designated to encapsulate the filter material. The geotextile must comply with the requirements included in sub-section SC6.4.6.21 Subsurface drainage.

Geotextile must also be designated for both Type A and Type B Drainage Mats.

SC6.4.4.2.14 Documentation – subsurface drainage drawings and calculations

The proposed location of all subsurface drains must be clearly indicated on the Drawings, including the nominal depth and width of the trench, and the location with respect to the line of the kerb/gutter or edge of pavement. The location of outlets and cleanouts must also be indicated on the Drawings.

SC6.4.4.3 Bridges and other structures

SC6.4.4.3.1 Introduction

(1) Objective

This sub-section sets out design considerations to be adopted in the design of structural engineering elements associated with

(a) road traffic bridges;

(b) pedestrian/cyclist bridges;

(c) any structure designed to carry a road or a path over a waterway, depression or obstacle; and

(d) temporary works.

(2) Design considerations

Such structures may be primarily constructed of concrete, timber, steel or other materials appropriate to the application. The design should always have a primary emphasis on safety and whole of life cycle costs. The structure/s should comply with current Safety in Design principles and guidelines.

The design is to be certified that the proposed structure will not become unfit for use during its intended design life. This assessment will have measured regard to all associated issues with the proposed structure including:

(a) consideration of any future infrastructure planning;

(b) economic constraints;

(c) physical or structural constraints;

(d) aesthetic considerations;

(e) flooding or hydraulic capacities (if applicable);

(f) safety in design;

(g) maintenance and repair constraints;

(h) constructability; and

(i) fit for purpose.

(3) Basis of design

(a) The basis of the proposed bridge design is to principally conform to Austroads' road design standards, and AS 5100 as appropriate. The design must be based on sound engineering principles, and certified by a suitably qualified engineer (RPEQ).

(b) The safety and service performance of a structure will depend on the quality control exercised in fabrication, supervision of the site, control of unavoidable imperfections and the experience and skill of the personnel involved. Specific attention must therefore be given to these particular factors.

(c) All design criteria for bridges in the Townsville City Council local government area must be approved by council prior to the design being carried out. The Designer must make reference and address all issues outlined in Appendix A of AS 5100.1.

(d) Adequate management control and supervision by experienced engineers (RPEQ) is required at all stages of the design and construction to prevent the occurrence of any unapproved non-conformances with the plans and specifications.

(e) Specifications must be notated on the Drawings with sufficient details to ensure that the above described strategies are able to be effectively implemented throughout the construction stage.

(4) Reference and source documents

(a) Development manual planning scheme sub-sections to be read and applied in conjunction with this sub-section are as follows:

SC6.4.4.1 - Geometric road design

SC6.4.4.2 - Pavement design

SC6.4.4.7 - Bicycle, pedestrian and shared path design

(b) Australian Standards

AS 1158	*Lighting for roads and public spaces*
AS/NZS 3845	*Road safety barrier systems*
AS 5100	*Bridge Design*
AS1428	Design for access and mobility

(c)

AS1170	Minimum design loads on structure (SAA Loading Code)
AS1684	National timber framing code
AS3600	Concrete structures
AS3700	Masonry in buildings (SAA Masonry Code)
AS4100	Steel structures

Other codes and guidelines referred to in the Australian Standards, as relevant.

(d) Department of Transport and Main Roads Technical Specifications

MRS70	*Concrete (10/11)*
MRS71	*Reinforcing Steel (06/09)*
MRS72	*Manufacture of Pre-cast Concrete Elements (08/13)*

Other

Austroads, *Guide to Bridge Technology Part 4 - Design Procurement and Concept Design, 2009*
Queensland Department of Transport and Main Roads, *Road Planning and Design Manual, 2006*
Queensland Department of Main Roads, *Road Traffic Noise Management: Code of Practice, 2000*
Queensland Department of Energy and Water Supply, *Queensland Urban Drainage Manual*

SC6.4.4.3.2 Road traffic and pedestrian bridges

(1) Bridge design must only be carried out by properly qualified persons who are Registered Professional Engineers of Queensland (RPEQ) and experienced in structures design. If requested, such designers must submit evidence of these qualifications and experience to council prior to approval of any bridge design.

(2) The *Bridge Design Code* (AS 5100) must be used for all bridge design.

(3) Bridges must have low maintenance finishes. Adequate precautions must be taken for protection of the materials used in the bridge design; for example, timber and steel require special consideration. Heavy debris and bed loads may be characteristic of some streams so that large spans with slender piers are encouraged. If floodwater overtopping is to occur, pedestrian safety rails and road safety barriers could be omitted to reduce debris collection on the roadway. Flood depth indicators and appropriate signposting will be provided in such cases.

(4) Preventative maintenance is a key issue affecting the design life of the structure. The Drawings must specify the design life of the structure together with the relevant maintenance programs to be adopted upon which the design life is based. Parameters used in the design must also be shown on the Drawings.

(5) Hydraulic design of bridge/s must be in accordance with the requirements for major structures in SC6.4.4.4 Stormwater drainage design.

(6) Where structures are designed to be inundated, the effect of the backwater gradient on upstream property must be identified on the Drawings. Detailed consideration of alternate evacuation routes are also to be considered in the event that the bridge structure is to be inundated.

(7) Where no inundation is permitted, appropriate afflux must be adopted together with a 500mm freeboard to the underside of the bridge deck. All road structures with a 1% annual exceedance probability (AEP) designed waterway which is in excess of 5sqm must be modelled using current hydrological modelling practices (software) to determine the upstream impacts over the full range of storm events up to and including the 1% AEP. Impacts of the PMF are also to be assessed on the structure.

(8) The designer is to enquire with the appropriate authority on any current or likely provisions for public utilities or services on bridges. These should be concealed for aesthetic reasons. Consultation with the appropriate utility authority is to be undertaken during the course of the structural design, particularly in regard to the location and placement of existing and future public utilities.

SC6.4.4.3.3 Provision for pedestrians and cyclists on road bridges

(1) Provision for pedestrians and cyclists on bridges is required in rural residential as well as urban areas. The

minimum provision is a 1.5m footpath with a 150mm high kerb at the traffic lane edge. The design is to consider pedestrian on the bridge. A safety railing is to be provided between pedestrians and the trafficable lane together with 1.5m (min) wide shoulder to accommodate on-road cyclists.

(2) Council may require the provision of a combined cycleway and pedestrian footway should the risk to on-road cyclists be too high.

(3) Disability access across the proposed bridge is to be DDA compliant and generally in accordance with AS 1428.

(4) Urban bridge approaches should be lit in accordance with AS 1158.

SC6.4.4.3.4 Structures other than bridges, associated with roads

Public utility structures, major culverts, major sign support structures, retaining walls, and the like will be designed by a competent, practicing engineer (RPEQ certified) who is accredited in the design of such structures. The design must be in accordance with the SC6.4 Development manual planning scheme policy, relevant Austroads codes, all relevant Australian Standards, and the requirements of any utility owners that may be applicable.

SC6.4.4.3.5 Structures used for public safety

(1) Since the requirement of road safety barriers and pedestrian safety rails on bridges are different, the design engineer must consider whether separate traffic and pedestrian barriers can be detailed to satisfy the major functional requirements.

(2) The *Bridge Design Code* (AS 5100.1 Sections 10 - 12) and AS/NZS 3845 are recommended references in this regard.

(3) It is essential that all safety barriers and rails have been fully tested and accredited for the intended use under quality assurance provisions.

(4) Bridge crossings in urban and rural residential areas must be provided with street lighting in accordance with AS 1158. Such requirements will be noted accordingly on the drawings.

SC6.4.4.3.6 Temporary works

Structures which are proposed for the temporary support of roads, services and the like must be designed by a qualified Engineer (RPEQ certified) experienced and accredited in the design of such structures and designed in accordance with the *Bridge Design Code* (AS 5100). A construction programme, indicating the sequence of events leading to the implementation and removal of the temporary structures must be specified on the drawings. The design of such temporary structures is to mandate the safe constructability and use of these structures throughout the term of the construction works.

SC6.4.4.4 Stormwater drainage design

SC6.4.4.4.1 Introduction

(1) Objectives

(a) The objectives of SC6.4.4.4 Stormwater drainage design are as follows:

(i) to ensure that inundation of private and public buildings located in flood-prone areas occurs only on rare occasions and that, in such events, surface flow routes convey floodwaters below the prescribed velocity/depth limits;

(ii) to provide convenience and safety for pedestrians and traffic in frequent stormwater flows by controlling those flows within prescribed limits; and

(iii) retain within each catchment as much incident rainfall and runoff as is possible and appropriate for the planned use and the characteristics of the catchment.

(b) In pursuit of these objectives, the following principles apply:

(i) new developments are to provide a stormwater drainage system in accordance with the "major/minor" system concept set out in QUDM (Third Edition 2013 – provisional or as amended); that is, the "major" system shall provide safe, well-defined overland flow paths for infrequent storm runoff events while the "minor" system shall be capable of carrying and controlling flows from frequent runoff events; and

(ii) redevelopment - where the proposed development replaces an existing development, stormwater must be managed in a way that does not exacerbate flooding, and /or adversely impact on neighbouring land or road. The level of drainage provided must be consistent with new development.

(2) Scope

The work to be executed under this sub-section consists of the design of stormwater drainage systems for urban and rural areas.

(3) Reference and source documents

(a) Development manual planning scheme policy sub-sections to be read and applied in conjunction with its sub-section are as follows:
SC6.4.6.4 Stormwater Drainage
SC6.4.6.5 Drainage Structures
SC6.4.6.6 Pipe Drainage
SC6.4.6.7 Precast Box Culverts
SC6.4.6.9 Open Drains

(b) Australian Standards

AS/NZS 1254	*PVC-U pipes and fittings for stormwater and surface water applications.*
AS/NZS 2032	*Installation of PVC pipe systems.*
AS/NZS 2566.1	*Buried flexible pipelines, structural design.*
ASNZS 3725	*Design for installation of buried concrete pipes.*
AS/NZS 4058	*Precast concrete pipes (pressure and non-pressure).*
AS 4139	*Fibre reinforced concrete pipes and fittings.*

(c) The State of Queensland Department of Energy and Water Supply, *Queensland Urban Drainage Manual – Third Edition 2013 provisional, 2013*.

(d) Department of Transport and Main Roads*, Road Drainage Manual, 2015*

(e) *Other*
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Austroads 2013, Guide to Road Design Part 5: Drainage – General and Hydrology Considerations 2013, Austroads Ltd, Sydney NSW.
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Henderson, FM., Open Channel Flow, 1966.
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Institute of Public Works Engineering Australia, Qld Division, Standard Drawings, 2000.
Main Roads Department, Urban Road Design Manual (URDM), Volume 2., Queensland. First Edition 1975 as subsequently amended.

(e) *Sangster, WM., Wood, HW., Smerdon, ET., and Bossy, HG, Pressure Changes at Storm Drain Junction, Engineering Series, Bulletin No. 41, Eng. Experiment Station, Univ. of Missouri 1958.*
SC6.7 Flood hazard planning scheme policy.

Townsville City Council SC6.4.4.8 Standard drawings
SD-015 Footpath service allocation new streets
SD-020 Concrete kerbing
SD-080 Subsoil drains
SD-085 Drainage connections
SD-200 Precast grated kerb inlet system and cast insitu stormwater manhole SD-205 Stormwater manhole details
SD-210 Manhole slab top details
SD-215 Raised grate field inlet manhole

SC6.4.4.4.2 Major and minor system design AEPs

(1) The Annual Exceedence Probability(AeP) is the probability of exceedence of a given rainfall intensity or discharge within a period of one year.

(2) The major system design AEP is the Defined Flood Event, being the 1% AEP, unless altered by Table 8.2.6.3(b) of the Flood hazard overlay code.

(3) The Minor system design AEPs must be in accordance with Table SC6.4.4.4.1.

Table SC6.4.4.4.1 Minor System Design AEP and ARI

Development Category	ARI (yrs)	AEP
Residential	2	39%
Commercial - Lower order (district centre and below)	2	39%
Commercial - Other (excluding Lower order commercial and Principal centre)	5	18%
Industrial	5	18%
Principal Centre (CBD)	10	10%
Rural Residential	20	5%
Parks and recreation areas (excluding community facilities)	1	1EY

(4) The Minor system design AEP for streets is as per the adjacent development category listed in Table SC6.4.4.4.1.

SC6.4.4.4.2 Hydrology

(1) Design rainfall data can be obtained from one of the following methods:

(a) Design intensity-frequency-duration (IFD) rainfall - IFD relationships shall be derived in accordance with Volume 1, Book II, of AR&R, 1998 for the particular catchment under consideration;

(b) The nine basic parameters read from Maps 1-9 in Volume 2 of AR&R shall be shown in the calculations submitted to council, except where the Bureau of Meteorology provides a polynomial relationship for the catchment; or

(c) Design IFD rainfalls can be obtained from the Bureau of Meteorology website for specific locations and these are to be submitted to council.

(2) Catchment area

(a) The area of land contributing stormwater runoff to the point under consideration. Consideration must be given to likely changes to individual catchment areas and catchment parameters caused by the full development of the catchment in accordance with the zonings in the Townsville City Plan.

(b) Where no detailed survey of the catchment is available, contour maps produced from council's GIS are to be used to determine the catchments and to measure areas. A suitable scale shall be chosen.

(c) Catchment area land use shall be based on current available zoning information or proposed future zonings, where applicable.

(3) Rational method

(a) Rational method calculations to determine peak flows shall be carried out in accordance with QUDM (Third Edition 2013 – provisional).

(b) All calculations shall be carried out or supervised by a qualified engineer (RPEQ certified) who is experienced in hydrologic and hydraulic design.

(c) Coefficients of discharge shall be calculated as per QUDM (Third Edition 2013 – provisional or as amended) and full details of coefficients utilised shall be provided.

(d) Details of percentage impervious for individual zonings are given in SC6.4.4.4 Attachment A.

(e) The time of concentration of a catchment is defined as the time required for storm run off to flow from the most remote point on the catchment to the outlet of the catchment. Most catchments will have multiple lengths of flow paths and gradients. The longest length flow path may not always govern the critical flow path. The hydrologic design should analyse several paths to assess any sensitivity to the catchment's time of concentration.

(f) Where the flow path is through areas having different flow characteristics or includes property and roadway, then the flow time of each portion of the flow path shall be calculated separately.

(g) The minimum time of concentration shall be taken as 5 minutes urban and 10 minutes rural.

(h) Flow paths to pits must be designed to accommodate the flows from the fully developed catchment and provide for anticipated obstructions such as fences, building pads, buildings and other likely obstructions. Any proposed changes to flow paths must be undertaken on a catchment wide basis to ensure flow paths are not diverted onto other land parcels which may result in damage or loss of enjoyment of the adjoining lands.

(i) Surface retardance "n*" shall generally be derived from information in Volume 1, Book 8 Section 1.5.4 of AR&R 1998. Values applicable to specific zoning types and overland flow path types are given below:

Flow across parks 0.35
Flow across rural residential land (sparse vegetation) 0.30
Flow across park residential (short prairie grass) 0.150
Flow across residential low density 0.21
Flow across residential high density flow across industrial 0.06
Flow across commercial 0.04
Flow across paved areas 0.01
Flow across asphalt roads 0.02

Flow across gravel areas 0.02.

(j) The design and analysis of stormwater drainage is to be based on the peak runoff flows from sub-catchments and from accumulated catchments. Designers are to show, by the assessment of partial catchment areas, that the peak flows have been identified.

(k) The rational method is not appropriate for use in catchments with floodplain storage, timing effects due to multiple flow paths, and detention basins.

(4) Hydrological models

(a) Council has carried out flood modelling for most area across Townsville. Hydrological information from these models such as peak flows should be obtained to assist with the design of the stormwater system.

(b) Other hydrological models may be used as long as the requirements of AR&R are met, summaries of calculations are provided and details are given of all program input and output.

Details on the modelling requirements should be obtained from SC6.7 Flood hazard planning scheme policy.
A sample of a summary sheet for hydrological calculations is given in SC6.4.4.4 Attachment B.

(c) Where computer analysis programs are used, copies of the final data files shall be provided on submission of the design to council and with the final drawings after approval by council.

SC6.4.4.4.3 Hydraulics

(1) Hydraulic grade line

(a) Hydraulic calculations shall generally be carried out in accordance with AR&R and shall be undertaken by a qualified person experienced in hydrologic and hydraulic design. The calculations shall substantiate the hydraulic grade line adopted for design of the system and shown on the drawings. Summaries of calculations are added to the plan and details of all calculations are given including listings of all programme input and output.

(b) The "major" system shall provide a safe, well-defined overland flow path for larger storm events up to the maximum defined flood event. The "minor" system shall be capable of carrying and design flows from the lesser nominated flood events based on the land zoning of the area.

(c) Downstream water surface level are to be obtained from council's current existing flood studies. If flood study information is not available, the most appropriate of the below is to be used:

(i) known hydraulic grade line level from downstream calculations including pit losses at the starting pit in the design event;

(ii) where the downstream starting point is a pit and the hydraulic grade line is unknown, details of the downstream system shall be obtained and further analysis performed to determine the hydraulic grade line;

(iii) where the outlet is an open channel and the design storm is the minor event, details of the downstream system shall be obtained and further analysis performed to determine the hydraulic grade line. The top of the outlet pipe or the hydraulic grade line, or mean high water springs shall be the downstream control, whichever is higher;

(iv) where the outlet is an open channel, the design storm is the major event and downstream flood levels are not known, details of the downstream system shall be obtained and further analysis performed to determine the hydraulic grade line. The top of the outlet pipe or the hydraulic grade line shall be the downstream control whichever is the higher;

(v) where the outlet is an open channel, the design storm is the major event and downstream flood levels are known, the downstream control shall be the highest of all duration events for the defined flood event;

(vi) mean high water springs (MHWS) where discharges are to river or creek systems within the intertidal zone:
In some instances, the downstream water surface level may need to be determined with the

development of a flood study. Details on the flood study requirements should be obtained from SC6.7 Flood hazard planning scheme policy; and

(vii) the downstream water surface level used in the calculations should be provided to council.

(2) Major/minor system

Design of the drainage system should be in accordance with the major/minor flood management concept which recognises the dual requirements of the drainage system to provide for convenience and the protection of life and property for all storm events up to the defined flood event.

All design work undertaken should follow the guidelines set down in the *Queensland Urban Design Manual* (Third edition 2013 - provisional) unless otherwise instructed in this sub-section.

(3) Minor system criteria

(a) Minimum conduit sizes shall be as follows:

(i) pipes 375mm diameter; and

(ii) box culverts 600mm wide x 300mm high.

(b) Maximum velocity of flow in stormwater pipelines shall be 4m/sec. Minimum velocity shall be determined by ensuring self-cleansing velocity is achieved; this requirement shall be deemed to be satisfied if the product of slope and diameter (S x D) is not less than 0.0008m where S = slope (m/m) and D is pipe diameter (m).

(4) Roadway flow width and depth

(a) Flow width and depth criteria for major and minor storm events must comply with QUDM section 7.4.

(5) Inlet pits and Manholes

(a) Inlet pits and manholes must be provided:

(i) to enable access for maintenance;

(ii) at changes in direction, grade, level or class of pipe; and

(iii) at junctions.

(b) The maximum recommended spacing of pits and manholes where flow widths are not critical should be spaced every 80m for ease of maintenance purposes. Kerb inlets shall be constructed in accordance with SC6.4.4.8 Standard drawings SD 200.

(c) Pit entry capacity calculations must be undertaken to provide for adequate spacing of pits, and to ensure flow capture has been adequately analysed. Flow under weirs and/or orifice conditions must be carefully considered. Information on pit entry capacities is available in the following sources:

(i) Queensland Urban Drainage Manual;

(ii) Pit relationships given in Volume 1, Book 7 of AR&R 1998; and

(iii) manufacturers' design specifications.

(f) Blockage factors to be applied to theoretical inflow capacities of inlet pits are given in Table SC6.4.4.4.2:

Tables SC6.4.4.4.2 Allowable pit capacities

Condition	Inlet Type	Blockage factor
Sag	Side entry	20%
Sag	Grated	50%
Sag	Combination	Side inlet capacity only Grate assumed completely blocked
Sag	"Letterbox"	50%
Continuous Grade	Side entry	20%
Continuous Grade	Grated	50%

Continuous Grade	Combination	90%
Field inlet	Flush	80%
Field inlet	Raised grate	50%

(6) Hydraulic losses

(a) Pressure change co-efficient "K" shall be determined from the appropriate charts given in *QUDM* Appendix 2.

(b) Allowable reduction in "K" due to benching is given in *QUDM* section 7.16.8.

(c) Computer program default pressure change co-efficient "K" shall not be acceptable unless they are consistent with those from the charts in *QUDM*. The chart used and relevant co-efficients for determining "K" value from that chart shall be noted on the hydraulic summary sheet provided for plan checking and included on the final design drawings.

(d) Bends may be permissible in certain circumstances and discussions with council regarding their use is required prior to detailed design. Appropriate values of pit pressure change co-efficient at bends are given in *QUDM*.

(e) The design must avoid clashes between services. However, where unavoidable clashes occur within the existing network, then the pressure change co-efficient "Kp" must be determined from the chart given in *QUDM* section 7.16.11.

(f) Requirements for private pipes entering council's system are given below:

(i) all pipe inlets, including subsoil pipes, must where possible, enter the main pipe system at junction pits. These must be finished off flush with and be grouted into the pit wall; and

(ii) if a junction has to be added then a junction pit shall be built at this location in accordance with this sub-section.

(g) Construction of a junction without a structure should be avoided where possible. Permission to do this is required by council prior to detailed design. Where this is unavoidable the pressure change coefficients Ku, for the upstream pipe and Kl, for the lateral pipe, must be determined from the chart given in *QUDM*.

(h) Going from larger upstream to smaller downstream conduits is not permitted without approval of council prior to detailed design. In going from smaller to larger pipes benching must be provided in pits to enable a smooth flow transition. Losses in sudden expansions and contractions are given in *QUDM*.

(i) Underground drainage systems must be designed as an overall system, with due regard to the upstream and downstream system and not as individual pipe lengths. Drainage system designs must clearly show the hydraulic grade line (HGL), especially in systems operation undue pressure.

(7) Major system – minimum freeboard criteria

(a) Where floor levels of adjacent buildings are above road level there must be a minimum freeboard of 300mm to floor level of adjacent buildings.

(b) Where floor levels of existing adjacent buildings are below, or less than 300mm above the top of kerb, and there is at least 100mm fall on the footpath towards the kerb, the maximum flow depth is 50mm above the top of kerb.

(c) Where floor levels of existing adjacent buildings are below, or less than 300mm above the top of kerb, and there is less than 100mm fall on the footpath towards the kerb, the maximum flow depth is at the top of kerb.

(d) Wave action wash that enters properties from passing vehicles must be considered.

(e) Road capacities and major system flood levels are to be determined adopting the roadway as an open channel. Assessment of flood impacts on adjoining properties must consider any effects of backwater from the adjacent waterway using backwater analysis techniques.

(8) Minimum grades

(a) Unlined drains must have a minimum grade of 0.5% and lined drains must have a minimum grade of 0.3%. This includes table drains and kerb and channel.

(b) Pipe and box culverts must have a minimum grade of 0.2%.

(9) Open channels

(a) Generally, open channels and swales must be designed to have smooth transitions with adequate access provisions for maintenance and cleaning. Where council permits the use of an open channel to convey flows from a development site to the receiving water body, such a channel must comply with the requirements of this sub-section.

(b) Design of open channels must be in accordance with Volume 1, Book VIII of AR&R 1998. Open channels must be designed to contain the major system flow.

(c) Friction losses in open channels must be determined using Mannings "n" values. Mannings "n" roughness co-efficients for open channels must generally be derived from information in Chapter 14 of AR&R. Mannings "n" values applicable to specific channel types are given in the table below:

Surface Type	Mannings “n”
Concrete Pipes or Box Sections	0.011
Concrete (trowel finish)	0.014
Concrete (formed without finishing)	0.016
Sprayed Concrete (gunite)	0.018
Bitumen Seal	0.018
Bricks or pavers	0.015
Pitchers or dressed stone on mortar	0.016
Rubble Masonry or Random stone in mortar	0.028
Rock Lining or Rip-Rap	0.028
Corrugated Metal	0.027
Earth (clear of weeds and debris)	0.022
Earth (with weeds and gravel)	0.028
Rock Cut	0.038

For all grass channels refer to the *Road Drainage Manual* (Chapter 8) for grass retardance factors.

(d) Where the product of average Velocity and average flow Depth for the design flow rate is greater than 0.4 m^2/s, the design must specifically provide for the safety of persons who may enter the channel in accordance with Volume 1, Book VIII of AR&R 1998.

(e) Maximum side slopes on grassed lined open channels must be in accordance with section 9.5.3 of *QUDM* (3rd Edition 2013 – provisional, or as amended.).

(f) Low flow provisions in open channels (man-made or altered channels) will require low flows to be contained within a pipe system or concrete lined channel section at the invert of the main channel. The width of the concrete lined channel section must be the width of the drain invert or at least sufficiently wide enough to accommodate the full width of a tractor with an absolute minimum width of 1.5 m.

(g) Open channels should be wide and shallow in preference to narrow and deep in order to maintain natural invert level to reduce the expression of groundwater.

(h) Designers should also ensure that longitudinal grades are sufficient to prevent the ponding of storm water for periods of more than 2 days after a rain event.

(i) Transition in channel slopes is to be designed to avoid or accommodate any hydraulic jumps due to the nature of the transition.

(j) Drop structures must be designed in open channels were the water velocity exceeds 2m/s. The design must address the size and location of the structure as well as details of any stilling basins and revetment works surrounding the structure.

(k) Special consideration must be given to erosion control where sodic soils occur. Details of treatment proposals prepared by a competent person must be provided and approved by council.

(10) Major structures

(a) All major structures in urban areas, including bridges and culverts, must be designed for the 1% AEP storm event with minimal afflux. Some afflux and upstream inundation may be permitted in certain rural and urban areas provided the increased upstream flooding does not inundate private property or critical infrastructure.

(b) A minimum clearance of 0.5m between the 1% AEP flood level and the underside of any structure is required to allow for passage of debris without blockage.

(c) Certified structural design must be provided for bridges and other major culvert structures and may be required on some specialised structures. Structural design must be carried out in accordance with the SC6.4.4.3 Bridges and other structures.

(d) Culverts (either pipe or box section) must be designed in accordance with information and charts provided in QUDM 3rd Edition - provisional (as amended).

(e) Safety limitations – overtopping of roadways. All floodwaters overtopping a major structure such as a culvert or bridge structures within a road are to be checked for safety and stability limitations for both pedestrians and vehicles. Assessment of the waterway crossing safety and stability is to be undertaken based on criteria outlined in *QUDM* 3rd Edition 2013 - provisional (as amended) – Table 7.4.3 and 7.4.4

Detention basins

(a) For each AEP a range of storm events shall be run to determine the peak flood level and discharge from the retarding basin. Storm patterns shall be those given in Volume 1, Book III of AR&R. The critical storm duration with the retarding basin is likely to be longer than without the basin. A graph showing the range of peak flood levels in the basin and peak discharges from the basin shall be provided for the storms examined.

(b) Flood routing should be modelled by methods outlined in AR&R. Rational method approximations of flood hydrographs are unacceptable.

(c) The high level outlet to any retarding basin shall have capacity to contain a minimum of the 1% year AEP flood event. Additional spillway capacity may be required due to the hazard category of the structure. The hazard category should be determined by reference to ANCOLD.

(d) The spillway design shall generally be in accordance with the requirements for Open channel design in SC6.4.4.4.3(7) Open channels and *QUDM* (Chapter 5).

(e) The low flow pipe intake shall be designed in accordance with the requirements of QUDM, Section 5.08.

(f) Freeboard - Minimum floor levels of dwelling shall be 0.3m above the Defined 1% AEP flood level in the basin.

(g) Public safety issues - Basin design is to consider the following aspects relating to public safety:

   (i) side slopes are to be a maximum of 1 in 6 to allow easy egress. Side slopes of greater than 1 in 4 may require handrails to assist in egress;

   (ii) water depths shall be, where possible, less than 1.5m in the defined AEP flood event. Where neither practical nor economic, greater depths may be acceptable. In that case the provision of safety refuge mounds should be considered;

   (iii) the depth indicators should be provided indicating maximum depth in the basin;

   (i) signage of the spillway is necessary to indicate the additional hazard;

   (ii) basins shall be designed so that no ponding of water occurs on to private property or roads;

   (iii) no planting of trees in basin embarkment walls is allowed;

   (iv) no basin spillway is to be located directly upstream of urban areas; and

   (v) submission of Drawings to the Dam Safety Committee is required where any of these guidelines are not met or council specifically requires such submission.

   (vi) Stepped spillways are used in rare instances for energy dissipation and scour control. Guidance on hydraulic design and analysis of these structures is as per Chanson 1994.

(12) Tidal barriers

The use of tidal barriers on stormwater outlets are required in areas affected by tides. The device used should meet the following criteria:

(a) limited pressure head required to allow the discharge of stormwater from the system without any manual intervention. Specifications of the device used should be supplied to council prior to detailed design;

(b) barriers should not be able to be wedged open to an incoming tide by litter;

(c) council will not accept hinged flap gates as a suitable solution; and

(d) minimal requirements for repairs and maintenance of the device. Any maintenance information for the device should be supplied to council prior to detailed design.

(13) Barriers at inlet and outlets

Provision shall be made for the safety of the public including children in regards to the inlet and outlet of the stormwater system and should be based on the following criteria:

(a) no opening into an underground system shall be wider than 150mm except at head walls to pipes and box culverts;

(b) headwalls on the inlets and outlets to underground drains in which the drain is longer than 30m and has a cross sectional area greater than 0.5m^2 must be protected with hand rails, guard rails or fencing which restricts easy access to the entry structure;

(c) trash screens or other forms of grates are not favoured across the front of inlets and are unlikely to be approved by council unless there is a tidal barrier on the outlet of the stormwater system – this may be considered by council;

(d) any grates over field inlet pits shall be set above the top of the pit so as to provide a 50mm gap between the top of the pit and the bottom of the grate. In areas of open space, marker posts must be used to identify each corner of the pit; and

(e) under no circumstances, should fixed barriers or grates be placed at the end of stormwater outlet.

SC6.4.4.4.4 Stormwater detention

(1) Installation of stormwater detention is required on all development sites where insufficient capacity in the downstream drainage systems exist and a minimum amount of detention will be that required to ensure no worsening of the flooding situation occurs during the defined flood event.

(2) The requirements for stormwater detention design are outlined in *QUDM.*

(3) The development must limit any increase in discharge rate for all storm events up to and including the defined flood event.

(4) The developed site must not discharge more stormwater than the discharge calculated for pre-development flows.

(5) Combined sedimentation and detention ponds must be designed in accordance with SC6.4.3.9 Water sensitive urban design guidelines so that remobilisation of sediment is minimised.

SC6.4.4.4.5 Interallotment drainage

(1) Interallotment drainage must be avoided wherever possible. Where interallotment drainage is proposed, the developer must demonstrate that no other drainage alternative is possible.

(2) Where interallotment drainage is unavoidable, it ~~must~~ should not cover more than 2 allotments and must be contained within an easement not less than 3m wide. The easement must be provided over the entire length of the drainage structure in favour of lots benefiting from and affected by the pipe. All interallotment and allotment drainage, connector pipes and surface water collection infrastructure remains the responsibility of the lot owner.

(3) Where interallotment drainage is unavoidable and serves more than 5 allotments, a minimum 375mm diameter pipe (Level 3 in accordance with Queensland Urban Drainage Manual, QUDM) must be provided to capture the flow and must be contained within an easement not less than 3m wide. The easement must be provided over the entire length of the drainage structure in favour of council over collector pipe.

~~(2)~~(4) Interallotment drainage shall not be provided in commercial and industrial developments. Commercial and industrial areas shall connect directly to the council stormwater network.

~~(3)~~(5) Where drainage is required over more than two allotments, a drainage easement is required in favour of council. See SC6.4.4.4.8 Drainage easements and drainage reserves.

~~(4)~~(6) Interallotment drains must be designed to accept concentrated drainage from buildings and paved areas on each allotment for flow rates having a design AEP the same as the "minor system" per Table SC6.4.4.4.1.

~~(5)~~(7) Major system flows within interallotment drains should be avoided where possible. In instances where this is unavoidable, the design of interallotment drainage must make allowance for major system flows, with appropriate freeboard.

~~(6)~~(8) In lieu of a more detailed analysis, the fraction impervious for surfaces contributing runoff to the interallotment drain are as per SC6.4.4.4 Attachment A.

~~(7)~~(9) Pipes must be designed to flow full at the design discharge without surcharging of inspection pits.

~~(8)~~(10) Interallotment drainage pits must be located at all changes of direction. ~~Pits must be constructed of concrete, with 100mm thick walls and floor and have a minimum 600mm x 600mm internal dimensions. Raised grated inlets are required at all locations. (including change in direction).~~ Pits must be constructed from an industry approved material and accepted by council for use.

~~(9)~~(11) The interallotment drainage must have a minimum longitudinal gradient of 0.5~~2~~% for grassed lined open channels and 0.4% for pipes to achieve self cleansing velocity or as agreed by council.

~~(10)~~(12) The interallotment drainage must be constructed from either fibre reinforced concrete drainage pipe, reinforced concrete pipe, or UPVC pipe which must conform respectively to the requirements of AS4139, AS/NZS4058 and AS/NZS1254 respectively.

~~(11)~~(13) Where interallotment drainage and sewer mains are laid adjacent to each other they must be spaced with 1.5m between pipe centrelines (where the pipe inverts are approximately equal).

~~(12)~~(14) Where there is a disparity in level between inverts the spacing must be submitted for approval.

~~(13)~~(15) Where sewer mains are in close proximity to interallotment drainage lines they must be shown on the interallotment drainage plan.

SC6.4.4.4.6 Detailed design

(1) Conduits

(a) Pipe bedding and cover requirements for reinforced and fibre reinforced concrete pipes shall be determined from the Concrete Pipe Association's *Concrete Pipe Guide* or AS/NZS 3725. For uPVC pipes, the requirements shall be to AS/NZS 2032.

(b) Conduit jointing shall be in accordance with manufacturer's specifications. S.R.C pipes shall use external band joints.

(c) Drainage lines in road reserves shall generally be located behind the kerb line and parallel to the kerb. Drainage lines in easements shall generally be centrally located within easements. Refer to SC6.4.4.8 Standard drawing SD-015.

(d) Drop structures shall be designed on drainage lines where the pipe gradient exceeds 5 per cent or water velocity exceeds 4m/s. The design details shall address the size, and position in the trench as well as spacing along the line.

Note—Buried flexible drainage pipes
Particular situations may be identified during the design of a development for the use of buried flexible pipes instead of the pipes specified in SC6.4.6.6 Pipe drainage.

In such cases, the design will be required to select the flexible pipe type appropriate for the particular application and prepare the relevant technical specification clauses for the supply and construction with reference to AS/NZS 2566.1, Buried flexible pipelines Part 1: Structural design. The proposed additional clauses would then be submitted, as an addendum to the development consent, for review and approval by council.

(2) Pit design
Pits shall be designed in accordance with SC6.4.4.8 Standard drawings SD-200, SD-205, SD 210 and SD-215. Safety and safe access are important in pit design and grates shall be of "bicycle safe" design.

(3) Stormwater discharge

(a) Scour protection at culvert, pipe system or kerb and channel outlets shall be designed in accordance with the guidelines outlined in *QUDM 3rd Edition - 2013 – provisional*, Section 8.7. Council will discourage the use of any outlet structure that proposes ponding at the outlet

(b) Where a developer proposes to concentrate stormwater onto an adjoining property, council will require the Developer to provide written agreement from the adjoining owner(s) granting permission to the discharge of stormwater through their property and the creation of any necessary easements.

(c) Where it is proposed to discharge runoff to an area under the control of another statutory authority, the design requirements of that statutory authority are also to be met.

(d) Piped stormwater drainage discharging to recreation reserves is to be taken to a point of discharge nominated by council and in the manner nominated by council.

(4) Trench subsoil drainage
Subsoil drainage should be designed and installed as per SC6.4.4.8 Standard drawings SD 080.

SC6.4.4.4.7 Documentation

(1) Drawings

(a) Catchment area plans shall be drawn to scales of 1:500, 1:1000 or 1:5000, unless alternative scales are specifically approved by council and shall show contours, direction of grading of kerb and channel, general layout of the drainage system with pit locations, catchment limits and any other information necessary for the design of the drainage system.

(b) The drainage system layout plan shall be drawn to a scale of 1:500 for urban areas and 1:1000 rural areas and shall show drainage pipeline location, drainage pit location and number and road centreline chainage, size of opening and any other information necessary for the design and construction of the drainage system.

(c) The plan shall also show all drainage easements, reserves and natural water courses. The plan may be combined with the road layout plan.

(d) The drainage system longitudinal section shall be drawn to a scale of 1:500 horizontally and 1:50 vertically and shall show pipe size, class and type, pipe support type in accordance with AS/NZS 3725 or AS/NZS 2032 as appropriate, pipeline and road chainages, pipeline grade, hydraulic grade line and any other information necessary for the design and construction of the drainage system.

(e) Open channel cross sections shall be drawn to a scale of 1:100 natural and shall show the direction in which the cross sections should be viewed. Reduced levels are to be to Australian height datum (AHD), unless otherwise approved by council where AHD is not available.

(f) Details including standard and non-standard pits and structures, pit benching, open channel designs and transitions shall be provided on the drawings to scales appropriate to the type and complexity of the detail being shown.

(g) As constructed drawings shall be submitted to council upon completion of the drainage construction and prior to council’s acceptance of completed works. The detailed drawings may form the basis of this information; however, any changes must be noted on these drawings.

(h) The as constructed plans must clearly identify the sections of the drainage system that will be owned by private residents as agreed by council.

(2) Easements and agreements

(a) Evidence of any Deed of Agreement necessary for the diversion of runoff through an adjoining property must be submitted prior to any approval of the engineering drawings required for operational works application. Easements must be created concurrently with the issue of the plan of survey.

(b) Where an agreement is reached with the adjacent landowners to increase flood levels on their property or otherwise adversely affect their property, a letter signed by all the landowners outlining what they have agreed to and witnessed by an independent person shall be submitted prior to any approval of the application.

(3) Summary sheets

A copy of a Hydrological Summary Sheet providing the minimum information set out in SC6.4.4.4 Attachment B.

(4) Computer program files and program output

(a) Computer program output may be provided as long as summary sheets for hydrological and hydraulic calculations in accordance with this design specification are provided with plans submitted for checking and with final drawings.

(b) Copies of final computer data files (electronic and hard copy), for both hydrological and hydraulic models shall be provided for council's data base of flooding and drainage information in formats previously agreed with council.

SC6.4.4.4.8 Drainage easements and drainage reserves

(1) Specifications for new easements and reserves

(a) Easements must be of a size to enable necessary works including, but not limited to, construction, maintenance and inspection, to be carried out.

~~(b)~~ Easement widths for drainage must be no less than the greater of the criteria ~~in Table SC6.4.4.4.3.~~ below

~~(c)~~(b)

Criteria	Type	Easement/Reserve Width
Pipe/Culvert	Pipe diameter/box culvert width ≤900mm	Minimum 3.0m
	Pipe diameter/box culvert width >900mm	Easement to extend to outside diameter/box culvert width + 1m each side of external edges of pipe/culvert
Channel/Drain	Base width ≤5m	Full bank width of channel/drain + 4m wide access path along one bank
	Base width ~~≤~~>5m	Full bank width of channel/drain + 4m wide access path along both sides of channel/drain

~~(d)~~(c) All drainage easements must be sized and located to ensure that they are not affected by, and do not impact on, an existing building’s footing zone of influence, and give consideration to any future building footings on the subject or adjoining land.

(2) Residential, commercial and industrial areas

All major drainage is to be located within a drainage reserve with the minimum widths of that reserve being capable of containing the 1 per cent AEP design flows plus a 4m strip on each side for maintenance access and safety purposes.

(3) Rural residential areas

(a) Easement must be created over all drains and natural water courses through private property. Unless council determines the land is to be set aside for public use and is to be handed to council.

(b) In rural residential areas adjacent to a major watercourse, council may require drainage reserves or easements to be extended to cover identified areas of riparian vegetation, which maybe beyond the strip required for maintenance access and safety purposes.

(4) Rural areas

(a) Easements or reserves are not required over natural watercourses. However easements must be provided over all drains where stormwater is diverted from the natural flow path and be wide enough to contain the flows from the defined flood event plus adequate width for maintenance and safety purposes.

(b) Where the land falls away from the road, easements for drainage are required through private property over formed drains from road culverts and table drains. The location of these easements shall be fixed during design and approval of operational works for the roadworks concerned.

(5) Maintenance of easements

(a) A drainage easement over a property restricts the use of the area of land contained within the easement for drainage purposes. Council's level of service for drainage easements is restricted to ensuring the drainage easement is capable of performing its purpose of carrying stormwater flows through the property. If an owner desires a higher order of maintenance for other reasons, this will be at the owner's ongoing cost and must not compromise the drainage function of the easement. Altering of the drain in the easement by the owner without the approval of council may result in action being undertaken by council to restore the drainage path at the expense of the owner.

(b) Where subdividers are required to provide drainage easements and reserves over approved drainage paths, then these are to be acquired over the entire land at the first stage of subdivision. Where surcharge paths are terminated at the end of stages then drainage easements are required over balance lands, with such easements being released progressively with future stages that provide the surcharge path down the future roads or drainage reserves.

(6) Instruments relating to the terms – easements upon private property

Standard wording for the instruments setting out the terms for the various types of easements that can be acquired for drainage are to be utilised, with each document being cognisant of council's needs for future grading and on-going maintenance. The document is to also ensure that the responsibility and definition of maintenance within drains is clearly defined on the instruments that accompany the easement documents. This is particularly important in the rural residential areas where some residents have an expectation that council will maintain the land (easement) to a much higher standard than is needed for drainage purposes. In particular, in relation to inter-allotment drains that are not a part of the public drainage system, provision is to be made in the easement document to state that all maintenance is the owner's responsibility but with provision being made to enable the council to carry out necessary works at the cost of the defaulting owner.

SC6.4.4.4 Attachment A - Design AEPs and fraction impervious for land use zones

Development Category	**Land use**	**Fraction impervious (fi)**
Residential zones category	Low density residential	0.65
	Medium density residential	0.7
	High density residential	0.9
	Rural residential	0.6
	Character residential	0.55
Centre zones category	Neighbourhood centre	0.9
	Local centre	0.9
	District centre	0.9
	Major centre	1
	Principal centre (CBD)	1
	Specialised centre	0.9
	Mixed use	0.9
Community facilities and Open space zone category	Sport & recreation	0.2
	Open Space	0.2
	Community facilities	0.95
	Environmental management & conservation	0.4
Industry zones category	Low impact industry	0.9
	Medium impact industry	0.9
	High impact industry	0.9
Rural zones category	Rural	0.1
Other zones category	Emerging community	-
	Special purpose	-

SC6.4.4.4 Attachment B - Hydrologic and Hydraulic calculation sheets

Click here to view SC6.4.4.4 Attachment B - Hydrologic and Hydraulic calculation sheets

SC6.4.4.5 Earthworks (design)

SC6.4.4.5.1 Introduction

(1) Objectives

This sub-section provides advice, guidelines and standards for earthworks including to ensure the:

(a) efficient, sustainable and economical design;

(b) enhancement of the environmental character of the site whilst maintaining the natural features of the site;

(c) provision of safe conditions for construction commensurate with the proposed purpose of the development;

(d) equality of building conditions for residential development; and

(e) earthworks does not impact on adjoining properties and developments.

(2) Scope

(a) This sub-section sets out requirements for earthworks involved in land development and subdivision. Conceptual requirements are presented as necessary considerations when preparing designs for earthworks.

(b) The scope of this sub-section assumes that the Designer is familiar with requirements cited in the various construction specifications, specifically those related to earthworks, clearing and grubbing and erosion and sedimentation. Additionally the Designer is required to make reference to the associated design sub-sections related to stormwater drainage design, geometric road design and stormwater quality management, and any other relevant best practice documents.

(3) Reference and source documents

(a) Development manual planning scheme policy sub-sections to be read and applied in conjunction with this sub-section are as follows:

(i) Construction sub-sections
SC6.4.6.1 Water sensitive urban design construction and establishment guidelines
SC6.4.6.11 Clearing and grubbing
SC6.4.6.10 Earthworks (construction)
SC6.4.6.26 Landscaping

(ii) Design sub-sections
SC6.4.3.8 Stormwater quality management plans for development
SC6.4.3.9 Water sensitive urban design guidelines
SC6.4.4.1 Geometric road design
SC6.4.4.4 Stormwater drainage design

(b) Australian Standards
AS3798 *Guidelines on earthworks for commercial and residential developments*
AS2870.1 *Residential slabs and footings - construction.*

(c) Qld Government Legislation
Work Health and Safety Act 2011

SC6.4.4.5.2 Earthworks concept design

(1) Areas of a site proposed for earthworks, building or recreational purposes may not be suitable in their natural state for their intended function without improvement works to:

(a) alleviate flooding of low-lying ground;

(b) fill gullies or create emergency flowpaths after underground stormwater piping has been installed;

(c) allow improved runoff from flat ground;

(d) regrade excessively steep slopes that would preclude economical construction of dwelling foundations; and

(e) allow effective recreational use or give reasonable access.

The Designer must review the natural surface contours as determined and identified on site and where necessary must design finished surface levels that ensure the land is suitably prepared.

(2) Areas should be regraded to minimise the necessity for underground drainage systems with surface inlet pits, and allow surface water to flow naturally to roads or drainage reserves without excessive concentration.

(3) The Designer must consider the implications of earthworks in relation to the existing natural environment. Generally earthworks must be minimised in heavily treed areas.

(4) Care must be taken to provide depressions for overland flow from low points and over major drainage lines, to direct stormwater for storms up to a 1% annual exceedance probability (AEP).

(5) The design of earthworks areas in conjunction with the design of roadworks must be considered with the objective of balancing cut to fill and achieving both an economical development and minimising haulage of imported fill or spoil to and from the development site. Bulk haulage should always be considered as having an adverse effect on adjacent development and infrastructure.

SC6.4.4.5.3 Special treatment of particular areas

(1) All lots must be regraded to a minimum level at the1% AEP flood level. In doing so, the Designer must ensure that other areas are then not affected by flooding. The site must be identified on the Drawings with appropriate notation of site specific requirements. As a guide, minimum lot grading should be 1:200 for residential development and minimum lot grading should be 1:400 for commercial development.

(2) In the event that an area is known to be affected by or inundated by local stormwater flows, the Designer must investigate the existing conditions as they relate to the proposed development and advise the Developer in the preliminary design report on all data obtained in the investigation and recommend appropriate contour adjustments. The report should be accompanied by sketch plans to clarify recommendations and any other relevant data.

(3) Site constraints either natural or otherwise may be required to be identified as a burden on developed property. The Designer must take this into account when preparing the design. The property may ultimately be affected by a "restriction as to user", which may be controlled by a legal Instrument placed on title to the land and/or by a message advising prospective purchasers of any restrictions affecting the land.

(4) The finished surface of filled areas must be designed to levels allowing an adequate cover depth over the pipeline (if piped) and permitting surface stormwater flow to be guided to inlet pits if depressions are retained in the finished surface contouring.

(5) The location of such features must be clearly defined on the earthworks plans and defined by distance to corner boundaries etc. for purposes of relocation. A geotechnical report specifying the site specific preparation and compaction requirements must be incorporated in the earthworks plan. A description of the minimum acceptable quality of the fill must also be specified on the plans, supported by geotechnical recommendations. All documentation necessary from various authorities to support the filling of dams and watercourses must be supplied with the Drawings.

(6) The finished level of any building area must be designed to ensure a desirable surface grading of 0.5% minimum oriented in the direction of the drainage system designed to cater for its catchment.

SC6.4.4.5.4 General standard of lot preparation

(1) Special requirements will apply where necessary but generally lots are to be cleared of low scrub, fallen timber, debris, stumps, large rocks and any trees which in the opinion of council are approaching the end of their functional life or are dangerous or will be hazardous to normal use of the development. Prior consultation with council's officer responsible for tree preservation, or other authorised council officer, is necessary. Such requirements must be shown on the Drawings.

(2) All timber and other materials cleared from lots must be removed from the site. All roots, loose timber, etc. which may contribute to drain blockage must be removed. Such requirements must be shown on the Drawings.

(3) In areas to be filled over butts of trees, allowance must be made for clearing of all trees and replanting with a minimum of six advanced suitable species to each lot; planting must to be clear of probable future building location and services and utilities, and not to be commenced until filling has been completed and graded, with provision for watering and maintenance for duration of the contract. These specific requirements must be shown on the Drawings.

(4) Selected trees must be preserved by approved means to prevent destruction normally caused by placement of

conventional filling or other action within the tree drip zone. The Tree Preservation Officer, or other authorised council officer, must be consulted for advice and all specific requirements noted on the Drawings.

SC6.4.4.5.5 Standard of fill for lots

(1) The following notations are to be incorporated in the Drawings. "Filling is to be of sound clean material, reasonable standard and free from large rock, stumps, organic matter and other debris". "Placing of filling on the prepared areas shall not commence until the authority to do so has been obtained from the council".

(2) All work must be in accordance with AS3798. Fill must be placed in layers not exceeding 150mm compacted thickness. All fill must be compacted to 95% standard maximum dry density. Maximum particle size is 2/3 of the layer thickness.

(3) Fill comprising natural sands or industrial wastes or by-products may only be used after the material type and location for its use is approved by council and will be subject to specific requirements determined by prevailing conditions.

(4) It is essential that prior advice be given of intended use of such materials. It should be noted that failure to obtain council's approval may lead to an order for removal of any material considered by council or other relevant authorities as unsuitable or in any way unfit for filling.

(5) All areas where filling has been placed must be dressed with clean arable topsoil, fertilised and sown with suitable grasses. This work must be carried out in accordance with the sub section SC6.4.6.26 Landscaping.

SC6.4.4.5.6 Temporary diversion drains

(1) Where temporary drains are required to divert surface flows away from the earthworks area, the location and silt/erosion control treatment must be clearly identified on the Drawings. The scale of such works must reflect the volume of water to be diverted.

The objective will be to ensure minimal soil disturbances and material loss off the site.

The requirements identified in SC6.4.4.4 Stormwater drainage design, SC6.4.3.8 Stormwater quality management plans for development, and SC6.4.3.9 Water sensitive urban design guidelines must be addressed for technical details and any additional requirements.

SC6.4.4.5.7 Concurrence with the Department of Environment and Heritage Protection

The Designer is recommended to refer to the Department of Environment and Heritage Protection with regard to any items requiring specific consideration when preparing an earthworks plan. Such plans may need to incorporate sediment/siltation/erosion control devices with specific reference to the stage at which these are to be provided. The responsibility rests with the Developer to make enquiries with the Department of Environment and Heritage Protection and subsequently obtain council approval to proposed measures.

SC6.4.4.5.8 As-constructed drawings

The Designer must annotate on the earthworks plan, the site specific detail to be shown on the as-constructed plans. Such detail must include a geotechnical report certifying the works to be suitable for the intended purpose and any other certifications, testing and survey data, as required in this sub-section.

SC6.4.4.5.9 Cartage of soil

(1) The Designer must refer to council for acceptable haul roads with applicable load limits. This detail must be shown on the earthworks plan. The payment of a Bond, as determined by council, may be required by the Developer where council has some concern about the ability of a haul road to sustain the loads without undue damage or maintenance requirements.

(2) Unless specific application is made to council and approval obtained, the plans must be annotated as follows: "All topsoil must be retained on the development site and utilised effectively to encourage appropriate revegetation."

SC6.4.4.5.10 Effect on adjoining properties

(1) Where it is proposed to divert or direct piped stormwater into adjoining properties, drainage easement rights must be created over the adjoining lots in accordance with the SC6.4.4.4 Stormwater drainage design.

(2) A written agreement between the Developer and adjoining property owners to carry out construction work on adjoining properties must to be submitted to council prior to works commencing.

(3) Works must not cause ponding of stormwater on adjacent allotments and no stormwater formerly flowing onto the site may be diverted onto other neighboring allotments or reserves.

(4) Earthworks must be graded so that the new land forms are free draining and all stormwater naturally falling into the site is collected within the property boundaries and discharged to a lawful point of discharge as agreed with council.

SC6.4.4.7 Pathway and Cycleway

SC6.4.4.7.1 Introduction

(1) Purpose

This sub-section aims to set standards and document requirements related to the provision of pathways and cycleways for the use of pedestrians and cyclists, for both on road and off road which encourage pedestrian activities and cycling for transportation and recreational purposes. Pathways and Cycleways are to be safe and convenient and must maintain a satisfactory level of service for path users of all abilities including users with disabilities and/or limited mobility. Pathways and Cycleways should provide a clear and continuous accessible path of travel, void of tripping hazards and unsafe obstacles.

The design of a development must encourage the use of pedestrian and cycle facilities and ensure that priority is given to pedestrians with direct links between a building's main entrance and any adjoining local activities and public transport services and recreational areas.

(2) Scope

(a) This sub-section sets out requirements to be used in the design of various types of pathways and cycleways for the use of pedestrians and cyclists.

(b) All relevant design principles contained in the Austroads' Guides referenced below must be integrated in the design of all pathways and cycleways and their associated infrastructure.

(3) Reference and source documents

(a) Development manual planning scheme policy sub-sections to be read and applied in conjunction with this policy sub-section are as follows:

9.4.6 Transport impact, access and parking code
SC6.4.4.1 Geometric road design
SC6.4.4.8 Standard drawings
SC6.4.3.3 Footpath Treatment Policy
SC6.4.3.5 Car parking and public transport facilities guidelines
SC6.4.3.6 Landscape Policy

(b) Australian Standards

AS 1428.1	*Design for access and mobility Part 1: General requirements for Access – New building work*
AS 1428.2	*Design for access and mobility Part 2: Enhanced and additional requirements-Buildings and facilities*
AS/NZS 1428.4.1	*Design for access and mobility Part 4.1: Means to assist the orientation of people with vision impairment-Tactile ground surface indicators*
AS 2890.3	*Parking facilities Part 3: Bicycle parking facilities*

(c) Austroads

Guide to Road Design Part 3: *Geometric Design*
Guide to Road Design Part 4: Intersections and Crossings – General
Guide to Road Design Part 6A: Pedestrian and Cyclist Paths
Cycling Aspects of Austroads Guides
Guide to Traffic Management Part 11: Parking

(d) Queensland government

Department of Transport and Main Roads specifications, *Manual of uniform traffic control devices (MUTCD)*
Road Planning and Design Manual Volume 3 Part 6A TRUM Manual
Technical Standards Publications - Technical Notes
Queensland Development Code, MP 4.1 – *Sustainable Buildings*

(e) Other

Bicycle Network Victoria – www.bicyclenetwork.com.au
Institute of Public Works Engineering Australia, Queensland, *Complete Streets - Guidelines for Urban Street Design.*
Roads and Traffic Authority, *NSW Bicycle Guidelines*, Version 1.2, July 2005.

(4) Definitions

Pedestrian	A person walking, and including people in wheelchairs, on roller skates or riding vehicles such as skate boards or other vehicles, other than a bicycle, powered by effort or a motor and with a maximum speed of 7 km/h
Walking	to advance or travel on foot at a moderate speed or pace; proceed by steps; move by advancing the feet alternately to move about or travel on foot for exercise or pleasure.
Cyclist	Rider of a bicycle or human-powered vehicle. On a vehicle with one or more wheels that is built to be propelled by human power through a belt, chain or gears (whether or not it has an auxiliary motor), and includes a pedicab, penny-farthing and unicycle: but not a wheelchair, wheeled toy or pedelec.
Cycling	also called **bicycling** or **biking**, is the use of bicycles for transport, recreation, exercise or sport.[1] Persons engaged in cycling are referred to as "cyclists",[2] "bikers",[3] or less commonly, as "bicyclists".[4] Apart from two-wheeled bicycles, "cycling" also includes the riding of unicycles, tricycles, quadracycles, recumbent and similar human-powered vehicles (HPVs).
Path / Pathway	Series of links along a public way defining the connection between nodes in a network, reserved for the movement of pedestrians, motorised wheelchairs and personal mobility devices, and cyclists to chosen destinations via suitable desire lines.
Cycleway	Portion of a road or path devoted to the use of bicycles.

SC6.4.4.7.2 Consultation

The designer should consult with council, the applicant's landscape consultants and relevant authorities prior to and during the preparation of pathway and cycleway designs.

SC6.4.4.7.3 Design concepts

The Designer should be familiar with the different geometric design requirements for the various types of pathways and cycleways in terms of:

(1) width;

(2) grade;

(3) stopping sight distance;

(4) change in grade;

(5) horizontal curvature;

(6) crossfall and drainage; and

(7) sight distance on horizontal curves.

These requirements are discussed in the Austroads Guides.

SC6.4.4.7.4 Types of Pathways and Cycleways

(1) By definition pedestrian paths are "off road"in that, pedestrian facilities are usually designed adjacent to roadways, and meet the criteria outlined in Austroads Guides, SC6.4.4.8 Standard drawings, and SC6.4.4.1 Geometric road design, and to take into consideration SC6.4.3.3 Footpath treatment policy. Common pathway types include:

(a) foothpath;

(b) shared path; and

(c) separated path.

(2) Cycleways can be provided on road and off road. The Austroads Guides provide detailed descriptions, warrants, widths, pavement marking etc. for the majority of these cycleways. The Austroads Guides provide advice on the suitability of pavement conditions, drainage pit grates etc. for on road cycleways. All cycleways may diverge from the road alignment to provide a safer alternative access.

(3) Common cycleway types include:

(a) On road:

(i) bicycle lane;

(ii) bicycle awareness zone (BAZ);

(iii) cycle route; and

(iv) bicycle/car parking lane; and

(b) Off road:

(i) footpath;

(ii) shared path;

(iii) separated path; and

(iv) bicycle path.

(4) Common pedestrian path types include:

(a) footpath;

(b) shared path; and

(c) separated path.

By definition pedestrian paths are "off road" in that, pedestrian facilities are usually designed adjacent to roadways, and meet the criteria outlined in SC6.4.3.3 Footpath treatment policy and SC6.4.4.8 Standard drawings, and SC6.4.4.1 Geometric road design

All paths may diverge from the road alignment to provide a safer alternative access.

(5) Provisions for pathways and cycleways at structures.

Designers must consider the best way to provide for a safe uninterrupted movement of pedestrians and cyclists.

The reference and source documents provide information on:

(i) acceptable widths and clearances;

(ii) types of pathways and cycleways;

(iii) handrails;

(iv) bridges;

(v) approach ramps;

(vi) safety; and

(vii) crime prevention through environmental design (CPTED) principles.

(6) Developments must make appropriate provision for the safe and convenient movement and provide accessibility of pedestrians and cyclists, both on-site and to and from surrounding networks. Design should include the provision of suitable routes and end-of-trip facilities to encourage and facilitate these forms of movement.

SC6.4.4.7.5 End of trip facilities

(1) Where appropriate, consideration must be given to the provision of adequate facilities at destinations for cyclists and pedestrians, to encourage bicycle path and pedestrian path usage.

(2) Such facilities could include:

(a) seats;

(b) secure bicycle parking;

(c) toilets and showers; and

(d) picnic facilities.

(3) The provision of bicycle parking must meet appropriate criteria discussed in the *Austroads Guide to Traffic Management Part 11: Parking* and in accordance with AS 2890.3.

SC6.4.4.7.6 Signage and pavement marking

(1) Adequate signage design for pathways and cycleways must be provided.

(2) Signs and pavement marking must provide for the safe and convenient use of the facility. The signs and

pavement marking must comply with *MUTCD* and SC6.4.4.8 Standard drawings, SC6.4.6.22 Pavement markings and SC6.4.6.24 Signposting.

SC6.4.4.7.7 Design standards

(1) Notwithstanding the guidelines provided in this sub-section and referenced documents, the following minimum standards have been determined as shown in Table SC6.4.4.7.1. Where these values are less than those in the referenced documents, Table SC6.4.4.7.1 may only be used in special circumstances with separate approval.

Table SC6.4.4.7.1 Minimum design standards

	Footpath	**Shared Path**
Path width	1.5m minimum preferred 1.5m minimum for one wheelchair and pedestrian (people with disabilities) 1.8m desirable minimum for two wheelchairs	2.5m absolute minimum 3m – 4m (3.5m desirable) major recreation paths
Crossfall	2.5% maximum (1 in 40) Aids people with a disability	2.5% maximum (1 in 40)
Gradient	1:33 25 m interval* 1:20 15 m interval* 1:14 9 m interval for ramps*	1:33 25m interval* 1:20 15m interval* 1:14 9m interval for ramps*
* Level rest areas 1.2m long should be provided if length is exceeded, and at each change in direction Intervals between 1:33 and 1:20 should be interpolated		
Lateral clearance beside path	0.3 m absolute minimum	1m desirable (cycling) 0.5m absolute minimum (0.3m absolute minimum fencing smooth features aligned parallel)
Vertical clearance	2.5m (pedestrians)	2.5m (cyclists)

Formation Width: During the design process allow 0.5 m minimum either side of reinstatement works. Ensure design for free draining across surface of the verge so as to not create ponding or tripping hazards.

Alternative situations

<table>
<tr><th></th><th colspan="3">Separated Path</th><th>Bicycle Path</th></tr>
<tr><td rowspan="4">Path width</td><td colspan="3">Two-way</td><td rowspan="4">2.5m acceptable minimum
3.0m desirable for high speeds
2.0m absolute minimum very low use at all times</td></tr>
<tr><td>Bicycle Path
2.5m desirable minimum</td><td>Footpath
2.0m desirable
≥1.5m absolute minimum</td><td>Total
4.5m</td></tr>
<tr><td colspan="3">One-way</td></tr>
<tr><td>Bicycle Path
1.5m desirable
2.0m maximum</td><td>Footpath
1.5m</td><td>Total
3.0m</td></tr>
<tr><td>Crossfall</td><td colspan="3">2.5% maximum (1 in 40)</td><td>2%-4% on sealed surfaces
Up to 5% on unsealed surfaces</td></tr>
<tr><td>Gradient</td><td colspan="3">1:33 25m interval*
1:20 15m interval*
1:14 9m interval for ramps*</td><td>3% maximum 200m
5% maximum 20m (if 3% cannot be achieved)
Steeper gradients should not be provided unless unavoidable</td></tr>
<tr><td>Superelevation for cycling</td><td colspan="3">2.5% maximum</td><td>Consider horizontal radii
2.5% desirable
Can go greater than or equal to 3% dependent on site and situation</td></tr>
<tr><td colspan="5">* Level rest areas 1.2m long should be provided if length is exceeded, and at each change in direction intervals between 1:33 and 1:20 should be interpolated</td></tr>
</table>

(2) To assist with the safety of pedestrians and cyclists during night time use, illumination of the off road pathways

and cycleways may be required. The lighting must be designed in accordance with AS/NZS 1158.3.1 Pedestrian area (Category P) lighting – Performance and design requirements and SC6.4.3.20 Public lighting and utilities services

(3) Safety and good alignment should not be compromised by inappropriate landscaping. The principles of crime prevention through environmental design (CPTED) should be a key design focus.

(4) Tactile ground surface indicators (TGSI) where required must be:

(a) standard yellow Polyurethane Tactile Indicator Studs (warning tactiles) and bars (directional tactiles), drill and lock installation; and

(b) supplied and installed in accordance with AS/NZS 1428.4.1, providing correct illuminance contrast; and AS1428.1 and AS4586 Slip Resistance of Pedestrian Surfaces and as per manufacturers specifications and in accordance with AS1884.

(5) Kerb ramps must be:

(a) in accordance with the standard drawings see SC6.4.3.3.3(3)(b) - SD-025: Kerb Ramp;

(b) in accordance with AS1428.1 *Design for Access and Mobility, Part 1: General requirements for access - New Building Works*;

(c) installed facing the direction of travel and aligned parallel and perpendicular with opposite kerb ramp ;

(d) located as per requirements for the flow of pedestrian traffic and the position of the signal button;

(e) constructed of broom finished plain natural concrete;

(f) installed with sharp transitions between adjacent surfaces (top and bottom); and

(g) Installed with Tactile Ground Surface Indicators (TGSI) in accordance wtih AS/NZS 1428.4.1 *Design for Access and Mobility, Part 4.1: Means to assist the orientation of people with vision impairment - Tactile ground surface indicators*.

SC6.4.4.8 Standard drawings

(1) Introduction

This sub-section comprises the current Townsville City Council standard drawings.

Standard drawings show the minimum standard that council has adopted with regard to certain types of work. Standards have been developed for works on drainage, irrigation, roads, sewerage, transport, water and other miscellaneous activities.

(2) List of standard drawings

Table SC6.4.4.8.1 Townsville City Council standard drawings for drainage
Table SC6.4.4.8.2 Townsville City Council standard drawings for irrigation
Table SC6.4.4.8.3 Townsville City Council standard drawings for roadworks
Table SC6.4.4.8.4 Townsville City Council standard drawings for sewerage
Table SC6.4.4.8.5 Townsville City Council standard drawings for transport
Table SC6.4.4.8.6 Townsville City Council standard drawings for water

Table SC6.4.4.8.1 Townsville City Council standard drawings for drainage

Drawing No.	Title	Revision number
SD-200	Precast Grated Kerb Inlet System and Cast Insitu Stormwater Manhole	C
SD-205	Stormwater Manhole Details	C
SD-210	Precast Stormwater Manhole – Slab Top Details	A
SD-215	Raised Grate Field Inlet Manhole	A

Table SC6.4.4.8.2 Townsville City Council standard drawings for irrigation

Drawing No.	Title	Revision No.
SD-4.1	XR 1 - 4 Panel and Screw Hole Layout	-
SD-4.2	XR 1 - 4 Terminal Layout and Power Diagram	-
SD-4.3	XR 1 - 4 Control Enclosure	-
SD-4.4	XR 1 - 4 Base and Antenna	-
SD-4.5	XR 1 - 4 Preferred Equipment List – Controller and Telemetry	-
SD-5.1	AC Irrinet ACE DR 24 – 48 Panel Layout	-
SD-5.2	AC Irrinet ACE DR 24 – 48 Terminal Layout	-
SD-5.3	AC Irrinet ACE DR 24 – 48 Control Enclosure	-
SD-5.4	AC Irrinet ACE DR 24 – 48 Base and Pole	-
SD-5.5	AC Irrinet ACE DR 24 – 48 Electrical Diagram	-
SD-5.6	AC Irrinet ACE DR 24 – 48 Screw Holes	-
SD-5.7	AC Irrinet ACE DR 24 – 48 Preferred Equipment List – Controller and Telemetry	-
SD-5.8	AC Irrinet ACE DR 24 – 48 Panel Layout Photo	-
SD-5.9	AC Irrinet ACE DR 24 – 48 Chassis Mounting Photo	-
SD-5.10	AC Irrinet ACE DR 24 – 48 Door Layout Photo	-
SD-7.1	Irrigation Design Data Example	-
SD-7.2	Irrigation Cabling Wiring Schedule Example	-
SD-8.1	Plan Conventions	-
SD-9.1	Survey Dimensions	-
SD-10.1	Water meter assembly 50MM and Above Type A	-
SD-10.2	Water meter assembly 50MM and Above Type B	-
SD-10.3	Water meter assembly 25M-32MM Type A	-
SD-10.4	Water meter assembly 25M-32MM Type B	-
SD-10.5	Water Meter Stands	-
SD-10.6	Valve Assembly Side View	-
SD-12.1	Sprinkler Installation	-
SD-12.2	Sprinkler Riser Large and Small	-

Drawing No.	Title	Revision No.
SD-13.1	Subdivision Services Allocation (figure 1, 2, 3, 4, 5, 6)	-
SD-14.1	Drip Irrigation Overview	-
SD-14.2	Drip Valve Assemblies	-
SD-14.3	Drip Valve Assembly 25MM and 40MM Internal Reg	-
SD-14.4	Drip Valve Assembly 25MM External Reg	-
SD-15.1	Drip Tube Holding Pin	-
SD-16.1	Curved Road Sprinkler Layout	-
SD-17.1	Conduit Placement in Valves	-
SD-17.2	Valve Assembly - Plan View and Electrical Pit	-
SD-18.1	Typical Pipe Trench Details	-
SD-19.1	Scheduling Co-efficient	-
SD-20.1	AC Irrinet M Slave 12 – 24 Panel Layout	-
SD-20.2	AC Irrinet M Slave 12 – 24 Terminal Layout	-
SD-20.3	AC Irrinet M Slave 12 – 24 Control Enclosure	-
SD-20.4	AC Irrinet M Slave 12 – 24 Base and Pole	-
SD-20.5	AC Irrinet M Slave 12 – 24 Electrical Diagram	-
SD-20.6	AC Irrinet M Slave 12 – 24 Screw Holes	-
SD-20.7	AC Irrinet M Slave 12 – 24 Preferred Equipment List – Controller and Telemetry	-
SD-21.1	AC Irrinet M Slave 36 – 48 Panel Layout	-
SD-21.2	AC Irrinet M Slave 36 – 48 Terminal Layout	-
SD-21.3	AC Irrinet M Slave 36 – 48 Control Enclosure	-
SD-21.4	AC Irrinet M Slave 36 – 48 Base and Pole	-
SD-21.5	AC Irrinet M Slave 36 – 48 Electrical Diagram	-
SD-21.6	AC Irrinet M Slave 36 – 48 Screw Holes	
SD-21.7	AC Irrinet M Slave 36 – 48 Preferred Equipment List – Controller and Telemetry	-
SD-22.1	AC Irrinet M 12 – 24 Panel Layout	-
SD-22.2	AC Irrinet M 12 – 24 Terminal Layout	-
SD-22.3	AC Irrinet M 12 – 24 Control Enclosure	-
SD-22.4	AC Irrinet M 12 – 24 Base and Pole	-
SD-22.5	AC Irrinet M 12 – 24 Electrical Diagram	-
SD-22.6	AC Irrinet M 12 – 24 Screw Holes	-
SD-22.7	AC Irrinet M 12 – 24 Preferred Equipment List – Controller and Telemetry	-
SD-23.1	AC Irrinet M 36 – 48 Panel Layout	-
SD-23.2	AC Irrinet M 36 – 48 Terminal Layout	-
SD-23.3	AC Irrinet M 36 – 48 Control Enclosure	-
SD-23.4	AC Irrinet M 36 – 48 Base and Pole	-
SD-23.5	AC Irrinet M 36 – 48 Electrical Diagram	-
SD-23.6	AC Irrinet M 36 – 48 Screw Holes	-
SD-23.7	AC Irrinet M 36 – 48 Preferred Equipment List – Controller and Telemetry	-
SD-26.1	Door Bracket	-
SD-26.2	Door Bracket Position	-
SD-26.3	Door Bracket – Irrinet M	-
SD-26.4	Door Bracket Position – Irrinet M	-
SD-27.1	Enclosure Earth Wiring	-
SD-28.1	Transceiver Interface Cable Type 1	-
SD-28.3	Aux Data Cable – RJ45 Modified Crossover Cable	-
SD-29.1	Rain Switch Installation	-
SD-31.1	Hydrometer Covers 50mm – 100mm	-
SD-31.2	Multijet Covers 25mm - 32mm	-

Drawing No.	Title	Revision No.
SD-32.1	Drinking Fountain Assembly	-
SD-32.2	Drinking Fountains Base	-
SD-33.1	Valve Nest Cover (sheet 1)	-
SD-33.2	Valve Nest Cover (sheet 2)	-
SD-33.3	Valve Nest Cover (sheet 3)	-
SD-33.4	Valve Nest Cover (sheet 4)	-

Table SC6.4.4.8.3 Townsville City Council standard drawings for roadworks

Drawing No.	Title	Revision No.
SD-001	Typical Road Cross Sections – Urban Streets	B
SD-002	Typical Road Cross Sections – Collector Roads	B
SD-003	Typical Road Cross Sections – Sub Arterial Roads	B
SD-004	Typical Road Cross Sections – Arterial Roads	B
SD-005	Typical Road Cross Sections – Industrial Roads	B
SD-006	Typical Road Cross Sections – B-Double Turning Path and Access Plan Example Drawing	B
SD-010	Typical Road Cross Sections – Rural Roads	B
SD-015	Verge Service Corridors – General Type Sections	E
SD-020	Concrete Kerbing	D
SD-025	Kerb Ramp	D
SD-030	Driveway Access Urban Residential Properties	I
SD-031	Driveway Access Industrial Properties	G
SD-032	Driveway crossovers urban residential properties	F
SD-055	Road Crossing and Footpath Reinstatement for Trench Laid Services	A
SD-060	Traffic Sign Installation	A
SD-065	Street Name Sign and Installation Details	A
SD-066	Miscellaneous Traffic Details – Shared Path Terminal Treatments Deflection Rail and Intersection at Side Road	B
SD-067	Miscellaneous Traffic Details – Pedestrian Refuge and Holding Rail	A
SD-070	Concrete Pathway Reinforced Concrete (Mesh) Alternative	D
SD-075	Concrete Pathway Reinforced Concrete (Fibre) Alternative	E
SD-080	Subsoil Drain	D
SD-085	Kerb and Channel Drainage Connections	A
SD-090	Driveway Access Rural Properties Type 1 - Access With Invert Slab H<300mm	B
SD-091	Driveway Access Rural Properties Type 2 - Conc. Access With Culvert Cast Insitu With Grate H≥300mm	B
SD-092	Driveway Access Rural Properties Type 3 - Gravel Access With Culvert Cast Insitu With Grate H≥300mm	B
SD-093	Driveway Access Rural Properties Type 4 - Conc. Access With Culvert Inverted Pre-cast Box Culvert H≥325mm	B
SD-094	Driveway Access Rural Properties Type 5 - Gravel Access With Culvert Inverted Pre-cast Box Culvert H≥325mm	B
SD-095	Driveway Access Rural Properties Type 6 – Access With Culvert Cast Insitu H≥450mm	B
SD-096	Driveway Access Rural Properties Type 7 - Conc. Access With Culvert 535mm<H<685mm	B
SD-097	Driveway Access Rural Properties Type 8 - Gravel Access With Culvert 535mm<H<685mm	B

Table SC6.4.4.8.4 Townsville City Council standard drawings for sewerage

Drawing No.	Title	Revision No.
SD-400	Sewerage Standard Drawing List	C
SD-405	Legends for Sewerage Drawings	C
SD-410	Typical Layout of Sewerage Details Example Plan	B
SD-411	Sewer Maintenance Shaft Typical Layout	B
SD-420	Small Sewerage Pump Stations Typical Plans, Sections and Details	C
SD-421	Sewerage Pump Stations Package Fibre Reinforced Plastic	B
SD-425	Small Sewerage Pump Stations Two Part Access Cover and Frame	B
SD-430	Sewerage Pump Stations Safety Grill Details	B
SD-435	Sewerage Pump Stations Washdown Service Installation	B
SD-440	Pressure Main Discharge to Maintenance Hole	B
SD-445	Overflow Maintenance Hole Arrangement	C
SD-450	Vents at Sewerage Rising Main Receiving Inspection Chambers and Pump Stations	D
SD-455	Property Connection Details Buried Interface Method	C
SD-460	Embedment and Trench Fill Typical Arrangement (sewer)	B
SD-461	Pipe Embedment Support Types	B
SD-463	Special Embedment - Piles, Concrete and Stabilised Supports	B
SD-470	Maintenance Holes - Sewers Less Than DN300 Cast In-Situ	C
SD-471	Maintenance Holes - Sewers Less Than DN300 Changes In Level Details and Channel Arrangements	C
SD-473	Maintenance Holes - Typical Channel Details	B
SD-474	Maintenance Holes - Alternative Drop Connections	D
SD-475	Maintenance Holes - Typical MH Cover Arrangements	B
SD-476	Maintenance Holes - Sewer DN375 to DN750	B
SD-480	Design Layouts - Longitudinal Sections	A
SD-481	Soil Classification Guidelines and Allowable Bearing Pressures for Bulkheads	A
SD-482	Trench Drainage Bulkheads and Trenchstop (sewer)	A
SD-483	Trench Drainage Typical Systems (sewer)	A
SD-484	Maintenance Holes - Pipe Connection Details	A
SD-485	Maintenance Holes - Connection Details DN110 to DN450 PE Pipes	A

Table SC6.4.4.8.5 Townsville City Council standard drawings for transport (21)

Drawing No.	Title	Revision No.
SD-500	Standard Bus Shelter Framing Details Sheet 1 of 2	E
SD-502	Standard Bus Shelter Slab and Footing Details Sheet 2 of 2	D
SD-505	Regional Bus Shelter Framing Details Sheet 1 of 2	C
SD-510	Regional Bus Shelter Construction Details Sheet 2 of 2	C
SD-515	Standard Bus Stop Urban Location Layout Details Type 1 and 2	D
SD-520	Regional Bus Stop Urban Location Layout Details Type 3 and 4	D
SD-525	Basic Bus Stop Layout Details Urban Location	B
SD-530	Standard Bus Stop Urban and Rural Locations Layout Details Type 7 and 8	B

Drawing No.	Title	Revision No.
SD-535	J Pole, Timetable Display Case, Rubbish Bin and Sleeve Installation Details	D
SD-540	School Bus Bus Stop Sign Details	B
SD-545	Bus Setdown – Urban Locations Layout Details	A
SD-550	Bus Setdown – Parking and Indented Details Urban Locations	A
SD-555	Bus Setdown Rural Location Layout Details	C
SD-560	Bus Setdown Rural Location Table Drain Precast Culvert Crossing	C
SD-565	Bus Setdown Rural Location Table Drain Cast-Insitu Culvert Crossing	B
SD-570	Standard-Country Bus Shelter – Framing, Slab and Footings Details	A
SD-575	Standard-City Bus Shelter Framing Details	B
SD-580	Standard-City Bus Shelter Slab and Footing	B
SD-585	Standard-City Bus Stop Urban Location Layout Details - Type 9 and 10	B
SD-590	Parking for People with Disabilities	A
SD-595	Taxi Rank	A
SD-596	Taxi sign details	A

Table SC6.4.4.8.6 Townsville City Council standard drawings for water

Drawing No.	Title	Revision No.
SD-300	Water Standard Drawing List	C
SD-305	Street Positioning of Mains, Valves, Hydrants and Domestic Water Service Connections	C
SD-310	Domestic Water Service Connections for 20mm Diameter Water Meters Rural Residential Area Only	C
SD-315	Typical Mains Construction Reticulation Main Arrangements	C
SD-320	Typical Mains Construction Connection to Existing Mains	B
SD-325	Embedment and Trench Fill Typical Arrangement (water)	C
SD-330	Standard Embedment - All Pipe Types	C
SD-335	Special Embedments - Inadequate and Poor Foundation	C
SD-340	Special Embedments - Concrete, Geotextile and Cement Stabilised Systems	C
SD-345	Valve and Hydrant Identification - Identification Markers and Marker Posts	C
SD-350	Typical Valve and Hydrant Installation Valve Arrangement	C
SD-355	Typical Valve and Hydrant Installation Hydrants and Air Relief Valves	C
SD-360	Typical Appurtenance Installation Scour Arrangements	B
SD-370	Soil Classification Guidelines and Allowable Bearing Pressures for Anchors and Thrust Blocks	A
SD-371	Thrust Block Details - Concrete Blocks	A
SD-372	Thrust and Anchor Blocks - Gate Valves and Vertical Bends	B
SD-373	Restrained Joint System DN100 to DN375 DI Mains	A
SD-374	Trench Drainage Bulkheads and Trenchstop (water)	A
SD-375	Trench Drainage Typical Systems (water)	A
SD-376	Buried Crossings Bored and Jacked Encasing Pipe Details	A
SD-377	Flanged Joints Bolting Details	A