DEVELOPMENT ENGINEERING SPECIFICATIONS - DESIGN SPECIFICATION

Date adopted by Council: 4 June 2001

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DEVELOPMENT DESIGN SPECIFICATION

DO

DOCUMENTATION

Revised June 2001

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DOCUMENTATION

D1 GEOMETRIC ROAD DESIGN (URBAN AND RURAL)

GENERAL

Developers should engage the services of suitably qualified Geotechnical Engineers to carry out investigations for pavement design subgrade evaluations.

DO.01 PLAN REQUIREMENTS

1.

(a) Reduction Ratios

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

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

(b) Plan Sheets

Separate sheets should be provided for

a. Cover sheets
b. Plan views
c. Longitudinal sections
d. Cross sections
e. Structural details
f. Erosion & Sedimentation Control
g. Standard drawings

(c) Plan Presentation

Plans are to be presented on A1 sheets unless otherwise authorised. They are to be clear and legible and prepared in consistent lettering and style. Council has the authority to refuse plans that do not meet these drafting requirements. Plans copied from other works will not be accepted. All plans shall be clearly referenced with notations and tables as appropriate. The designer should always be mindful that apart from being a permanent record and legal document, plans should be easily read and understood by the Contractor, and others involved in the construction of the works. Terminology should be kept in 'plain english' where possible. ***Permanent Record***

2. Work as Executed plans shall be submitted to Council upon completion of the road construction and prior to release of the linen plan. The detailed design plans may form the basis of this information, however, any changes must be noted on these plans. The Contractor shall supply plans in electronic format to Council upon completion. ***W.A.E.***

3. Cross Section spacings shall be 10m for kerb and gutter and 20m for roads. Additional cross sections are required at high points, low points, S S, T S, T P and S C. ***Spacings***

D2 PAVEMENT DESIGN

DO.02 DESIGN CRITERIA AND CALCULATIONS

Submission Details

1. All considerations, assumptions, subgrade test results, and calculations shall be submitted with the pavement design for approval by Council.

Drawings

2. The Drawings shall clearly indi cate the structure, material types and layer thicknesses of the proposed pavement and surfacing.

3. Work as Executed plans shall be submitted to Council upon completion of the pavement construction and prior to release of the linen plan. The detailed design plans may form the basis of this information, however, any changes must be noted on these plans. The Contractor shall supply plans in electronic format to Council upon completion.

D4 SUBSURFACE DRAINAGE DESIGN

DO.03 DESIGN DRAWINGS AND CALCULATIONS

1. The proposed location of all subsurface drains shall be clearly indicated on the Design 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. Where practicable, the location of outlets and cleanouts shall also be indicated on the Drawings.

2. Assumptions and/or calculations made in the determination of the need or otherwise for subsurface drainage in special circumstances or as a variation to the requirements of this specification shall be submitted to Council for approval with the Design Drawings.

D5 STORMWATER DRAINAGE DESIGN

DO.04 PLANS

Scales for Drawings

1. Catchment Area Plans shall be drawn at scales of 1:500, 1:4000 or 1:25000, unless alternative scales are specifically approved by Council and shall show contours, direction of grading of kerb and gutter, general layout of the drainage system with pit locations, catchment limits and any other information necessary for the design of the drainage system.

2. The Drainage System Layout Plan shall be drawn at a scale of 1:500 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.

3. The plan shall also show all drainage easements, reserves and natural water courses.

4. The Drainage System Longitudinal Section shall be drawn at a scale of 1:500 horizontally and 1:50 vertically and shall show pipe size, class and type, jointing type, pipeline and road chainages, pipeline grade, hydraulic grade line and any other information

necessary for the design and construction of the drainage system.

5. Open Channel Cross Sections shall be drawn at a scale of 1:100 natural and shall show the direction in which the cross sections should be viewed. Reduced levels are to be at Australian Height Datum, AHD, unless otherwise approved by Council where AHD is not available. Cross sections may alternatively be provided on floppy disk in HEC2 format as a data input file for the design flow rates. ***Open Channels***

6. Special Details including non-standard pits, pit benching, open channel designs, culverts and transitions shall be provided on the design drawings at scales appropriate to the type and complexity of the detail being shown.

7. Work as Executed Plans shall be submitted to Council upon completion of the drainage construction and prior to release of the linen plan. The detailed design plans may form the basis of this information, however, any changes must be noted on these plans. The Contractor shall supply plans in electronic format to Council upon completion. ***Work-as-Executed Plans***

DO.05 EASEMENTS AND AGREEMENTS

1. Evidence of any Deed of A greement necessary to be entered into as part of the drainage system will need to be submitted prior to any approval of the engineering plans. Easements will need to be created prior to approval of the linen plan of subdivision.

2. Where an agreement is reached with an adjacent landowner to increase flood levels on his property or otherwise adversely affect his 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 engineering plans.

DO.06 SUMMARY SHEETS

1. A copy of a Hydrological Summary Sheet providing the minimum information set out in AR&R 1987. ***Hydrology***

2. A copy of a Hydraulic Summary Sheet providing the minimum information set out in AR &R 1987. ***Hydraulics***

DO.07 COMPUTER PROGRAM FILES AND PROGRAM OUTPUT

1. Computer program output may be provided as long as summary sheets for Hydrological and Hydraulic calculations in accordance with this Specification are provided with plans submitted for checking and with final drawings.

2. Copies of final computer data files, 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.

D6 SITE REGRADING

DO.08 PLANS

1. Load limits and location of haul roads are to be shown on the Site Regrading Plan. The Consultant shall refer to Council for acceptable haul roads with applicable load limits. ***Load Limits on haul roads***

2. The payment of a Bond may be required by the developer/contractor where Council has some concern about the ability of a haul road to sustain the loads without undue damage or maintenance requirements. ***Possible Bond Requirement***

3. The site regrading plans shall show extent and depth of the site regrading ***Extent/Depth***

DO.09 PERMIT TO ENTER TO DISCHARGE STORMWATER/CONSTRUCT

1. Where it is proposed to divert, direct or intensify the flow of stormwater into adjoining property, a "permit to discharge stormwater shall be sought and submitted to Council prior to the approval of Engineering design plans." The above shall apply unless otherwise specified by Council. A permit shall also be sought to carry out construction work on adjoining property and such permit also presented to Council. ***Permit Required***

DO.10 TOPSOIL

1. Unless specific application is made to Council and approval obtained, the plans will be annotated as follows: ***Topsoil***

"All topsoil shall be retained on the development site and utilised effectively to encourage appropriate revegetation."

D9 CYCLEWAY AND PATHWAY

DO.11 PRESENTATION OF DESIGNS

1. The following listing outlines Council's minimum requirements for presentation of cycleway and/or pathway designs.

- All plans for cycleways/pathways are to be presented at the reduction ratio 1:500. ***Plans***
- The cycleway plan sheet may be incorporated into the road plan where clarity permits. Specific details are to be provided at reduction ratio 1:200.
- Longitudinal Sections will be required for all of f-road cycleways where grades exceed 4%. ***Long Sections***
- Longitudinal Sections will have reduction ratios of 1:500 horizontal and 1:100 vertical.
- Cross Sections will be presented at 1:100 reduction ratio (natural) and transition tables will be required where cross falls vary or superelevation is provided. ***Cross Sections***
- A typical cross section will be detailed to indicate pavement materials and layer depths.

2. Work as Executed plans shall be submitted to Council upon completion of the cycleway or pathway construction and prior to release of the linen plan. The detailed design plans may form the basis of this information, however, any changes must be noted on these plans. The Contractor shall supply plans in electronic format to Council upon completion.

D7 – EROSION CONTROL AND STORMWATER MANAGEMENT

DO.12 DETAILED DESIGN

1. Detailed designs shall include scaled drawings (no larger than 1:1000) and detailed specifications/diagrams which can be readily understood and applied on site by supervisory staff.

Items to be included, but not limited to, shall be:

- existing and final contours
- the location of all earthworks including roads, areas of cut and fill and re-grading
- location of access haulage tracks and borrow pits
- location and design criteria of erosion and sediment control structures
- location and description of existing vegetation
- proposed vegetated buffer strips and "no access" areas
- location of critical areas (vegetated buffer strips, drainage lines and structures, water bodies, unstable slopes, flood plains and seasonally wet areas)
- type and location of diversion works to direct uncontaminated water around areas to be disturbed
- stockpile sites and treatment thereof
- revegetation program
- procedures for maintenance of erosion and sediment control both during and after construction, until end of Defects Liability Period.
- details for staging of works

DEVELOPMENT DESIGN SPECIFICATION

D1

Modified 3

GEOMETRIC ROAD DESIGN (Urban and Rural)

Revised June 2001

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DEVELOPMENT DESIGN SPECIFICATION D1 - DESIGN (Urban and Rural)

GENERAL

D1.01 SCOPE

1. This section sets out design specifications to be used in the subdivision of land.

2. All relevant design principles must be integrated in the development of the road network. A careful balance is required between maximising amenity, safety considerations and those related to legibility and convenience.

D1.02 AIMS

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

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

D1.03 REFERENCE AND SOURCE DOCUMENTS

(a) Council Specifications

All Specifications for Design and Construction.

Singleton Shire Council Road Management Strategy – Road Hierarchy

(b) Australian Standards

AS 2890.1 Parking facilities: Off-street car parking.

AS2890.2 Off Street Parking – Commercial Vehicle Facilities

(c) State Authorities

Roads and Traffic Authority NSW - Road Design Guide.
Department of Housing - Road Manual, 1987.
Department of Urban Affairs (formerly Environment) and Planning – Technical Bulletin 12 (1981), Residential Road Widths.

(d) Other

AUSTROADS Guide to the Geometric Design of Rural Roads.
Guide Policy for the Geometric Design of Major Urban Roads.
Guide to Traffic Engineering Practice:

PART 5,	Intersections at Grade
PART 6,	Roundabouts
PART 10,	Local Area Traffic Management
PART 13,	Pedestrians
PART 14,	Bicycles

The Institute of Municipal Engineering Australia, Qld Division - 1993: Design Guidelines for Subdivisional Streetworks.

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

Joint Venture for More Affordable Housing - 1989: Australian Model Code for Residential Development.

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

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

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

Colman, J 1978, ARRB: Streets for Living.

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

D1.04 CONSULTATION

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

D1.05 PLANNING CONCEPTS

Road Hierarchy

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

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

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

4. The road network should reinforce legibility by providing sufficient differentiation between the road functions.

Legibility

5. Wherever possible distinct landmark features such as watercourses, mature vegetation or ridge lines should be emphasised within the structural layout so as to enhance the legibility.

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

7. The maximum number of turning movements at intersections or junctions that a visitor should be required to undertake to reach a particular address within the development should be minimised.

D1.06 WITHDRAWN

URBAN DESIGN CRITERIA

D1.07 ROAD HIERARCHY

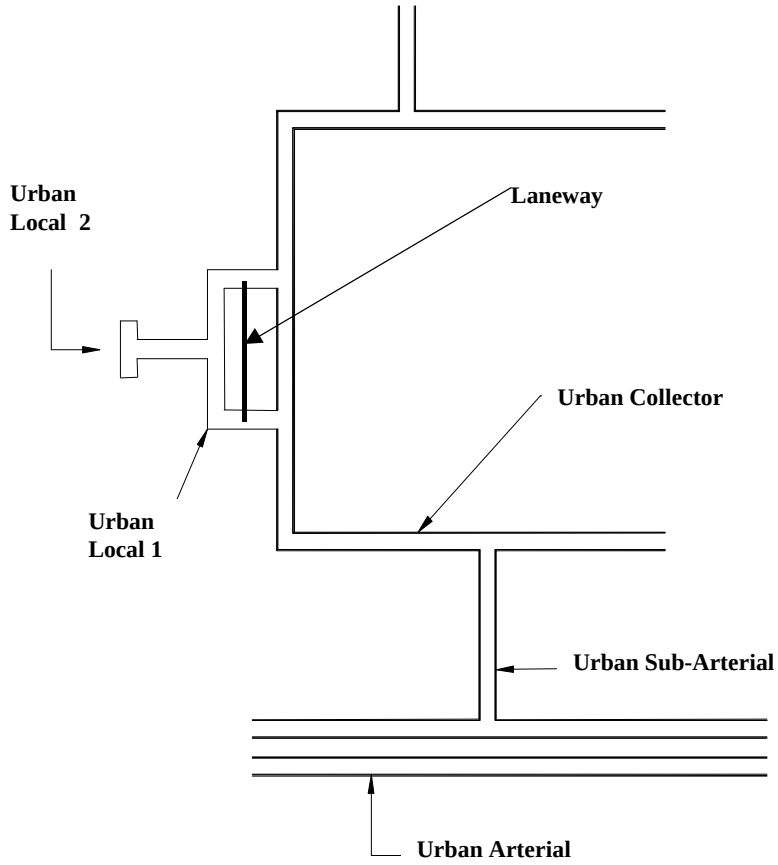
1. A hierarchical road network is essential to maximise road safety, residential amenity and legibility. Each class of road in the network serves a distinct set of functions and is designed accordingly. The design should convey to motorists the predominant function of the road. For information on all the existing urban roads and streets that are maintained by council refer to Singleton Shire Council "Roads Management Strategy".

Urban Hierarchy Classes and Parameters

Class	Description	Design Considerations
Urban Arterial	Primarily carry through traffic from one region to another.	Direct access for single dwelling allotments is not permitted. Access to multi-unit developments and non-residential land uses are also not permitted.
Urban Sub-Arterial	Connect the arterial roads to areas of development or carry traffic directly from one part of a region to another.	Direct accss for single dwelling allotments is to be discouraged. Access may be provided to multi-unit developments and non-residential land uses (at the discretion of Council).
Urban Collector	Connect the sub-arterial roads to the local road system in developed areas.	This class of streets have a residential function but they also carry a higher volume of traffic collected from local streets. A reasonable level of residential amenity and safety is maintained by restricting traffic volumes and speeds. However, amenity & resident safety do not have as high a priority as local streets.
Urban Local 1	Local roads that allow through traffic and primarily provide access to residential properties and possibly some minor commercial development.	Streets in this class should provide a balance between the status of that street in terms of its access and residential amenity functions. Resident safety and amenity are dominant but to a lesser degree than Urban Local 2 roads. However, they should have features which aid pedestrian and cycle movements.
Urban Local 2	No through roads that provide access to residential properties (ie, cul-de-sacs).	The prime consideration with this class of road is to ensure residential space and amenity. They should have features which aid pedestrian and cycle movements. Motorised traffic is subservient in terms of speed and volume, to those elements of space, amenity, pedestrians and cyclists.
Laneway	Roads that primarily provide rear access to various land uses.	The main consideration with laneways is to ensure that the type of vehicle that will access the specific land uses can do so safely. Steps should be taken to minimise traffic speed.

For example, a graphical depiction of Singleton Shire Council's Urban Road Hierarchy is given below:

Urban Road Hierarchy for New Urban Subdivisions



D1.08 ROAD NETWORK

1. The design features of each type of road convey to the motorist its primary functions and encourage appropriate driver behaviour.

2. Traffic volumes and speeds on any road should be compatible with the residential functions of that road.

3. The maximum length of a local street and laneway 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, cycle and vehicular movements. This length will also ensure that residential convenience is not unduly impaired as a result of speed restraints.

4. The time required for motorists to travel on all streets within the development should be minimised.

5. Where local streets form part of a pe destrian or cycle network, access links should provide suitable connectivity with adjoining local streets or open space systems so as to ensure such pedestrian and cycle network are functionally efficient.

6. The road network should ensure that no road l inks with another road which is more than two levels higher or lower in the hierarchy. ***Road Links***

7. Connections between internal roads should be T-junctions or controlled by roundabouts.

8. The road layout should conform to the requirements of the ex ternal road network and satisfy the transport provisions of an outline development plan.

External Road Network

9. The external road network should be designed and located to provide routes which are more convenient for potential through local road 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 projected movements. The internal road system should not provide through routes that are more convenient than the external road network.

10. Where approved, cul-de-sacs longer than 150m shall be designed to Urban Local 1 Criteria.

D1.09 DESIGN SPEED

RTA Guidelines

1. Design speed is generally used as the basic parameter in the specification of design standards, determining the minimum design value for other elements. The NSW Roads and Traffic Authority bases its current design standards on a travel speed rather than a design speed. Travel speed identifies a speed/horizontal radius relationship. This approach is intended for roads of a minimum travel speed of 60 km/h. The maximum speed limit in NSW for built-up areas is 60 km/h and this should be used in calculating design values which depend on speed, (eg collector and distributor roads) however, in difficult topography, the design speed may be reduced. Vehicular speeds are also limited by road intersections as well as changes in horizontal and vertical alignment.

Low Speeds

2. 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. It should be recognised that in low standard roads, operating speeds will tend to be in excess of arbitrary speed standards. It must be ensured that potentially hazardous features are visible to the driver and adopting traffic engineering measures which will help a driver avoid errors of judgement.

3. Generally the following minimum design speeds should be adopted:

Urban Local 2 & Laneways	60 km/h
Urban Local 1	60 km/h
Urban Collector	70 km/h
Urban Sub Arterial & Arterial	80 km/h

D1.10 LONGITUDINAL GRADIENT

Flat Terrain

1. A general minimum gradient of 0.5% should be adopted. Maximum recommended grades are shown in Table D1.1

Table D1.1

	Laneways	Urban Local 1 &Urban Local 2	Urban Collector & Urban Sub - Arterial	Urban Arterial
Desirable maximum percentage	12	10	8	6
Absolute maximum percentage*	14	12	10	8

* maximum length of a longitudinal grade <= the absolute maximum percentage and > the desirable maximum percentage shall be 75m.

2. Longitudinal grade through intersections should not exceed 4 per cent, the actual gradient being dependent on the type of terrain. Design of the road alignment and the grades used are interrelated. A steep grade on a side street is undesirable if vehicles have to stand waiting for traffic in the priority road. Turning circles in cul-de-sacs on steep grades should have grades less than 5%.

Intersection

D1.11 HORIZONTAL CURVES AND TURNING MOVEMENTS

Transition Curves

1. The Horizontal Curves and turning movements should conform with RTA Road Design Guide.

D1.12 VERTICAL CURVES

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

2. For adequate riding comfort, lengths of sag vertical curves should conform with the RTA Road Design Guide. As residential roads are usually lit at night, the criterion for designing sag vertical curves is a vertical acceleration of 0.05 g for desirable riding comfort, and 0.10 g for minimum riding comfort.

Riding Comfort

3. Junctions of roads should be located at a safe distance from a crest, determined by visibility from the side road. Careful consideration shall be given in the location of a side road at a crest. Refer to the RTA Road Design Guide for site distances.

Side Road

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

Sag Curves

5. The three dimensional coordination of the horizontal and vertical alignment of a road should be aimed at improved traffic safety and aesthetics. Economic considerations often require a compromise with aesthetic considerations. The design speed of the road in both horizontal and vertical planes should be of the same order.

D1.13 SUPERELEVATION

1. The use of su perelevation in association with horizontal curves is an essential aspect of geometric design of roads with design speeds in excess of 60 km/h.

2. The maximum superelevation for urban roads of higher design speeds should be 5 per cent. Any increase in the longitudinal grade leading to excessive crossfall at intersections should be considered with caution. While it is desirable to superelevate all curves, negative crossfall should be limited to 3 per cent.

Negative Crossfall

3. In general, curve radii larger than the minimum and superelevation rates less than the maximum should be used where possible.

Coefficient of Side Friction

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

Tables D1.2, D1.3 WITHDRAWN

Table D1.4

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

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

Offset Crown

5. Plan transitions are desirable on superelevated cur ves 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. On the outside of superelevation, or where the longitudinal grade of the gutter is less than 0.5 per cent, a crossfall of 63mm in a 450mm wide gutter may be adopted.

D1.14 CARRIAGEWAY WIDTH

Functions

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

Table D1.5

Urban Hierarchy Class	Road Reserve Width *(m)	Maximum Traffic Volume (vpd)	Minimum Carriageway Width (m)**	Minimum verge / footway width - each side (m)
Urban Local 2	18	100	9.0	4.0
Urban Local 1	20	2,000	11.0	4.0
Urban Collector	25	3,000	13.0	4.0
Urban Sub- Arterial & Urban Arterial	25	6,000	13.0	4.0

* Road Reserve width includes footpath/cycleway and kerb requirements

** Carriageway width includes the provision for parallel parking for both sides of carriageway

D1.15 CROSSFALLS

1. For typical pavement crossfalls refer to Austroads Guide policy for geometric design of major urban roads.

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

Priority Road

D1.16 FOOTWAY AREAS

1. A suitable design for the footway will depend on utility services, the width of pathways, access to adjoining properties, likely pedestrian usage and preservation of trees. Low level paths are undesirable but may be used if normal crossfalls are impracticable. Crossfalls in footway paving should not exceed 4 per cent, as above this paving can be slippery. Longitudinal grade usually parallels that of the road and this may be steeper than 5 per cent. Refer to Section D.9 – Cycleways & Pathways Design.

Utility Services

D1.17 INTERSECTIONS, TURNING MOVEMENTS AND CUL-DE-SACS

1. The design of intersections or junctions should allow all move ments to occur safely without undue delay. Projected traffic volumes should be used in designing all intersections.

Traffic Volumes

2. The design for all intersections should be designed in accordance with the publication AUSTROADS Guide to Traffic Engineering Practice, PART 5, Intersections at Grade.

Main Roads

3. Intersections with classified roads are to be designed and constructed in accordance with the requirements of the Roads and Traffic Authority.

Classified Roads

4. Where intersections are required to serve a development, complete reconstruction of the existing road pavements will be necessary where the speed environment and/ or irregularity of the existing road pavement requires reconstruction to be undertaken.

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

Criteria

- The streets intersect preferably at right-angles and not less than 70°.
- The landform allows clear sight distance on each of the approach legs of the intersection.
- The minor street intersects the convex side of the major street.
- The vertical grade l ines at the intersection do not impose undue driving difficulties.
- The vertical grade lines at the intersection will allow for any direct surface drainage.
- Two side streets intersecting a major street in a staggered pattern should have a minimum centre-line spacing of 40 m.

6. Sight distances as outlined in Section 2 of the RTA “Road Design Guide” are to be provided for horizontal and vertical curves at all intersections.

7. Where required, appropriate provision should be made for vehicles to park safely.

8. In cul-de-sac streets (Urban Local 2 Streets) adequate provision should be made at the end of the road for vehicle types which frequently use the streets to turn around.

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

Turning Movements

10. All vehicle turning movements are accommodated utilising AUSTROADS Design Vehicles and Turning Templates, as follows:

- For turning movements involving Urban Sub-Arterial Streets, the "design semi-trailer" with turning path radius 15.0 m.
- For turning movements involving Urban Collector or Urban Local 1 streets, but not Urban Sub-Arterial Streets, the "design single unit" bus with turning path radius 15.0 m.
- For turning movements on laneways but not involving Urban Collector, Urban Local 1 streets or Urban Sub-Arterial Streets, the garbage collection vehicle used by the local authority.
- For turning movements at the head of Urban Local 2 streets sufficient area is provided for the "design single unit" truck to make a three-point turn or where the length of the street is less than 60.0m for the "design car" to make a three-point turn.

Turning Radii

11. Turning radii at intersections or driveways on arterial or sub arterial roads shall be designed to accommodate the intended movements without allowing desired speeds to be exceeded.

Bus Routes

12. On bus routes 3-centred curves with radii 7.0 m, 10.0 m, 7.0 m are used at junctions and intersections.

13. Combined entry and exit dri veways on urban sub-arterial roads are 6.0 m wide and separate entry and exit driveways are 3.0 m wide.

D1.18 ROUNDABOUTS

1. Roundabouts are to be approved by the Council and/or the Roads & Traffic Authority.

2. Roundabouts should generally be design ed in accordance with the requirements of the publication AUSTROADS Guide to Traffic Engineering Practice - PART 6 Roundabouts and RTA document “Roundabouts Geometric Design Method” Designs adopting alternative criteria will be considered on their merits. Roundabout design should generally comply with the following:

- entry width to provide adequate capacity
- adequate circulation width, compatible with the entry widths and design vehicles e.g. buses, trucks, cars.
- central islands of diameter sufficient only to give drivers guidance on the manoeuvres expected
- deflection of the traffic to the left on entry to promote gyratory movement
- adequate deflection of crossing movements to ensure low traffic speeds
- a simple, clear and conspicuous layout
- design to ensure that the speed of all vehicles approaching the intersection will be less than 50 km/h.

D1.19 TRAFFIC CALMING

Speed reduction can be achieved by:

- creating a visual environment conducive to lower speeds. This can be achieved by 'segmenting' streets into relatively short lengths (less than 300m), using appropriate devices, streetscapes, or street alignment to create short sight lines
- using devices which shift vehicle paths laterally (roundabouts, corners)

D1.20 PARKING

1. The parking requirements for normal levels of activity associated with any land use as specified in the RTA's "Guide to Traffic Generating Developments" are to be provided on-site.

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

3. 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.

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

Joint Use

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

Tandem

6. A single (car) space is 6.5m x 2.5m and combined spaces are 13.0m x 2.5m (for two cars) and 20m x 2.5m (for truck parking) with adequate tapers at both ends to allow the necessary parking manoeuvres determined by using AUSTROADS Turning Templates.

Verge Spaces

7. All verge spaces and indented parking areas are constructed of concrete, interlocking pavers, lawn pavers, bitumen with crushed rock or other suitable material and are designed to withstand the loads and manoeuvring stresses of vehicles expected to use those spaces.

8. The layout and access arrangements for parking areas for non-residential land uses should conform to Australian Standard 2890.1 and 2890.2.

D1.21 BUS ROUTES

Buses

1. Bus routes will normally be identified by Council. It is important that the road hierarchy adequately caters for buses.

Tables D1.6,D1.7 deleted

RURAL DESIGN CRITERIA

D1.22 GENERAL

1. In addition to the foregoing sections this section specifically applies to all those sites identified as being suited to rural subdivisions inclusive of rural homesites and hobby farms types of developments.

Design Speed

2. 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 RTA Road Design Guide.

3. Where appropriate superelevation, widening and centreline shift and their associated transitions are to comply with the RTA Road Design Guide.

Table Drain

4. Where the table drain is likely to s cour a RTA Type SH dish drain, or similar structure is to be constructed along the invert. Also for grades of less than 0.5%, the table drains are to be designed to prevent siltation.

5. Generally, rural subdivisions should be designed to de ny access to the existing road network from the lots created within the subdivision. Lots should gain access to the internal subdivision road.

Access

6. Access should be limited to one point on to local or arterial road networks.

D1.23 SIGHT DISTANCES

1. Recommended sight distances are given in the RTA Road Design Guide.

D1.24 HORIZONTAL AND VERTICAL ALIGNMENT

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

D1.25 INTERSECTIONS

1. Intersections should generally be designed in accordance with the publication AUSTROADS Guide to Traffic Engineering Practice - Part 5, Intersections at Grade. The type of intersection required will depend on existing and planned connecting roads. Consideration should be given to left turn treatments, deceleration and acceleration lands.

Staggered Junctions

2. An absolute minimum spacing of 40m should be adopted for staggered junctions. The intersection angle between two roads should preferably be 90 °, and variations to this should be within +/- 20° band.

D1.26 PLAN & SUPERELEVATION TRANSITIONS

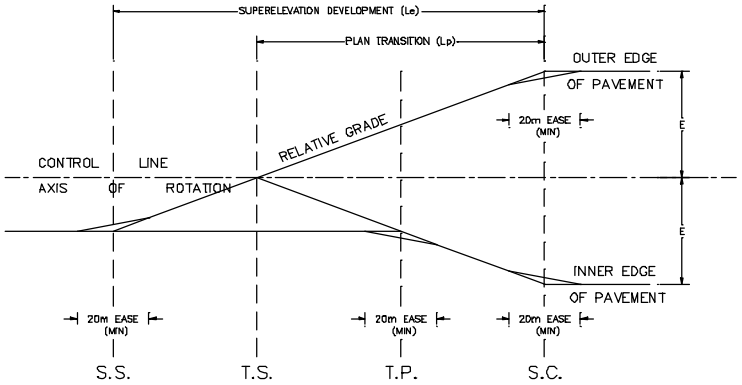
1. A plan transition is the length over which widening and shift is developed to provide a natural path for vehicles entering a horizontal curve. Widening on horizontal curves compensates for differential tracking of front and

rear wheels of vehicles, and overhang of vehicles.

A super-elevation transition is the length over which normal road cross-fall is developed up to full superelevation. This transition provides for comfortable travel between the straight alignment of a road and the horizontal curve and avoids abrupt changes in cross-fall.

Crossfall Changes

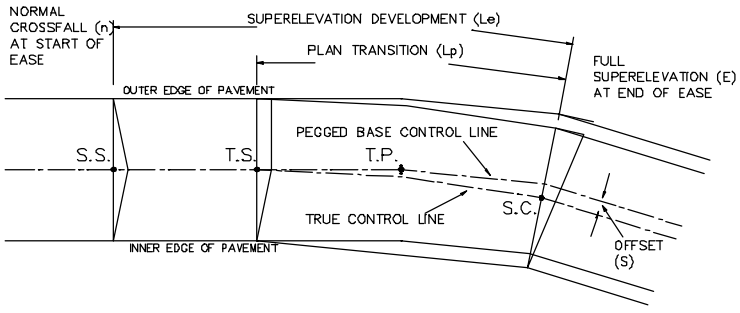
2. Abrupt changes in crossfall, can cause discomfort in travel and create a visible kink in the pavement. A rate of change of superelevation of no more than 0.5 per cent relative to the centre line should ensure against this. The wider the pavement the longer the transition. Superelevation transitions should be used at all changes in crossfall, not just for curves.



NOTES
1. T.S. = TANGENT SPIRAL, COMMON POINT OF TANGENT AND SPIRAL
2. T.P. = TANGENT POINT, COMMON POINT OF TANGENT AND ARC
3. S.S. = START OF SUPERELEVATION TRANSITION
4. S.C. = SPIRAL CURVE, COMMON POINT ON SPIRAL AND CIRCULAR CURVE
5. n = NORMAL CROSSFALL (%)
6. E = SUPERELEVATION (%)
7. ALL LONGITUDINAL MEASUREMENTS ARE MADE ALONG THE PEGGED CONTROL LINE
8. ALL LATERAL MEASUREMENTS ARE MADE PERPENDICULAR TO THE PEGGED CONTROL LINE

SUPERELEVATION PROFILES

NOT TO SCALE



SUPERELEVATION DEVELOPMENT DIAGRAM

NOT TO SCALE

NOTE THE TRANSITIONS AS SHOWN, REFER TO THE CUBIC PARABOLA. IN COMPUTER AIDED DESIGN, THE PLAN TRANSITION IS USUALLY A CLOTHOID SPIRAL AND IS SET OUT WITH REFERENCE TO A PEGGED BASE LINE.

D1.27 CARRIAGEWAYS

The minimum carriageway widths for rural roads are detailed in Table D1.8

Table D1.8

Road Type	Road Reserve Width	Seal Width	Formation Width	Traffic Lanes	Shoulders
Rural Sub Arterial	25m	8.5m	10m (+1.5m table drains & verges if needed	2x3.5m	2x1.5m (0.75m seal on each shoulder
Rural Collector	20m	8.0m	9m (+1.5m table drains & verges if needed	2x3.5m	2x1m (0.5m seal on each shoulder)
Rural Local 1	20m	7m	8m (+1.5m table drains & verges if needed	2x3m	2x1m (0.5m seal on each shoulder)
Rural Local 2	20m	7m	8m (+1.5m table drains & verges if needed	2x3m	2x1m (0.5m seal on each shoulder)
Rural Local 3	20m	4m	5m (+1.5m table drains & verges if needed	2x3m	2x1m (0.5m seal on each shoulder)

D1.28 DESIGN SPEED

Superelevation

Calculation

Reference should be made to RTA Road Design Guide for superelevation calculation.

Longitudinal Gradient

Desirable maximum grades

The values listed in Table D1.9 are the desirable maximum grades that should be adopted for sealed roads. Grades on roads in cuttings and at the superelevation transitions of horizontal curves should be adequate for proper drainage of table drains and gutters. The minimum grade of table drains should be 0.5%. For grades of less than 0.5%, the table drains are to be designed to prevent siltation.

Table D1.9

DESIGN SPEED (Km/h)	TERRAIN		
	FLAT	ROLLING	MOUNTAINOUS
60	7	8	10
80	5	6	8
100	4	5	7
120	4	5	---

a) Grades over 10% will only be permitted in special circumstances with the express written approval of Council's Director - Operations.

b) For unsealed surfaces, the above values should be reduced by 1%.

D1.29 SCOUR PROTECTION

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

D1.30 ROAD HIERARCHY

1. A hierarchical road network is essential to maximise road safety, residential amenity and legibility. Each class of road in the network serves a distinct set of functions and is designed accordingly. The design should convey to motorists the predominant function of the road. For information on all the existing urban roads and streets that are maintained by council refer to Singleton Shire Council "Roads Management Strategy".

Rural Hierarchy Classes and Parameters

Class	Description	Design Considerations
Rural Arterial	Carry through traffic from one region to another	Access to multi-unit developments, non-residential land uses and single dwelling allotments are at the discretion of the Roads and Traffic Authority.
Rural Sub-Arterial	Connect the Arterial Roads to areas of development or carry traffic directly from one part of a region to another.	Direct access for single dwelling allotments is to be discouraged. Access may be provided to multi-unit developments and non-residential land uses (at the discretion of Council).
Rural Collector	Connect the Sub-Arterial Roads to the Local Road system	This class of road carry a higher volume of traffic collected from the lower trafficked rural local roads. Residential amenity & safety do not have as high a priority as Rural Local 1,2 and 3 roads.
Rural Local 1	Mostly used as local access roads, but allow through traffic.	Roads in these classes should provide a balance between the status of that road in terms of its access, and residential amenity functions. Resident safety and amenity are the dominant design considerations.
Rural Local 2	Mostly used as local access roads, but allow a minor amount of through residential traffic.	
Rural Local 3	No through road used as a local access road.	The prime consideration with these classes of roads is to ensure residential space and amenity. Motorised traffic is subservient in terms of speed and volume, to those elements of space and amenity.

SPECIAL REQUIREMENTS

D1.31 URBAN PRIVATE RIGHT OF WAY'S

1. Urban Private Right of Way's shall be rigid (concrete) pavements and shall be designed in accordance with either CACA -T33 or AUSTROADS Pavement Design. ***Rigid (Concrete)***

D1.32 RURAL PRIVATE RIGHT OF WAY'S

1. Rural private Right of Way's shall be constructed in accordance with Council's "Minor Rural Road Construction" Standard (Appendix 1 of Construction Specification). ***Construction standard***

2. The maximum grade of any rural right of way shall be 14%. ***Maximum grade***

D1.33 WORKS IN ROAD AGREEMENT

1. All works within a council public road requires a Works in Road Agreement with Council

DEVELOPMENT DESIGN SPECIFICATION

D2

Modified 3

PAVEMENT DESIGN

CONTENTS

PAVEMENT DESIGN

GENERAL

D2.01 SCOPE

1. The work to be executed under this Specification consists of the design of the 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. ***Design Criteria***

2. The Specification contains procedures for the design of the following forms of surfaced road pavement construction: ***Surfaced Pavement Types***
   (a) flexible pavements consisting of unbound granular materials;
   (b) flexible pavements that contain one or more bound layers, including pavements with asphalt layers other than thin asphalt wearing surfaces;
   (c) rigid pavements (ie. Cement concrete pavements);

D2.02 OBJECTIVES

1. 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 adequately and requires minimal maintenance under the anticipated traffic loading for the design life adopted. ***Pavement Performance***

D2.03 REFERENCE AND SOURCE DOCUMENTS

(a) Council Specifications

D1	-	Geometric Road Design
D4	-	Subsurface Drainage Design
C242	-	Flexible Pavements
C244	-	Sprayed Bituminous Surfacing
C245	-	Asphaltic Concrete
C247	-	Mass Concrete Subbase
C248	-	Plain or Reinforced Concrete Base

(b) State Authorities

Roads and Traffic Authority, NSW – Sprayed Sealing Guide, 1992.

(c) Other

AUSTROADS	-	Pavement Design, A Guide to the Structural Design of Road Pavements, 1992.
AUSTROADS	-	Guide to Control of Moisture in Roads.
ARRB-APRG 21	-	A Guide to the Design of New Pavements for Light Traffic.
CACA - T33	-	Cement and Concrete Association, T33 - Concrete Street and Parking Area Pavement Design, 1984.
CACA - TN52	-	Cement and Concrete Association, TN52 - Single-Lane Concrete Bus Bays, 1984.

PAVEMENT DESIGN CRITERIA

D2.04 DESIGN VARIABLES

1. Regardless of the type of road pavement proposed, the design of the pavement shall involve consideration of the following five input variables: ***Design Variables***
   (a) Design Traffic
   (b) Subgrade Evaluation
   (c) Environment
   (d) Pavement and Surfacing Materials
   (e) Construction and Maintenance Considerations (including cost)
   (f) Whole of Life Cycle Costs

D2.05 DESIGN TRAFFIC

1. The design traffic shall be calculated based on the following minimum design lives:- ***Minimum Pavement Design Life***
   (a) Rural Flexible, Unbound Granular – 20 years
   (b) Urban Flexible, Unbound Granular – 30 years
   (b) Flexible, containing one or more bound layers - 30 years
   (c) Rigid (Concrete) – 60 years

2. Design traffic shall 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 shall take account of both the construction traffic associated with the subdivision development and the in-service traffic. ***Design Traffic***

3. The pavement design shall include all traffic data and/or assumptions made in the calculation of the design traffic. ***Traffic Data***

4. Reference should be made to ARRB-APRG 21,A Guide to the Design of New Pavements for Light Traffic for the calculation of design traffic volumes less than 10^6 ESAs & AUSTROADS Pavement Design for design traffic volumes approaching or exceeding 10^6 ESAs or exceeding 10^6. ***Design Traffic Volumes***

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

Street Type:		Design ESA's - 30 yr design life
Urban Residential	- Laneways	2×10^4
	- Urban Local 2	6×10^4
	- Urban Local 1	3×10^5
	- Urban Collector	1×10^6
	- Urban Sub-Arterial	2×10^6

Street Type:		Design ESA's - 20 yr design life
Rural Residential	- Rural Local 1,2 & 3	2×10^4
	- Rural Collector & Sub-Arterial	3×10^5

Street Type:	Design ESA's - 30 yr design life
Commercial and Industrial	5×10^6

D2.06 SUBGRADE EVALUATION

1. The measure of subgrade support shall be the California Bearing Ratio (CBR). ***CBR***

2. The following factors must be considered in determining the design strength/stiffness of the subgrade: ***Design Consideration***
   (a) Sequence of earthworks construction
   (b) The compaction moisture content and field density specified for construction
   (c) Moisture changes during service life
   (d) Subgrade variability
   (e) The presence or otherwise of weak layers below the design subgrade level.

3. The calculation of the Design CBR shall be based on a minimum of three 4 day soaked CBR laboratory samples for each subgrade area, compacted to the relative density specified for construction, and corrected to allow for the effects of climatic zone, and soil type if appropriate (as per the guidelines in ARRB-APRG 21) to give an estimated equilibrium in-situ CBR. The Design CBR for each subgrade area is computed by using the appropriate formulae as follows: ***Calculation of Design CBR***

Design CBR = Least of estimated equilibrium CBRs, for less than five results
Design CBR = 10th percentile of all estimated equilibrium CBRS, for five or more results
= C - 1.3S
Where C is the mean of all estimated equilibrium CBRs, and
S is the standard deviation of all values.

5. 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. ***Field Confirmation***

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

D2.07 ENVIRONMENT

1. 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 Pavement Design, ARRB-APRG 21, and to NAASRA (Now AUSTROADS) - Guide to Control of Moisture in Roads. ***Reference***

2. 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 including the effects of urbanisation
   (d) Relative permeability of pavement layers
   (e) Whether shoulders are sealed or not

3. The effect of changes in moisture content on the strength/stiffness of the subgrade shall be taken into account by evaluating the design subgrade strength parameters (ie. CBR) at the highest moisture content likely to occur during the design life, ie the Design Moisture Content. ***Evaluate Design CBR***

4. 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. ***Temperature Change***

5. The pavement design shall 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.

D2.08 PAVEMENT AND SURFACING MATERIALS

1. Pavement materials can be classified into essentially four categories according to their fundamental behaviour under the effects of applied loadings: ***Pavement Classification***
   (a) Unbound granular materials, including modified granular materials
   (b) Lightly bound (cemented) granular materials
   (c) Asphaltic Concrete
   (d) Cement Concrete

2. Surfacing materials can also be classified into essentially 3 categories or types:- ***Surfacing Classification***
   (a) Sprayed bituminous seals (flush seals)
   (b) Asphaltic concrete
   (c) Cement Concrete

3. Unbound granular materials, including modified granular materials, shall satisfy the requirements of the Construction Specification for FLEXIBLE PAVEMENTS.

4. Lightly bound (cemented) granular materials shall satisfy the requirements of the Construction Specification for FLEXIBLE PAVEMENTS.

5. Asphaltic concrete shall satisfy the requirements of the Construction Specification for ASPHALTIC CONCRETE.

6. Cement concrete shall satisfy the requirements of the Construction Specifications for MASS CONCRETE SUBBASE, PLAIN OR REINFORCED CONCRETE BASE, or FIBRE REINFORCED CONCRETE, as appropriate.

7. Sprayed bituminous seals shall satisfy the requirements of the Construction Specification for SPRAYED BITUMINOUS SURFACING.

D2.09 CONSTRUCTION AND MAINTENANCE CONSIDERATIONS

1. 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:
   (a) Extent and type of drainage
   (b) Available equipment of the Contractor
   (c) Use of stabilisation
   (d) Aesthetic, environmental and safety requirements
   (e) Social considerations
   (f) Construction under traffic
   (g) Use of staged construction
   (h) Whole of Life Cycle Costs

   These factors are further discussed in AUSTROADS Pavement Design.

PAVEMENT THICKNESS DESIGN

D2.10 PAVEMENT STRUCTURE - GENERAL

1. The pavement thickness, shall be as per the submitted pavement design, or the following figures, whichever is the greater: ***Minimum Pavement Thickness***

• Rural Arterial	500mm	• Urban Arterial	= 600mm
• Rural Sub-Arterial	= 450mm	• Urban Sub Arterial	= 500mm
• Rural Collector	= 400mm	• Urban Collector	= 450mm
• Rural Local 1	= 300mm	• Urban Local 1	= 400mm
• Rural Local 2	= 220mm	• Urban Local 2	= 300mm
• Rural Local 3	= 200mm	• Laneway	= 300mm

2. Notwithstanding subgrade testing and subsequent pavement thickness design, the thickness of subbase and base layers shall not be less than the following:-
   (a) Flexible pavement: Subbase 150mm, Base 150mm
   (b) Rigid pavement: Subbase 150mm, Base 150mm

3. The subbase layer shall extend an amount equal to the total pavement thickness behind the rear face of any kerbing and/or guttering. ***Subbase Extent***

4. The base and surfacing shall 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 shall also extend an amount equal to the total pavement thickness behind the rear face of the kerbing and/or guttering. ***Base Extent***

5. For unkerbed roads, the subbase and base layers shall extend at least to the nominated width of shoulder.

D2.11 UNBOUND GRANULAR FLEXIBLE PAVEMENTS (BITUMINOUS OR ASPHALTIC CONCRETE SURFACED)

1. Unbound granular flexible pavements with thin bituminous or asphaltic concrete surfacings, including those with cement or lime modified granular materials, with design traffic up to 10^6 ESAs shall be designed in accordance with ARRB-APRG21 using Figure 13.8.2 (A), based on a 95% confidence level (ie no strength allowance shall be given for asphaltic concrete).

2. For design traffic above 10^6 ESAs, the design shall be in accordance with AUSTROADS Pavement Design (no strength allowance shall be given for asphaltic concrete)

D2.12 FLEXIBLE PAVEMENTS CONTAINING BOUND LAYERS (BITUMINOUS SURFACED)

1. Flexible pavements containing one or more bound layers, including cement stabilised layers or asphaltic concrete layers other than thin asphalt surfacings, i.e. less than 100mm, shall be designed in accordance with AUSTROADS Pavement Design.

2. As an alternative to AUSTROADS Pavement Design for design traffic up to 10^6 ESAs, bound layers may be assumed to be equivalent to unbound layers of the same thickness, and the pavement designed in accordance with ARRB-APRG21 using Figure 13.8.2 (A), based on a 95% confidence level.

3. Pavements are only to be stabilised if the unbound gravel does not meet strength and CBR requirements. ***Criteria***

4. Lightly bound Pavements are to have an unconfined compressive strength of between 1.2MPa and 1.7Mpa at seven (7) days using 'Benchcure Test Method'. Only cementitious binders are to be used ***Max Strength***

D2.13 RIGID PAVEMENTS

1. Rigid (concrete) pavements, with design traffic up to 10^6 ESAs shall be designed in accordance with either CACA -T33 or AUSTROADS Pavement Design. ***Rigid (Concrete)***

2. Rigid (concrete) pavements for design traffic above 10^6 ESAs, the design shall be in accordance with AUSTROADS Pavement Design.

3. Single lane concrete bus bays adjacent to a flexible pavement shall be designed in accordance with CACA -TN52.

D2.14 WITHDRAWN

D2.15 WITHDRAWN

SURFACING DESIGN

D2.16 CHOICE OF SURFACE TYPE

1. Except where the pavement is designed for concrete, the wearing surface shall be a bituminous wearing surface as follows:- ***Wearing Surface***

   (a) Sub-Arterial Collector and Local Roads:
   - primer seal plus two coat flush seal, or
   - primer seal, plus one coat flush seal, plus bituminous microsurfacing, or
   - primer seal, plus asphalt.

   (b) Industrial streets:
   - primer seal, plus asphalt

2. At intersections, intersection approaches and cul-de-sac bulbs with flush seals, asphalt surfacing shall be provided within the vehicle braking and turning zones. ***Braking & Turning***

D2.17 SPRAYED BITUMINOUS SEALS (FLUSH SEALS)

1. The design of sprayed bituminous (flush) seals, including primer seals, shall be in accordance with the RTA Sprayed Sealing Guide. ***Seal Design***

2. 7mm primer seals shall be indicated on the Drawings below all flush seals, bituminous microsurfacing, and asphalt surfacings. Where a 7mm primer seal is impractical, a 10mm primer seal shall be indicated in lieu. ***Primer Seal***

DEVELOPMENT DESIGN SPECIFICATION

D3

Modified 3

STRUCTURES BRIDGE DESIGN

CONTENTS

CLAUSE **PAGE**

DEVELOPMENT DESIGN SPECIFICATION D3
STRUCTURES/BRIDGE DESIGN

GENERAL

D3.01 SCOPE

1. This section sets out design considerations to be adopted in the design of structural engineering elements for land subdivisions. Such activities will include:

- Road traffic bridges
- Pedestrian bridges
- Structures other than bridges, but associat ed with roads (eg retaining walls)
- Small earth dams, detention basins
- Structures used for public safety (traffic barriers, pedestrian barriers, street lighting)
- Major sign support structures
- Temporary works

D3.02 OBJECTIVE

1. The aim of design shall be the achievement of acceptable probabilities that the structure being designed will not become unfit for use during its design life, having regard to economic, physical, aesthetic and other relevant constraints. ***Design Life***

D3.03 BASIS OF DESIGN

1. Specifications shall be provided with the design plans for construction purposes. Council's construction specification is to be used where suitable.

D3.04 REFERENCE AND SOURCE DOCUMENTS

(a) Council Specifications ***Specifications***

D1	-	Geometric Road Design
D5	-	Stormwater Drainage Design
D7		Erosion Control and Stormwater Management Design

(b) Australian Standards ***Standards***

AS1158	-	(Set) Road lighting
AS1170	-	Minimum design loads on structures (SAA Loading Code)
AS1684	-	National Timber Framing Code
AS3600	-	Concrete structures
AS3700	-	Masonry in buildings (SAA Masonry Code)
AS/NZS3845	-	Road Safety barrier systems
AS4100	-	Steel structures
AS1720.1		Timber design code

Other relevant codes and guidelines with the above.

(c) Other

AUSTROADS	-	Bridge Design Code
Inst. of Eng.	-	Australian Rainfall and Runoff
KD Nelson	-	Design and Construction of Small Earth Dams

D3.05 ROAD TRAFFIC BRIDGES

1. Structural design of bridges is a complex matter generally falling outside the scope of many small civil engineering consultancies. Council requires this work to be approved by Singleton Shire Council.

A.C.E.A. Listing

2. However, this does not preclude submissions by other qualified persons in which cases Council reserves the right to call for evidence of the qualifications and experience of the responsible designer; or to seek referral of the design calculations to an appropriate A.C.E.A. firm for checking. The latter requirement will be at the proponents cost, if directed.

Checking

3. The Austroads Bridge Design Code is the appropriate general reference for bridge proposals.

4. Council normally requires bridges to have low maintenance finishes; therefore timber and steel are not usually acceptable construction materials, unless suitable precautions are adopted. Heavy debris and bed loads may be characteristic of some streams so that large spans with slender piers are encouraged. If overtopping is permitted, handrails and guardrails are usually omitted. Flood depth indicators will be provided in such cases.

Debris

Overtopping

5. Preventative maintenance is a key issue affecting the design life of the structure. The design plans shall 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 shall also be shown on the design plans.

Design Life Maintenance

6. Unless otherwise indicated on the Development Application, small bridges within allotments shall be designed with appropriate afflux to convey the 5 year ARI storm event without afflux together with certification stating that the bridge is capable of withstanding the inundation loadings for up to the 100 year ARI storm event. If in the opinion of the designer, such certification is impractical, the structure shall be designed to convey the 100 year ARI storm event without inundation.

Small Bridges

Design Storm Event

7. Where structures are designed to be inundated, the effect of the backwater gradient on upstream property shall be identified on the design plans.

8. Bridges located in roadways which are to be dedicated as public roads shall be designed to convey the stormwater event identified in the drainage design specification. Where no inundation is permitted, appropriate afflux shall be adopted together with a 500mm freeboard to the underside of the bridge deck.

Freeboard

9. Designers should enquire regarding current of likely provision for public utilities in bridges.

Public Utilities

D3.06 PEDESTRIAN BRIDGES

1. Provision for pedestrians on bridges is required in rural residential as well as urban areas. The minimum provision is a 1.5m footpath with kerb at the road traffic edge and handrail.

Pedestrians

2. Council may require the provision of separate ped estrian carriageways in other situations should the anticipated traffic warrant it. Urban bridge approaches should be lit. Designers should enquire regarding the current and future utility services which the bridge may be required to carry. These should be concealed for aesthetic reasons. Disabled access shall be considered in the design.

Carriage of Utilities

D3.07 STRUCTURES OTHER THAN BRIDGES, ASSOCIATED WITH ROADS

1. Public utility structures, retaining walls, and the like will be designed by a

competent, practicing engineer, accredited in the design of such structures. The consultant shall refer to the Austroads code and any other Australian standards to execute the design.

D3.08 SMALL EARTH DAMS/DETENTION BASINS

1. Small earth dams may be designed following the guidelines in "Design and Construction of Small Earth Dams" by K D Nelson together with relevant geotechnical recommendations. The structural design of weir outlets to resist failure shall be considered in design.

Fencing

2. Childproof fencing shall be nominated where unacceptable risk exists due to the location of the dam/basin in relation to the urban nature of the area. This requirement shall be determined by Council.

3. The consultant shall carry out the design with recognition of the potential risk on existing and planned infrastructure downstream, assuming the probability of dam/basin failure.

Qualification

4. The consultant shall be a qualified civil or structural engineer having accreditation in the design of such structures.

5. The consultant shall be required to certify the design and ultimately certify the work-as-executed plans for compliance with the design. All relevant details shall be shown on the design plans.

D3.09 STRUCTURES USED FOR PUBLIC SAFETY

Barriers

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

2. The AUSTROADS Bridge Design Code and AS/NZS 3845 are recommended references in this regard.

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

Lighting

4. Bridge crossings in urban and rural residential areas shall be provided with streetlighting in accordance with AS1158. Such requirements will be noted accordingly on the Drawings.

D3.10 TEMPORARY WORKS

Programme of Temporary Provisions

1. Structures which are proposed for the temporary support of roads, services and the like shall be designed by a qualified Engineer experienced and accredited in the design of such structures. A construction programme, indicating the sequence of events leading to the implementation and removal of the temporary structures shall be specified on the design plans.

SPECIAL REQUIREMENTS

D3.11 RESERVED

D3.12 RESERVED

NOTE: ALL STRUCTURES WITHIN A COUNCIL PUBLIC ROAD REQUIRE A

STRUCTURE IN ROAD AGREEMENT WITH COUNCIL

DEVELOPMENT DESIGN SPECIFICATION

D4

Modified 3

SUBSURFACE DRAINAGE DESIGN

CONTENTS

CLAUSE **PAGE**

DEVELOPMENT DESIGN SPECIFICATION D4

SUBSURFACE DRAINAGE DESIGN

GENERAL

D4.01 SCOPE

1. The work to be executed under this Specification consists of the design of the subsurface drainage system for the road pavement and/or subgrade.

2. This specification contains procedures for the design of subsurface drainage, including:

(a) Subsoil and Foundation Drains

(b) Sub-Pavement Drains

(c) Drainage Mats, including Type A and Type B Mats.

3. Reference guidelines for the application and design of subsurface drainage include ARRB Special Reports 35 and 41, and the AUSTROADS publication - Guide to the Control of Moisture in Roads. The full titles of these guidelines are given below.

D4.02 OBJECTIVES

1. 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.

Control Moisture Content

D4.03 TERMINOLOGY

1. Subsoil drains are intended for the drainage of ground water or seepage from the subgrade and/or the subbase in cuttings.

Subsoil Drains

2. Foundation drains are intended for the draina ge of seepage, springs and wet areas within and adjacent to the foundations of the road formation.

Foundation Drains

3. 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.

Sub-pavement Drains

4. 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 A Drainage Mats

5. 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.

Type B Drainage Mats

D4.04 REFERENCE AND SOURCE DOCUMENTS

(a) Council Specification

C230	-	Subsurface Drainage - General
C231	-	Subsoil and Foundation Drains
C232	-	Pavement Drains
C233	-	Drainage Mats

(b) Australian Standards

AS2439.1	-	Perforated drainage pipe and associated fittings

(c) RTA Specifications

MR Form 1160	-	Supply and Delivery of Seamless Tubular Filter Fabric.
3555	-	Slotted Fibre Reinforced Concret e Pipe for Subsurface Drainage

(d) Other

AUSTROADS	-	Guide to the Control of Moisture in Roads, 1983
ARRB-SR35	-	Australian Road Research Board, Special Report No. 35 - Subsurface Drainage of Road Structures, Gerke R.J., 1987.
ARRB-SR41	-	Australian Road Research Board, Special Report No. 41 - A structural Design Guide for Flexible Residential Street Pavements, Mulholland P.J., 1989..

SUBSOIL AND SUB-PAVEMENT DRAINS

D4.05 WARRANTS FOR USE

Subsoil Drains

1. Subsoil drains are designed to drain groundwater or seepage from the subgrade and/or subbase in cuttings.

Sub-pavement Drains

2. 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.

Geotechnical Survey

3. Subsoil or sub-pavement drains may need to 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:

Locations

(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 or isolated springs.

(c) Irrigated, flood-prone or other poorly drained areas.

(d) Highly moisture susceptible subgrades, ie. 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.

(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.

During Construction

4. 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 shall be suitably annotated to the potential need for subsoil or sub-pavement drains in addition to those shown on the Drawings.

D4.06 LAYOUT, ALIGNMENT AND GRADE

Typical Cross Sections

1. Typical cross sections of subsoil and sub-pa vement drains are shown below in Figures D4.1 and D4.2. As indicated in these figures, subsoil drain trenches are excavated to below subgrade level, while sub-pavement drains extend into or adjacent to the pavement layers to facilitate drainage of the pavement layers in addition to the subgrade.

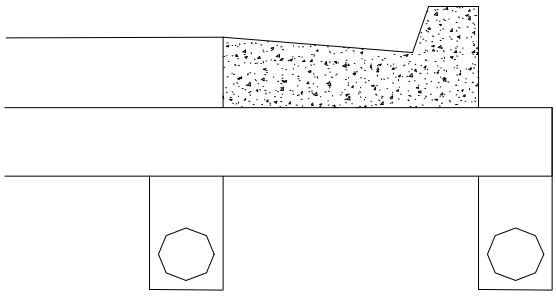
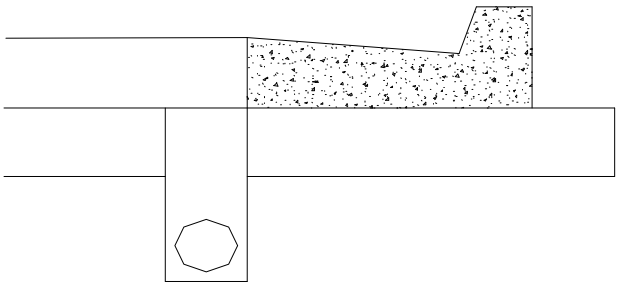


Figure D4.1 - Typical Subsoil Drain



1Figure D4.2 - Typical Subpavement Drain

2 In unkerbed roads, subsoil and sub-pavement drains shall be located within the shoulder, preferably at the edge of the pavement layers as shown in Figure D4.2. ***Unkerbed Roads***

3. The minimum desirable longitudinal design grade shall be 1.0-1.5%. For non corrugated pipes, an absolute minimum grade of 0.5% is acceptable. ***Grade***

4. Trench widths shall be a minimum of 300mm, with a minimum depth below finished subgrade level of 600mm in earth and 450mm in rock, and below the invert level of any service crossings. ***Trench Dimensions***

5. Outlets shall be sp aced at maximum intervals of 150 metres. Where possible, subsoil and sub-pavement drainage pipes shall discharge into gully pits or other stormwater drainage structures. Where not possible, outlets shall be provided through fill batters. ***Outlets***

6. Cleanouts are to be provided at the commencement of each run of drain, and at intervals not exceeding 80 metres. Cleanouts shall generally be located directly at the rear of kerb or at the edge of shoulder, as applicable. ***Cleanouts***

7. Details of outlets and cleanouts are to be shown on the drawings. ***Details Outlets & Cleanouts***

FOUNDATION DRAINS

D4.07 WARRANTS FOR USE

1. 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. ***Foundation Drains***

2. 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 shall be shown on the plans. However, more commonly, the need to provide foundation drains is determined during construction, and hence in this situation requirements and locations cannot always be ascertained at the design stage. ***Geotechnical Survey During Construction***

3. Where the road formation traverses known swampy, flood-prone, or watercharged strata, the design Drawings shall be suitable annotated to the potential need for foundation drains at various locations, in addition to those shown on the Drawings.

D4.08 LAYOUT, ALIGNMENT AND GRADE

1. Typical cross-sections of foundation drains are shown below in Figure D4.3. ***Typical Cross Section***

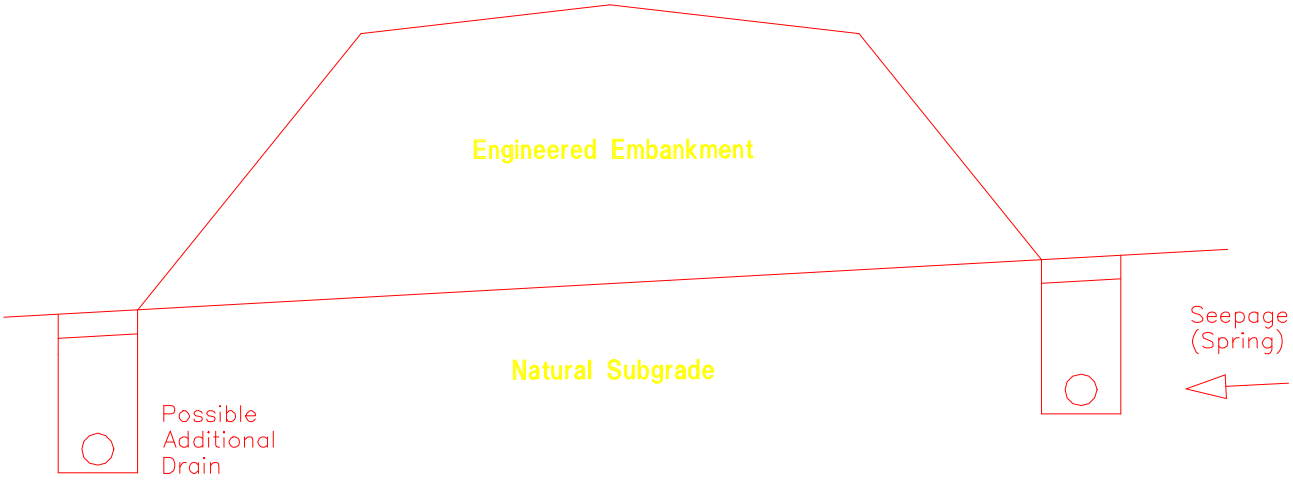


Figure D4.3 - Foundation Drain

2. The minimum desirable design grade shall be 1.0-1.5%. For non corrugated pipes an absolute minimum grade of 0.5% is acceptable. ***Grade***

3. Foundation drains shall be a minimum trench width of 300mm, with a variable trench depth to suit the application and ground conditions on site. ***Trench Dimensions***

4. Outlets shall be spaced at maximum intervals of 150 metres. ***Outlets***

5. Where practicable, cleanouts are to be provided at the commencement of each run of foundation drain and at intervals not exceeding 80 metres. Where not practicable to provide intermediate cleanouts, outlets shall be spaced at maximum intervals of 100 metres. ***Cleanouts***

DRAINAGE MATS (BLANKETS)

D4.09 WARRANTS FOR USE

1. 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 A Mats***

2. 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 shall be constructed after completion of the subgrade construction and before construction of the pavement. ***Type B Mats***

3. The need to design for the provision of drainage mats should be apparent from ***Geotechnical***

the result of the geotechnical survey along the proposed road formation alignment. ***Survey***

MATERIALS

D4.10 SUBSOIL AND SUB-PAVEMENT DRAIN PIPE

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

2. Corrugated plastic pipe shall be Class 1000 conforming with the requirements of AS2439.1. Joints, couplings, elbows, tees and caps shall also comply with AS2439.1.

3. Slotted fibre reinforced concrete pipe shall be designated type “100 DMR” meeting the requirements of RTA Specification No. 3555.

4. Slotted rigid UPVC pipe shall be of a type and class approved by Council.

5. All pipe shall be slotted, and fitted with seamless tubular filter fabric complying with MR Form 1160, except for cleanouts and outlets through fill batters which shall be unslotted pipe.

D4.11 INTRA PAVEMENT DRAIN PIPE

1. Pipes for use in Type B Drainage Mats shall be designated 100mm diameter slotted fibre reinforced concrete pipe, designated type 100 DMR pipe, meeting the requirements of RTA Specification 3555, shall be designated for intra pavement drains where crushed rock subbase layer thicknesses are greater than 200mm, for edge drains where any part of the shoulder consists of material other than concrete, and for use in Type B Drainage Mats.

D4.12 FILTER MATERIAL

1. The types of filter material covered by this Specification shall 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.

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

2. Material requirements and gradings for each type of filter material are included in the Construction Specification, SUBSURFACE DRAINAGE GENERAL.

3. The type of filter material specified to backfill the sub-surface drainage trenche s (subsoil, foundation and sub-pavement drains) shall depend 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 ARRB Special Report 35.

D4.13 GEOTEXTILE

1. Where necessary to provide separation (ie. prevent infiltration of fines) between the filter material in the trench and the subgrade or pavement material, geotextile shall be designated to encapsulate the filter material. The geotextile shall comply with the requirements included in the Construction Specification, SUBSRUFACE DRAINAGE GENERAL.

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

D4.14 WITHDRAWN

SPECIAL REQUIREMENTS

D4.15 RESERVED

D4.16 RESERVED

D4.17 RESERVED

D4.18 RESERVED

SINGLETON SHIRE COUNCIL

DEVELOPMENT DESIGN SPECIFICATION

D5

STORMWATER DRAINAGE DESIGN

CONTENTS

DEVELOPMENT DESIGN SPECIFICATION D5
STORMWATER DRAINAGE DESIGN

GENERAL

D5.01 SCOPE

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

D5.02 OBJECTIVES

1. The objectives of stormwater drainage design are as follows:

   (a) 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.

   (b) To provide convenience and safety for pedestrians and traffic in frequent stormwater flows by controlling those flows within prescribed limits.

   (c) 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.

2. In pursuit of these objectives, the following principles shall apply: ***Design Principles***

   (a) New Developments are to provide a stormwater drainage system in accordance with the "major/minor" system concept set out in Chapter 14 of Australian Rainfall & Runoff, 1987 (ARR 1987); that is, the "major" system shall provide safe, well-defined overland flow paths for rare and extreme storm runoff events while the "minor" system shall be capable of carrying and controlling flows from frequent runoff events.

   (b) Redevelopment - Where the proposed development replaces an existing development, the on-site drainage system is to be designed in such a way that the estimated peak flow rate from the site for the design average recurrence interval (ARI) of the receiving minor system is no greater than that which would be expected from the existing development.

D5.03 REFERENCE AND SOURCE DOCUMENTS

(a) Council Specifications

C220	-	Stormwater Drainage – General
C221	-	Pipe Drainage
C222	-	Precast Box Culverts
C223	-	Drainage Structures
C224	-	Open Drains including Kerb & Gutter

(b) Australian Standards

AS 1254 - Unplasticised PVC (uPVC) pipes and fittings for storm and surface water applications.
AS 2032 - Code of practice for installation of uPVC pipe systems.
AS 3725 - Loads on buried concrete pipes.
AS 4058 - Precast concrete pipes.
AS 4139 - Fibre reinforced concrete pipes and fittings.

(c) State Authorities

RTA, NSW - Model Analysis to determine Hydraulic Capacities of Kerb Inlets and Gully Pit Gratings, 1979.

(d) Other

AUSTROADS - Bridge Design Code.

Inst. of Eng. - Australian Rainfall and Runoff - A guide to flood estimation. Aug 1987.

Queensland Urban Drainage Manual, Volumes 1 & 2, 1993.

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.

Hare CM. - Magnitude of Hydraulic Losses at Junctions in Piped Drainage Systems. Transactions, Inst. of Eng. Aust., Feb. 1983.

Concrete Pipe Association of Australia
- Concrete Pipe Guide, charts for the selection of concrete pipes to suit varying conditions.

Henderson, FM. Open Channel Flow, 1966.

Chow, Ven Te - Open Channel Hydraulics, 1959.

John Argue - Australian Road Research Board Special Report 34
- Stormwater drainage design in small urban catchments: a handbook for Australian practice.

Australian National Conference On Large Dams, Leederville WA.
- ANCOLD 1986, Guidelines on Design Floods for Dams.

RURAL & URBAN HYDROLOGY

GENERAL

D5.04 DESIGN RAINFALL DATA

1. Design Intensity-Frequency-Duration (IFD) Rainfall - IFD relationships shall be derived in accordance with Chapter 2, Volume 1 or ARR 1987, for the particular catchment under consideration. ***I-F-D Relationships***

2. The nine basic parameters read from Maps 1-9 in Volume 2 of ARR 1987 shall be shown in the calculations submitted to Council, except where the Bureau of

Meteorology provides a polynomial relationship for the catchment.

3. Design Average Recurrence Interval (ARI) – For design under the "major/m inor" concept, the design ARIs to be used are given below.

Average Recurrence Intervals

4. Minimum recurrence intervals for events depends on the zoning of the land being serviced by the drainage system. The system design ARIs are detailed below:-

- 100 years for structures that impact on the road network of sub-arterial and collection roads
- 50 years for structures that impact on the road network of local roads
- 20 years for commercial “minor” systems
- 10 years for industrial area “minor” systems
- 10 years for residential area “minor” systems
- 10 years for rural residential area “minor” systems generally
- 1 year for parks and recreation area “minor” system

5. In addition, where a development is designed in such a way that the major system flows involve surcharge across private property, then the underground system (both pipes and inlets) shall be designed to permit flows into and contain flows having an ARI of 100 years from the upstream catchment which would otherwise flow across the property. A surcharge path shall be defined for systems even where 100 year ARI flows can be maintained within the system. Easements are to be provided in private property over pipe systems and surcharge paths.

D5.05 CATCHMENT AREA

1. The catchment area of any point is defin ed by the limits from where surface runoff will make its way, either by natural or man made paths, to this point. Consideration shall be given to likely changes to individual catchment areas due to the full development of the catchment.

Catchment Definition

2. Where no detailed survey of the catchment is available, orthophoto maps are to be used to determine the catchments and to measure areas.

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

RURAL HYDROLOGY

1. Rural Drainage Design shall be undertaken in accordance with AR & R 1987 5.4.1.

2. The C Factor shall be modified to take into account local runoff factors

SOIL TYPE (ST)	:	SAND	=	1.0
		CLAYEY SAND	=	1.1
		SANDY CLAY	=	1.15
		CLAY	=	1.2
		ROCK	=	1.25

Can interpolate between soil type

SLOPE (SL): 0-5% - 0; 5-15% - 1.1; 15-25% - 1.25;

VEGETATION (V): No vegetation: 1.2 Grassland: 1.1
Heavily timbered: 1.0

Ffy = Frequency Factors

SINGLETON (C) = $(C_{10} \times ST \times SL \times V) \times FF_Y$

Minimum Singleton (C) Factor to be 0.3.

URBAN HYDROLOGY

D5.06 RATIONAL METHOD

1. Rational Method calculations to determine peak flows shall be carried out in accordance with Chapter 14, AR&R 1987 and the requirements of this Specification.

Qualified Person

2. All calculations shall be carried out by a qualified person experienced in hydrologic and hydraulic design. Full details of all calculations are to be provided with the Design. Full details of all calculations are to be provided with the design.

Runoff Coefficients

3. Coefficients of Run-off shall be calculated as per Section 14.5 of AR&R 1987 and full details of coefficients utilised shall be provided.

Times of Concentration

4. Times of Concentration - The time of concentr ation of a catchment is defined as the time required for storm runoff to flow from the most remote point on the catchment to the outlet of the catchment.

5. 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.

7. The maximum time of concentration in an urban area shall be 20 minutes unless sufficient evidence is provided to justify a greater time.

8. Flow paths to pits shall be representative of the fully developed catchment considering such things as fencing and the likely locations of buildings and shall be shown for each collection pit on the catchment area plan. Consideration shall be given to likely changes to individual flow paths due to the full development of the catchment.

9. Surface roughness coefficients "n" shall generally be derived from information in Chapter 14 of AR&R 1987. Values applicable to specific zoning types and overland flow path types are given below:

Overland Flow Retardance

Flow across Parks	0.35
Flow across Rural Residential land	0.20 - 0.30
Flow across Residential single dwelling	0.20
Flow across Residential duplex or other	0.10
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

D5.07 OTHER HYDROLOGICAL MODELS

1. Other hydrological models may be used as long as the requirements of AR&R 1987 are met, summaries of calculations are provided and details are given of all program input and output.

Alternative Models(AR&R Chapter 14)

2. 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.

HYDRAULICS

The minimum diameter of pipes shall be 375mm for Urban and 450mm for Rural.

Pipe Diameter

D5.08 HYDRAULIC GRADE LINE

1. Hydraulic calculations shall generally be carri ed out in accordance with Australian Rainfall and Runoff 1987 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 program input and output. The summary sheets in AR&R are to be presented.

Qualified Person

Calculations A R & R

2. The "major" system shall provide safe, well-defined overland flow paths for rare and extreme storm runoff events while the "minor" system shall be capable of carrying and controlling flows from frequent runoff events.

3. Downstream water surface level requirements are given below:-

Downstream Control

(a) Known hydraulic grade line level from downstream calculations including pit losses at the starting pit in the design event.

(b) Where the downstream starting point is a pit and the hydraulic grade line is unknown, a level of 0.15m below the invert of the pit inlet in the downstream pit is to be adopted.

(c) Where the outlet is an open channel and the design storm is the minor event the top of the outlet pipe shall be the downstream control.

(d) Where the outlet is an open channel, the design storm is the major event and downstream flood levels are not known, the top of the outlet pipe shall be the downstream control.

(e) 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 1% probability flood level.

4. The water surface in drainage pits shall be limited to 0.150m, below the gutter invert for inlet pits and 0.150m below the underside of the lid for junction pits. ***Water Surface Limits***

D5.09 MINOR SYSTEM CRITERIA

1. The acceptable gutter flow widths in the 10 ARI event is 2.5 metres maximum. Wider flow widths may be approved on roads with flat grades. ***Gutter Flow Widths***

2. Minimum conduit sizes are given below: ***Conduit Sizes***
   - The minimum pipe size shall be 375mm diameter.
   - The minimum box culvert size shall be 600mm wide x 300mm high.

3. All stormwater pipes shall be self cleansing and shall have a maximum velocity of 3.5m/s. ***Velocity Limits***

D5.10 PITS

1. Inlet Pits shall be spaced so that the gutter flow width is limited in accordance with this specification and so that the inlet efficiency is not affected by adjacent inlet openings. Preference shall be given to the location of drainage pits at the centre of allotments (except at intersections). ***Spacing***

2. Other pits shall be provided:
   - To enable access for maintenance.
   - At changes in direction, grade, level, size or class of pipe.
   - At junctions.

3. The maximum recommended spacing of pits where flow widths are not critical are generally 100m.

4. Maximum kerb inlet lengths to sid e entry pits are to be a preferred maximum of 3.0m, with an absolute maximum of 5.0m where the grade is 10% or more, and an absolute maximum of 4.0m where the grade is less than 10%. ***Inlet Capacity***

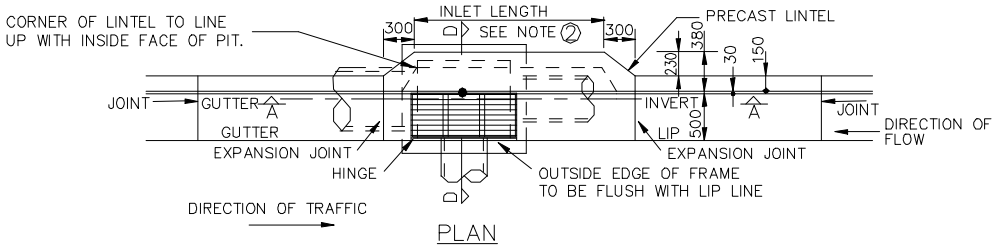
5. Information on pit capacities is available in the following sources:-
   - Roads and Traffic Authority's "Model analysis to determine Hydraulic Capacities of Kerb Inlets and Gully Pit Gratings", with due allowance to inlet bypass due to grade, for grade inlet pits, and recognised orifice or weir formulae for sag inlet pits.
   - Pit relationships given in Chapter 14 of AR&R 1987.

6. None of these pit charts include any blockage factors. The percentage of theoretical capacity allowed in relation to type of pit is given in Table D5-1:- ***Allowance for Inlet Blockage***

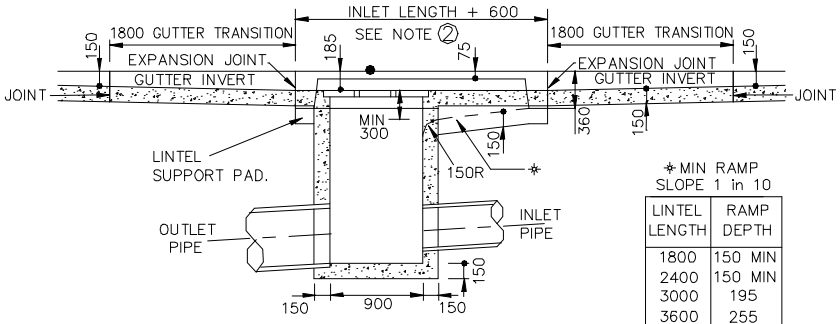
Condition	Inlet Type	Percentage of Theoretical Capacity Allowed
Sag	Side entry	80%
Sag	Grated	50%
Sag	Combination	80%Side inlet capacity only Grate assumed completely blocked
Sag	"Letterbox"	50%
Continuous Grade	Side entry	80%
Continuous Grade	Grated	50%
Continuous Grade	Combination	80%

Table D5-1

7. The type of pit required is an 'opening behind kerb with lid and lintel'. Standard Drawings for grated kerb inlet pit, grated junction and kerb and gutter are set out in Figures D5-1, D5-2 and D5-3.



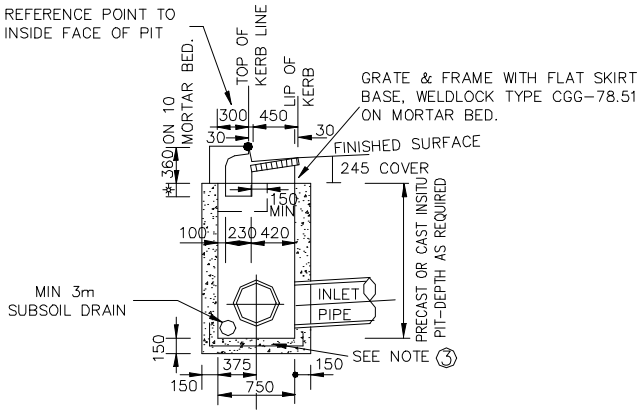
PLAN
STANDARD PIT A (ON GRADE)



* MIN RAMP SLOPE 1 in 10

LINTEL LENGTH	RAMP DEPTH
1800	150 MIN
2400	150 MIN
3000	195
3600	255
4200	325

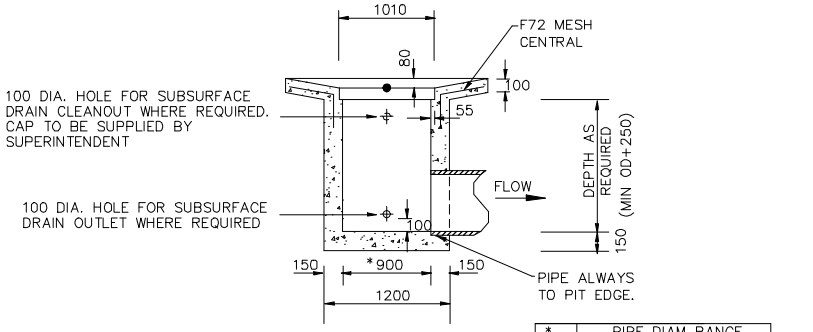
SECTION A–A ELEVATION



SECTION D–D ELEVATION
FOR PIPE DIAMETER UP TO 525mm

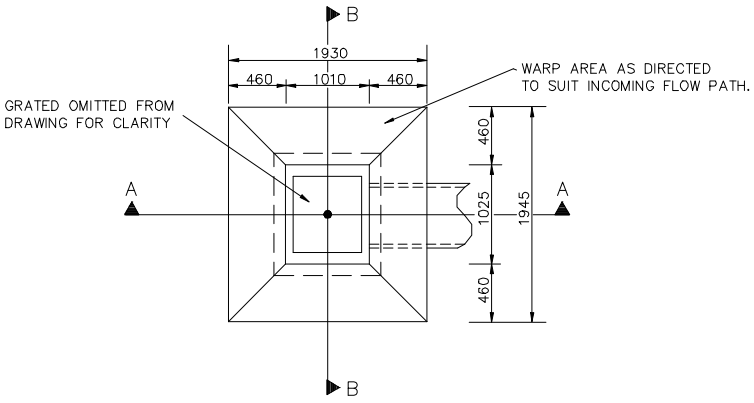
NOTES:
1. LEVEL OF GULLY PIT & POSITION OF GRATE SHOWN IN THIS DRAWING REFER TO THIS POINT
2. ALL LINTELS TO BE APPROVED PRECAST TYPE. DIMENSIONS SHOWN ON PLAN TO DENOTE CLEAR OPENINGS. MIN SIZE 1.2m
3. PITS DEEPER THAN 1.8m TO HAVE 200 THICK WALLS AND BASE WITH F81 MESH CENTRALLY PLACED. Y12 CORNER BARS @400 C/C 450 LEGS IN BASE AND SIDE

GRATED KERB INLET PIT
Figure D5-1

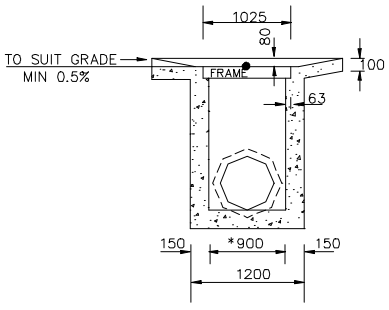


SECTION A–A

*	PIPE DIAM RANGE
900	600mm TO 750mm INCL
1200	825mm TO 900mm INCL



PLAN

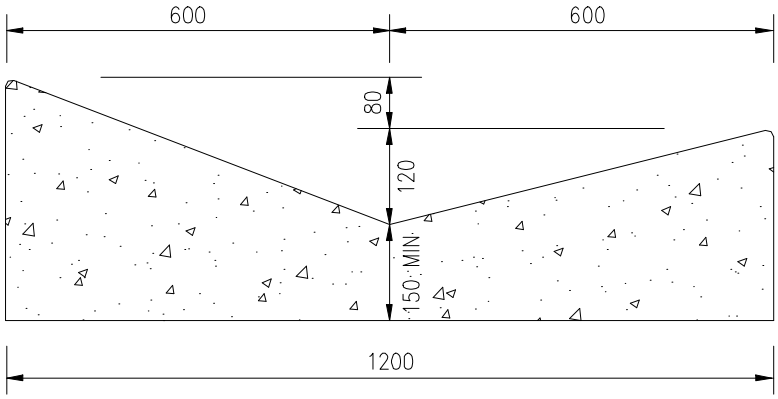


SECTION B–B

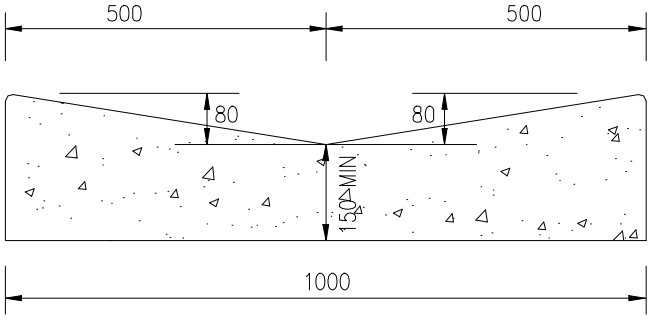
NOTES

1. ALL DIMENSIONS ARE IN MILLIMETRES
2. DRAWING NOT TO SCALE
3. CONCRETE COMPRESSIVE STRENGTH F'c 25MPA
4. LOCCATION AND LEVEL OF GULLY PIT SHOWN IN THE DRAWINGS REFER TO THIS POINT: ●
5. SIDE WALLS OF ALL PITS DEEPER THAN 1500 ARE TO BE REINFORCED WITH ONE LAYER OF F82 MESH RETURNED 300 INTO BASE
6. DEPTH OF PIT NOT TO EXCEED 3500
7. PITS DEEPER THAN 1200 TO BE FITTED WITH PLASTIC COATED OR GALVANISED STEP IRONS AT 350 CENTRES
8. ALL EXPOSED EDGES TO BE ROUNDED WITH 20 RADIUS
9. FOR DETAILS OF GULLY GRATING AND FRAME SEE WELDLOCK GRATE CODE PC9090B OR APPROVED AQUIVALENT
10. BENCH PITS ARE DIRECTED BY SUPERINTENDENT
11. PROVIDE MIN 900mm PINNED TURF SURROUND
12. SHAPE ADJACENT AREAS TO ASSIST WATER COLLECTION.

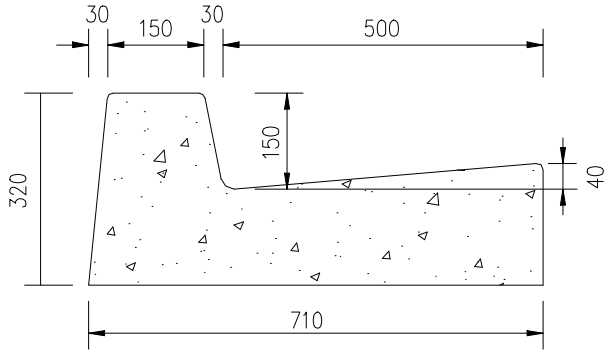
STANDARD GRATED JUNCTION
Figure D5-2



MODIFIED 'V' DRAIN
(SK)



DISH CROSSING
INCREASED WATERWAY
(SC)



BARRIER KERB WITH GUTTER
(SL)

TYPICAL KERB & GUTTER DETAILS
Figure D5-3

D5.11 HYDRAULIC LOSSES

Pit Losses

1. The pressure change co-efficient "Ke" shall be determined from either Missouri Charts and/or Hare (1983)

2. Computer program default pressure change co-efficient "Ke" shall not be acceptable unless they are consistent with those from the charts in D5.12.1 The chart used and relevant coefficients for determining "Ke" value from that chart shall be noted on the hydraulic summary sheet provided for plan checking and included on the final design drawings.

Bend Losses

3. Bends may be permissible in certain circumstances and discussions with Council regarding their use is required prior to detailed design.

Service Entry Losses

4. The Design must avoid clashes between services.

5. Requirements for private pipes entering Council's system are given below:-

   (a) All pipe inlets, including roof and subsoil pipes, shall where possible, enter the main pipe system at junction pits. These shall be finished off flush with and be grouted into the pit wall.

   (b) If a junction has to be added which is larger than 225mm then a junction pit shall be built at this location in accordance with this Specification.

   (c) For smaller inlets, the drainage pipes may be broken into to allow interconnection with the main line. In this case the sideline shall be finished flush with and be grouted into the main line.

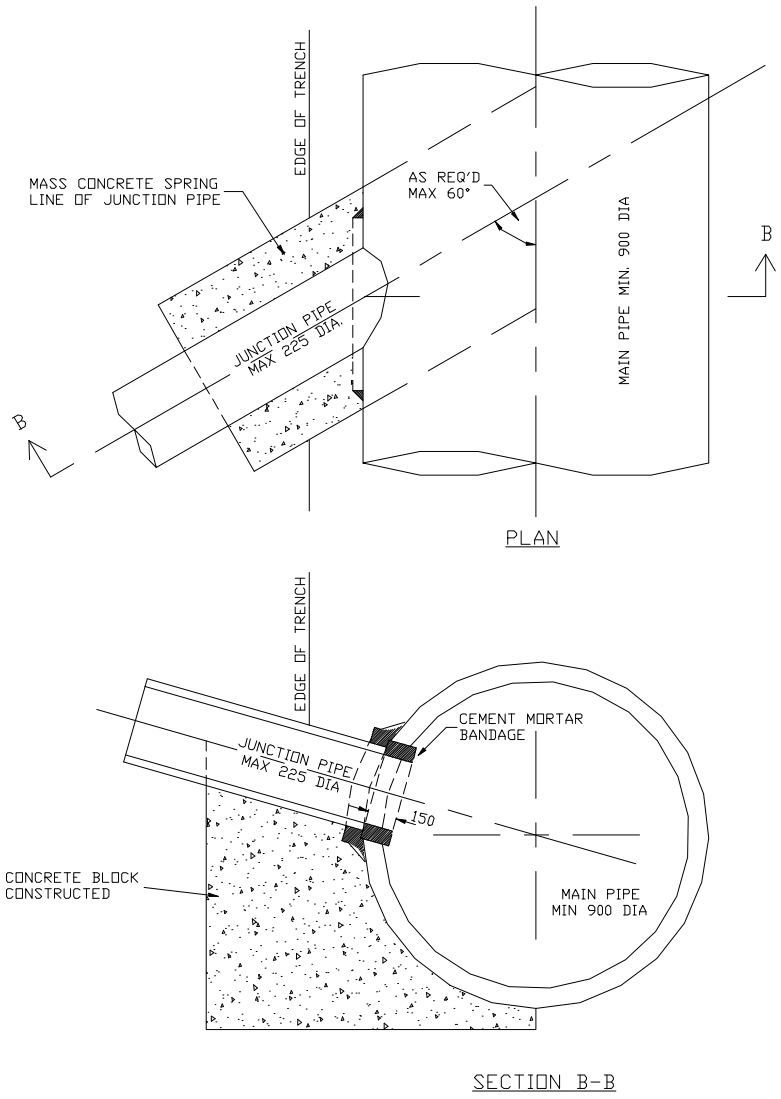


DIAGRAM OF PRIVATE PIPES ENTERING COUNCIL'S SYSTEM
Figure D5-4

6. Construction of a junction without a structure must be avoided. ***Pipe Junction Losses***

7. Going from larger upstream to smaller downstream conduits is not permitted. In going from smaller to larger pipes benching shall be provided in pits to enable a smooth flow transition. ***Contraction/ Expansion Losses***

8. Drainage pipe systems shall be designed as an overall system, with due regard to the upstream and downstream system and not as individual pipe lengths. Drainage pipeline systems shall generally be designed as gravity systems flowing full at design discharge, but may be pressurised with the use of appropriate pits and joints. Pipe friction losses and pipe sizes in relation to discharge shall be determined using the Colebrook-White formula with the acceptable roughness coefficients being 0.6mm for concrete pipes. ***Pipe Friction Losses***

D5.12 MAJOR SYSTEM CRITERIA

1. Surcharging of drainage systems which would provide for water depth above the top of kerb will not be permitted except as defined below. Surcharging of drainage system for storm frequencies greater than 20 ARI may be permitted across the road centreline where the road pavement is below the natural surface of the adjoining private property. Flow across footpaths will only be permitted in situations specifically approved by Council, where this will not cause flooding of private property. ***Surcharging***

2. The velocity x depth product of flow across the footpath and within the road reserve shall be such that safety of children and vehicles is considered. The maximum allowable depth of water is 0.2 metres and the maximum velocity x depth product of $0.4m^2/s$ is permitted. Where the safety of only vehicles can be affected, a maximum velocity x depth product of $0.6m^2/s$ is permitted. In open channels the above velocity x depth product criteria will be followed where possible or the design shall address the requirements for safety in relation to children by providing safe egress points from the channel or other appropriate methods. ***Velocity/ Depth Criteria***

3. Freeboard requirements for floor levels and levee bank levels from flood levels in open channels, roadways and stormwater surcharge paths are given below: ***Freeboard***

a) Generally ***Generally***

(i) a minimum freeboard of 0.3m shall be provided between the 100 year flood level and floor levels on structures and entrances to underground car parks. A higher freeboard may be required in certain circumstances and

(ii) where the road is in fill or overtopping of kerbs and flow through properties may occur a 100mm freeboard shall be provided between the ponding level of water in the road and the high point in the footpath. Driveway construction in these instances needs to consider this requirement.

b) In surcharge paths a minimum freeboard of 0.5 shall be provided between the surcharge path of the 100 year flood level and floor levels on structures and entrances to underground car parks. ***Surcharge Paths***

c) In Open Channels a minimum freeboard of 0.8m shall be provided between the open channel 100 year flood level and floor levels on structures and entrances to underground car parks. ***Open Channels***

d) Floor levels for residential developments in the Singleton town area shall comply with the minimum floor heights specified on Singleton Local Environmental Plan 1996 Floor Heights Restriction Map (Map No 9). ***Singleton Floodplain***

4. Flow capacities should be calculated using Technical Note 4 in Chapter 14 of AR&R 1987 with a flow adjustment factor. (Page 304 AR & R) ***Roadway Capacities***

D5.13 OPEN CHANNELS

1. Generally, open channels will only be permitted where they form part of the trunk drainage system and shall 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 shall comply with the requirements of this Specification. ***Safety***

2. Design of open channels shall be generally in accordance with Chapter 14, Volume 1 of ARR 1987, and shall be designed with safety requirements as set out in Section 14.10.4 of ARR 1987 as a primary criterion. Open channels will be designed to contain the major system flow assuming that the minor system is fully blocked. All flow shall be maintained in a subcritical form.

3. Friction losses in open channels shall be determined using Manning's "n" values given below:- ***Channel Roughness***

Manning's "n" Roughness Coefficients for open channels shall generally be derived from information in Chapter 14 of AR&R 1987. Manning's "n" values applicable to specific channel types are given below:-

Concrete Pipes or Box Sections	0.012
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)	0.022
Earth (with weeds and gravel)	0.028
Rock Cut	0.038
Short Grass	0.033
Long Grass	0.043

4. Where the product of average Velocity and average flow Depth for the design flow rate is greater than $0.4m^2/s$, the design will be required to specifically provide for the safety of persons who may enter the channel.

Side Slopes

5. Maximum side slopes on grassed lined open channels shall be 1 in 4, with a preference given to 1 in 6 side slopes, channel inverts shall generally have minimum cross slopes of 1 in 20.

Low Flows

6. Low flow provisions in open channels (man-made or al tered channels) will require low flows to be contained within a pipe system or concrete lined channel section at the invert of the main channel. Subsurface drainage shall be provided in grass lined channels to prevent waterlogging of the channel bed.

Hydraulic Jumps

7. Transition in channel slopes to be designed to avoid any hydraulic jumps due to the nature of the transition.

D5.14 MAJOR STRUCTURES

Afflux

Definition: A major structure is a structure with a waterway area> 5m²

1. All major structur es shall be designed for the 100 year ARI storm event without afflux in urban areas. Some afflux and upstream inundation may be permitted in certain rural and urban areas provided the increased upstream flooding is minimal and does not inundate private property.

Freeboard

2. A minimum clearance of 0.6m between the 100 year ARI flood level and the underside of any major structure superstructure is required to allow for passage of debris without blockage.

Bridges

3. All bridges shall be designed for the 100 year ARI flood without afflux.

4. Certified structural design shall be required on bridges and other major culvert structures and may be required on some specialised structures. Structural design shall be carried out in accordance with AUSTROADS Bridge Design Code.

Culverts

5. All culverts shall be designed for 100 year ARI Flood without afflux in urban areas.

6. Culverts (either pipe or box section) shall be designed in accordance with charts provided in Austroads “Waterways Designs” 1994, with due regard being given to inlet and exit losses, inlet and outlet control and scour protection.

D5.15 RETARDING BASINS

Critical Storm Duration

1. For each ARI 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 AR&R 1987 Volume II.

2. 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.

3. Flood Routing should be modelled by methods outlined in AR&R 1987. ***Routing***

4. The high level outlet to any retarding basin shall have capacity to contain a minimum of the 100 year ARI 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 (1986). Where retarding basins are used the whole catchment to the outlet shall be modelled. ***High Level Outlet***

5. The spillway design shall generally be in accordance with the requirements for Open Channel Design in this Specification.

6. Pipe systems shall contain the minor flow through the Retarding Basin wall. Outlet pipes shall be rubber ring jointed with lifting holes securely sealed. Pipe and culvert bedding shall be specified to minimise its permeability, and cut off walls and seepage collars installed where appropriate. ***Low Flow Provision***

7. The low flow pipe intake shall be protected to prevent blockages.

8. Freeboard – Minimum floor levels of dwelling shall be 0.5m above the 100 year ARI flood level in the basin. ***Freeboard at Dwellings***

9. Public Safety Issues - Basin design is to consider the following aspects relating to public safety.

Safety Issues

- 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.
- Water depths shall be, where possible, less than 1.2m in the 20 year ARI storm event. Where neither practical or economic greater depths may be acceptable. In that case the provision of safety refuge mounds should be considered.
- The depth indicators should be provided indicating maximum depth in the basin.
- Protection of the low flow intake pipe shall be undertaken to reduce hazards for people trapped in the basin.
- Signage of the spillway is necessary to indicate the additional hazard.
- Basins shall be designed so that no ponding of water occurs on to private property or roads.
- No planting of trees in basin walls is allowed.
- The need for fencing to exclude the public
- No basin spillway is to be located directly upstream of urban areas.
- Design of basin shall take into account effects of other services

STORMWATER DETENTION

D5.16 STORMWATER DETENTION

Re-development

1. Installation of Stormwater Detention is required on redevelopment sites where under capacity drainage systems exist. A redevelopment site is defined as a site which used to have or was originally zoned to have a lower density development than is proposed.

INTERALLOTMENT DRAINAGE

D5.17 INTERALLOTMENT DRAINAGE

1. Interallotment Drainage shall be provided for every allotment which does not drain directly to its street frontage or a council pipe drainage system.

2. Interallotment drainage shall be contained within an easement not less than 1.0m wide , and the easement shall be in favour of the upstream allotments.

3. Pipe Capacity - The interallotment drain shall be designed to accept concent rated drainage from buildings and paved areas on each allotment for flow rates having a design ARI the same as the "minor" street drainage system. The time of concentration is to be 5 minutes for each property on the line being analysed.

Impervious Area

4. In lieu of m ore detailed analysis, the following areas of impervious surface are assumed to be contributing runoff to the interallotment drain:-

Development Type	% of Lot Area
Residential	70
Industrial	80

- Commercial 90

5. Pipes shall be designed to flow full at the design discharge without surcharging of inspection pits.

Pits

6. Interallotment drainage pits shall be located at all changes of direction. Pits shall be constructed of concrete, with 100mm thick walls and floor and have a minimum 600 x 600 internal dimensions. Pits shall be with a 100mm concrete lid finished flush with the surface of works. Depressed grated inlets are acceptable. Pipes shall be a minimum of 150mm.

Grade

7. Pipes - Minimum Grade - The interallotment dra inage shall have the minimum grade for self cleansing.

Pipe Type

8. Interallotment Drainage Pipe Standards – The interallotment drainage shall be constructed from rubber ring jointed pipes of either reinforced concrete pipe or uPVC pipe which shall conform respectively to the requirements of AS 4058 and AS 1254. In public road Reserves and recreation reserves where vehicle loads may be encountered, reinforced concrete pipe only, shall be used.

Sewer

9. Interallotment Drainage Pipe - Relationship to Sewe r Mains - Where interallotment drainage and sewer mains are laid adjacent to each other they are to be spaced 1.5 metres between pipe centrelines.

10. Where sewer mains are within 5m of interallotment drainage lines they are to be shown on the interallotment drainage plan.

DETAILED DESIGN

D5.18 CONDUITS

1. Conduit and Material Standards – Conduits and materials shall be in accordance with the standards for RC and uPVC pipes.

Bedding

2. Pipe Bedding and Cover - Pipe Bedding and Cover Requirements for reinforced and fibre reinforced concrete pipes shall be determined from the Concrete Pipe Association "Concrete Pipe Guide" or AS 3725. For uPVC pipes, the requirements shall be to AS 2032.

3. Conduit Jointing - Conduit Jointing shall be rubber ring jointed.

4. Conduit Location - 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.

D5.19 PIT DESIGN

1. Pits shall be designed with benching to improve hydraulic efficiency and reduce water ponding. Typical pit designs and other pit design requirements are provided by Council (see Figures D5-1 and D5-2). Safety and safe access are important considerations in pit design

D5.20 STORMWATER DISCHARGE

Scour

1. Scour protection at culvert or pipe system outlets shall be constructed in accordance with Department of Land & Water Conservation recommendations summarised in “Urban Erosion & Sediment Control Field Guide” and in accordance with Figure D5-5. Council’s approval will be required where outlet conditions dictate the use of more substantial energy dissipation arrangements.

2. At points of discharge of gutters or stormwater drainage lines or at any concentration of stormwater from one or on to adjoining properties, either upstream or downstream, Council will require the subdivider to enter into a Deed of Agreement with the adjoining owner(s) granting permission to the discharge of stormwater drainage and the creation of any necessary easements with the cost of the easement being met by the developer.

Easements

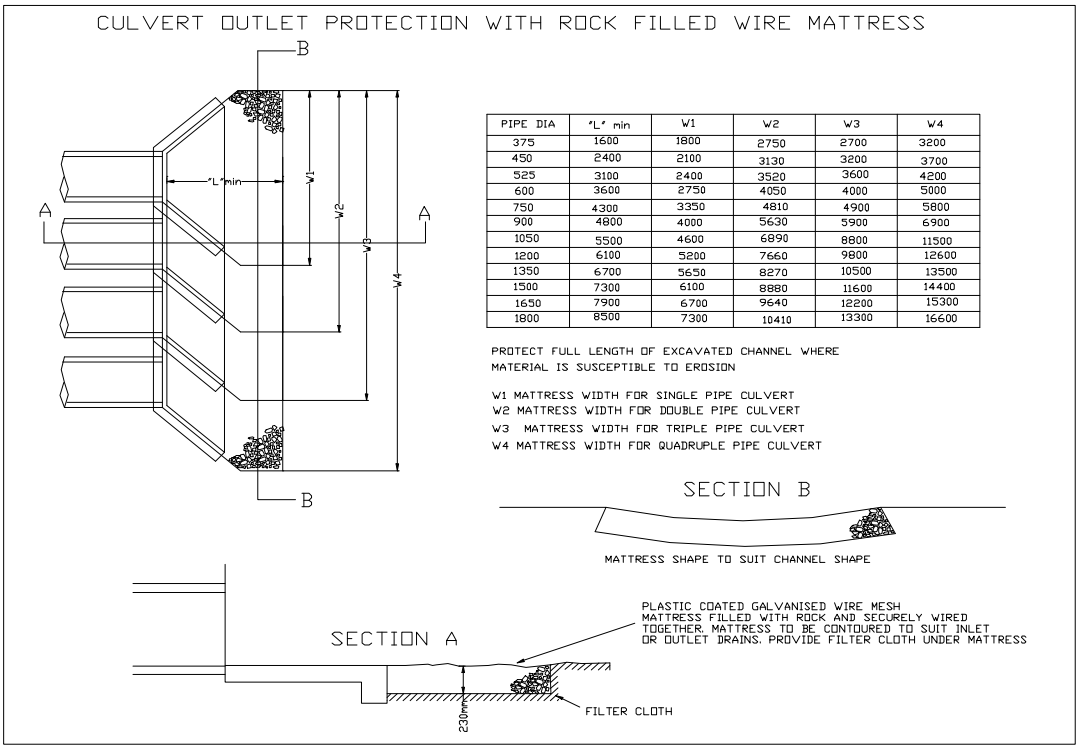
3. Where the drainage is to discharge to an area under the control of another statutory authority eg, Public Works and Railway operators, the design requirements of that Statutory Authority are also to be met.

4. The minimum drainage easement width shall be 3.0m for drainage systems to be taken over by Council. The overall width of the easement in Council's favour will be such as to contain the full width of overland flow or open channel flow in the major system design event.

Council Control

5. Discharge to Recreation Reserves – Piped stormwater drainage discharging to recreation reserves is to be taken to a natural water course and discharged in an approved outlet structure or alternatively taken to the nearest trunk stormwater line.

CULVERT OUTLET PROTECTION WITH ROCK FILLED WIRE MATTRESS
Figure D5-5



D5.21 MISCELLANEOUS

1. Subsoil drainage in Pipe Trenches – S ubsoil Drainage shall be provided in pipe trenches as outlined below.

2. In cases where pipe trenches are backfilled with sand or other pervious material, a 3m length of subsoil drain shall be constructed in the bottom of the trench immediately upstream from each pit or headwall. The subsoil drain shall consist of 100mm diameter subsoil drainage pipes, in accordance with Council's Sub-Surface Specifications. ***Subsoil Drainage Line***

3. The upstream end of the subsoil drain shall be sealed with cement mortar, and the downstream end shall discharge through the wall of the pit or headwall.

4. Termination of Kerb and Gutter and Associated Scour Protection - Kerb and Gutter shall be extended to drainage pit or natural point of outlet. Where outlet velocity is greater than 2.5m per second or where the kerb and gutter discharge causes scour, then protection shall be provided to prevent scour and dissipate the flow. ***Kerb & Gutter Termination***

D5.22 WITHDRAWN

D5.23 WITHDRAWN

D5.24 WITHDRAWN

D5.25 WITHDRAWN

SPECIAL REQUIREMENTS

D5.26 RESERVED

D5.27 RESERVED

D5.28 RESERVED

DEVELOPMENT DESIGN SPECIFICATION

D6

Modified 3

SITE REGRADING

CONTENTS

DEVELOPMENT DESIGN SPECIFICATION D6
SITE REGRADING

GENERAL

D6.01 SCOPE

1. This design specification sets out requirements for the site regrading involved in land development and subdivision. Conceptual requirements are presented as necessary considerations when preparing designs for site regrading.

2. The scope of this specification assumes that the Designer is familiar with requirements cited in the various construction specifications, specifically those related to earthworks, clearing and grubbing, erosion and sedimentation. Additionally the Designer needs to make reference to the associated design specifications related to drainage design, geometric road design and stormwater management and erosion design.

Familiarity with other Specifications Required

D6.02 OBJECTIVES

1. This specification aims to assist the Designer in achieving:

Efficient

- efficient and economical design
- enhancement of the environmental character of the site whilst maintaining the natural features of the site

Environmentally Sound

- provision of safe conditions for construction commensurate with the proposed purpose of the development

Safe for Construction

- equality of building conditions for residential development
- a minimal impact on adjoining properties and developments.

Impact on Adjoining Properties

D6.03 REFERENCE AND SOURCE DOCUMENTS

(a) Council Specifications

Construction Specifications

C211	-	Control of Erosion and Sedimentation
C212	-	Clearing and Grubbing
C213	-	Earthworks
C273		Landscaping

Design Specifications

D1	-	Geometric Road Design
D5	-	Stormwater Drain Design
D7	-	Stormwater Management and Erosion Design

(b) Australian Standards

AS 3798	-	Guidelines on earthworks for commercial and residential developments

AS 2870-1996 - Residential slabs and footings - Construction.

D6.04 SITE REGRADING CONCEPT

1. Areas of a site proposed for 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 und erground 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

(e) Allow effective recreational use or give reasonable access

The Consultant shall review the natural surface contours and where necessary shall design finished surface levels that ensure the land is suitably prepared

Drainage

2. Where practical, 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.

Natural Environment

3. The Consultant shall consider the implications of site regrading in relation to the existing natural environment. Generally site regrading shall be minimised in heavily treed areas.

Overland Flow

4. Care shall be taken to provide depressions for overland flow from low points and over major drainage lines, to direct stormwater for storms up to a 100 year average recurrence interval.

Minimal Road Haulage

5. The design of site regrading areas in conjunction with the design of roadworks shall 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 an adverse effect on adjacent development, and infrastructure.

D6.05 SPECIAL TREATMENT OF PARTICULAR AREAS

Flooding

1. Areas abuttin g localised flooding or nuisance drainage sites shall be site regraded to a minimum level of 0.5 metres above the 100 ARI Flood levels. The site shall be identified on the design plans with appropriate notation of site specific requirements.

DLWC Approval

2. Regrading of land on the declared Singleton Floodplain and/or within 20 metres of a watercourse shall not be undertaken without the prior written consent of Department of Land & Water Conservation.

Inundation Areas

3. In the event that an area is known to be affected by or inundated by local stormwater flows, the Designer shall 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 normally be accompanied by sketch plans to clarify recommendations.

Restrictions on Land Use

4. Site constraints either natural or otherwise may be required to be identified as a burden on developed property. It is recommended that the designer 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 88B Instrument placed on title to the land and/or by a Section 149 message advising prospective purchasers of any restrictions affecting the land.

5. The finished surface of filled areas shall 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. ***Piped Gullies or Depressions***

6. The location of such features shall be clearly defined on the site regrading plans and defined by distance to corner boundaries, monuments, etc for purposes of relocation at the geotechnical testing stage for work as executed plans. A geotechnical report specifying the site specific preparation and compaction requirements will be required to be incorporated with the site regrading plan. A description of the minimum acceptable quality of the fill shall also be specified on the plans, supported by geotechnical recommendations. All documentation necessary from various authorities to support the filling of dams and watercourses shall be supplied with the design plans. ***Dams and Water Courses***

7. The finished level of any building area shall be designed to ensure a minimum surface grading of 1.5% oriented in the direction of the drainage system designed to cater for its catchment. ***Flat Ground***

8. Building areas containing natural ground slopes of an excessively steep nature, ie greater than 15% shall be brought to the attention of a Geotechnical Engineer for investigation of compatibility with dwelling types proposed. Specific requirements shall be noted on the design plans. ***Steep Slopes***

D6.06 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. Such requirements shall be shown on the design plan. ***Clearing***

2. All timber and other materials cleared from lots shall be removed from the site. All roots, loose timber, etc which may contribute to drain blockage shall be removed. Such requirements shall be shown on the design plan. ***Disposal***

3. In areas to be filled around butts of trees, refer to Construction Specification Landscaping C273. ***Filling around Trees***

4. Where trees are to be removed an allowance is to be made for clearing of all trees and replanting with a minimum of six (6) advanced suitable species to each lot; planting to be clear of probable future building location, 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 shall be shown on the design plans. ***Trees Removed***

4. Selected trees shall be preserved by approved means to prevent destruction normally caused by placement of conventional filling or other action. Refer to Construction Specification Landscaping C273 for measures to be undertaken for preservation of trees ***Preservation of Trees***

D6.07 STANDARD OF FILL FOR LOTS

1. The following notations are to be incorporated in the design plans. "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 shall be in accordance with AS 3798. Fill is to be placed in layers not exceeding 150mm compacted thickness. All fill is to be compacted to 95% standard maximum dry density. Maximum particle size shall be 2/3 of the layer thickness. ***Fill Quality***

3. Fill comprising industrial wastes or by-products shall not be accepted by Council ***Restricted Fill***

4. All areas where filling has been placed are to be dressed with 50mm clean arable topsoil, fertilised and sown with suitable grasses. ***Top Dressing***

D6.08 TEMPORARY DIVERSION DRAINS

1. Where temporary drains are required to divert sur face flows away from the site regrading area, the location and silt/erosion control treatment shall be clearly identified on the engineering plans. The scale of such works shall reflect the volume of water to be diverted. ***Erosion***

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

The requirements identified in Council's Specification Erosion Control and Stormwater Management ‘D7’ should be addressed for any requirements.

D6.09 WITHDRAWN

D6.10 WITHDRAWN

D6.11 WITHDRAWN

D6.12 WITHDRAWN

SPECIAL REQUIREMENTS

D6.13 RESERVED

D6.14 RESERVED

D6.15 RESERVED

DEVELOPMENT DESIGN SPECIFICATION

D7

Modified 3

EROSION CONTROL AND STORMWATER MANAGEMENT

EROSION CONTROL AND STORMWATER MANAGEMENT

GENERAL

D7.01 SCOPE

1. Virtually all construction activity which requires the disturbance of the soil surface and the existing vegetation, naturally predisposes the construction site to erosion. This in turn leads to sediment loss in the resultant run-off water. ***Erosion***

2. Since such soil disturbance is a necessary part of development, it is essential therefore to develop measures which reduce the erosion hazard of any particular construction activity. Having done that, it is necessary to control run-off water, which carries the sediment, in such a way as to reduce the amount of that sediment leaving the site to an acceptable level. ***Reduce Sedimentation***

3. After construction is complete and the site fully rehabilitated, permanent water quality control structures and features commence their role. These include trash racks, gross pollutant traps, wet retention basins and the creation of, or increase in size of wetlands. ***Water Quality***

D7.02 AIMS

1. To limit/minimise the amount of site disturbance. ***Site Disturbance***

2. Isolate the site by diverting clean upstream water around or through the development where possible. ***Diversion Works***

3. Control runoff and sediment movement as its point source rather than at one final point. ***Point Source***

4. Stage earthworks and **progressively revegetate** the site where possible to reduce the area contributing sediment. This in turn increases the efficiency and effectiveness of the entire sediment control system while decreasing the number and size of controls required. ***Progressive Revegetation***

5. Provide an effective major stormwater system economical in terms of capital, operational and maintenance costs, incorporating water quality controls. ***Major Stormwater***

6. Retain topsoil for effective revegetation works. ***Topsoil***

7. Locate sediment control structures where they are most effective and efficient. ***Sediment Structures***

D7.03 REFERENCE AND SOURCE DOCUMENTS

(a) Council Specifications

D5	-	Stormwater Drainage Design
C211	-	Control of Erosion and Sedimentation
C273	-	Landscaping

(b) NSW State Legislation

Clean Waters Act, 1970
Dams Safety Act, 1978
Soil Conservaiton Act, 1938
Water Act, 1912

(c) ACT Government Publications

Design Manual for Urban Erosion and Sediment Control - July 1988
"Protecting the Murrumbidgee from the Effects of Land Development"
"Guidelines for Erosion and Sediment Control on Building Sites"
Implications for Building Construction
Pollution Control on Residential Building Sites (Brochures)
Field Guide - Erosion and Sediment Control
Australian Journal of Soil and Water Conservation - Vol 3, Number 1

(d) State Authorities

NSW Department of Housing
- Soil and Water Management for Urban Development.

Roads and Traffic Authority
- Erosion and Sedimentation Design Considerations.

Soil Conservation Service
- Erosion and Sediment Control - Model Policy and Code of Practice (Discussion Paper).

NSW Department of Land and Water Conservation (DLWC)
- Urban Erosion and Sediment Control.

State Environmental Planning Policy No.14 - Coastal Wetlands.

(e) Other

Wyong Shire Council
- Techniques of Erosion and Sediment Control (June 1992 & October 1993).

Presentation Papers by Mr Noel Nebauer
- Flood Mitigation Conferences - Bankstown & Taree
- Sediment and Erosion Control Seminars - Service Authorities

Singleton Shire Council
- Erosion & Sediment Control Development Control Plan – 1999.

D7.04 PLANNING & CONCEPT DESIGN

1. Assess the physical characteristics and limitations of soils, landform and drainage of the site and plan the subdivision accordingly. ***Site Characteristics***

D7.05 DETAILED DESIGN

1. After development consent is given an erosion and sediment control/water management plan shall be submitted to Council as part of the detailed engineering design. This plan must give all details for erosion, sediment and pollution controls. Note: **This design shall be site specific** and not a generalisation of erosion control philosophy. It may also form part of the contract specifications for a contractor to comply with during construction. ***Site Specific***

2. A soil test to determine erosion potential is required for all Erosion and Sediment Control Designs. ***Soil Test***

3. No site works shall commence prior to approval of the detailed engineering design. All works are to be carried out in accordance with the approved management plan. Its implementation must be supervised by personnel with appropriate qualifications and/or experience in soil conservation on construction sites. ***Approval***

4. Notwithstanding the foregoing, Council may require erosion or sediment control works to be carried out additional to or instead of those works specified in the approved plan, should circumstances change during construction. ***Additional Works***

EROSION CONTROL

D7.06 BUFFER ZONES

1. Buffer zones are corridors of vege tation adjacent to waterways or disturbed areas. The vegetation filters suspended solids and reduces the nutrient levels in run-off. Wetlands, stream and rivers adjacent to construction sites shall be protected by buffer zones. ***Filters***

2. Buffer zone pe rformance increases as catchment area and slope gradient decreases. Thirty-metre-wide buffer zones generally provide adequate protection. ***Performance***

Slope %	Buffer Width in Metres
2	15
4	20
6	30
8	40
10	50
12	60
14	70

3. Buffer zones can reduce the need for other erosion and sediment control measures. However, contaminated water in a concentrated form will require treatment both at its sources point and final disposal. ***Contaminated Water***

4. A fence shall be used to exclude traffic from buffer zones to prevent damage to the vegetation, particularly during any construction phase. ***Fencing***

D7.07 "NO ACCESS" AREAS

1. It is Council's Policy to conserve as much existing vegetation in new developments as possible. ***Conserve Vegetation***

2. The landsc ape plan shall incorporate as much existing native vegetation as possible.

3. The "no access" fence locations shall be shown on the detailed design. These locations will be approximate only as machinery type, topography etc will determine actual on site location. ***No Access***

4. Fenced areas shall be clearly signposted "No Access Area".

D7.08 DIVERSION WORKS

1. Diversion works may be in the form of earth drains and banks, haybales, sand bags or pipelines and may be permanent or temporary. ***Diversion Types***

2. Such techniques are used to divert the upstream water around the site. Such flows shall discharge to a formal drainage point or open areas where level spreader banks should ensure a broad water spread. ***Discharge Point***

3. Pipelines may also be use d to convey uncontaminated water through the development site, and discharge the flow to a formal drainage point/dissapator if necessary. Such pipelines may also form part of the overall final drainage system. ***Pipelines***

4. Design of the diversion system should suit the following:-

Drain Shape

(a) The drain should preferably be dish shaped with batter grades of less than 2:1

Pipe Capacity

(b) If a piped system is selected its design capacity shall be a minimum of the capacity nominated in the design Specification STORMWATER DRAINAGE.

Peak Flows

5. Diversion works are to be designed to carry peak flows at non-erosive velocities in bare soil.

Non-Erosive Linings

6. Generally, the channel should be lined with turf. However, where velocities are designed in excess of 2m per second, non erosive linings such as concrete, geotextiles, grouted rock etc or velocity reducers (check dams etc) are required.

7. Typical arrangements of diversion drains and banks are shown in Figure D7-1.

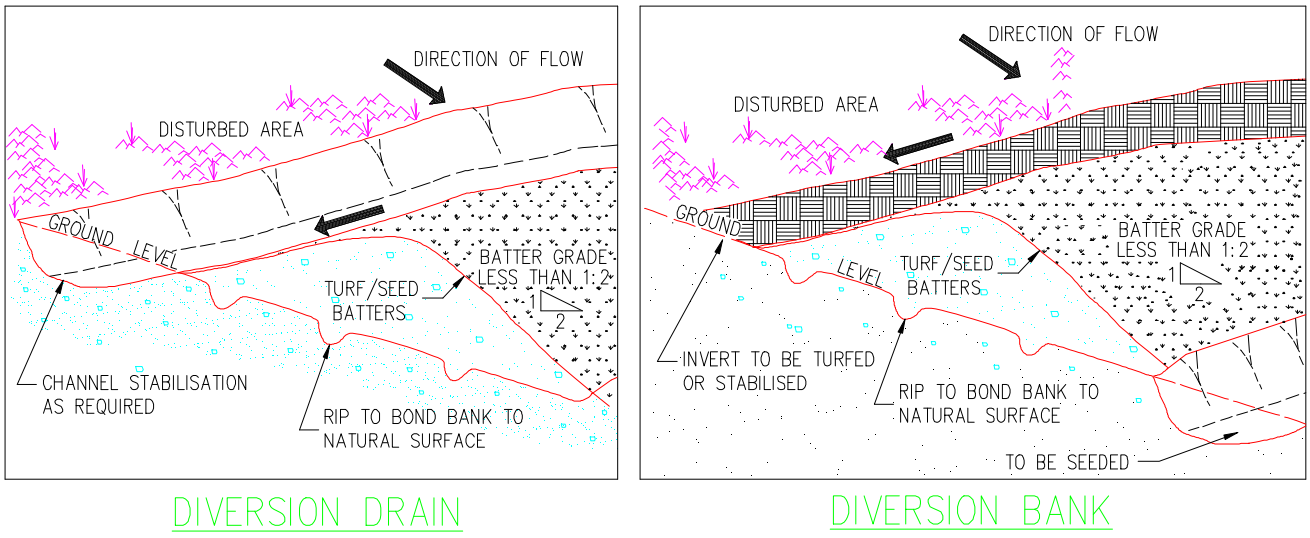


Figure D7-1 - Diversion Drains/Banks

D7.09 DROP DOWN DRAINS

Lined Drains

1. These are temporary or permanent drains which divert concentrated run-off down slopes such as road batters without causing erosion. They usually consist of a dished earth drain smoothly shaped, consolidated and lined with a variety of materials or they may be a flexible/rigid pipe or half pipe.

Piped Drains

2. Drop down drains consisting or rigid, or flexible, pipes are very effective as a temporary measure during road construction used in association with an earth windrow (or bund wall) along the top edge of the batter. Run-off flowing along the windrow is directed to the pipe by which water is conveyed down the batter. It is a simple matter to extend the pipe as the batter rises.

Capacity

3. Drop down drains shall have sufficient capacity for a minimum 1 in 5 year peak flow without eroding. Energy dissipators may be required to reduce the flow velocity at the outlet of the drop down drain.

D7.10 STOCKPILES

Approved Plan

1. Location of stockpiles shall be indicated on the approved engineering plans.

2. Stockpile sites shall be located: ***Location***

   (a) Clear of existing or proposed drainage lines.

   (b) Clear of areas likely to be disturbed during construction.

   (c) Clear of the drip zone of trees.

   (d) Preferably on reasonably flat areas.

3. Stockpiles must be protected from erosion and sediment loss by: ***Erosion Protection***

   (a) The installation of diversion works.

   (b) The use of silt fences, haybales etc or other approved controls on the downstream side.

   (c) Compaction.

   (d) Revegetation if left exposed for longer than 30 days (refer to Landscaping Construction Specification for seed mix).

   The combination of the measures to be used is to be discussed with Council.

4. Site topsoil shall be isolated from subsoil material in separate stockpiles. ***Separate Stockpiles***

D7.11 SEDIMENT BASINS/TRAPS/DAMS

1. Sediment traps are either permanent or temporary sediment control devices that intercept sediment and run-off usually at the final discharge point of the site. ***Sediment Control***

2. They are formed by excavation and/or by constructing embankments. ***Construction***

3. There are two types, wet and dry basins. ***Types***

4. Preferably sediment traps shall not be located directly upstream of residential areas. ***Location***

5. Basin design must meet the following: ***Design Criteria***

(a) Volume/capacity of the trap shall be 250m^3/ha of disturbed site including the building areas.

(b) An additional allowance of 50m ^{3}/ha is required if diversion controls are not used to direct clean upstream water from outside the site away from construction areas.

(c) The capacity shall be measured below the invert of the lowest incoming flow. Otherwise pipelines and associated works will be affected.

(d) A secondary or emergency stabilise d spillway must be provided to prevent overtopping of the structure. This shall be directed to a safe overland flow path.

(e) The basin shall have a minimum of 0.5 metres freeboard above the level of the spillway.

(f) The basin shall be surrounded by a fence if required by Council.

(g) Access must be provided to the basin for maintenance.

(h) The basin shall have an arbitrary length to width ratio of between 2 and 3:1. This encourages soil particle settlement. The entry and exit points should be located at the opposite ends of the basin.

(i) If this is not possible some form of approved baffles shall be installed to minimise short circuiting of the flow.

(j) Discharge of the basin shall be via a perforated riser encapsulated by a filter device for a dry basin.

(k) Internal basin batters shall be a maximum of 3:1 and external batters a maximum of 2:1.

(l) All disturbed areas including batters shall be topsoiled and seeded.

(m) A 150mm UPVC low flow pipe is to be designed into the structure.

D7.12 SEDIMENT TRAPS/ BARRIERS FOR MINOR CATCHMENTS

1. These are silt retention/filtering structures of a temporary nature used in situations where the catchment does not exceed 0.5ha. ***Filtering Structures***

2. Such sediment traps/barriers generally consist of: ***Barrier Types***

(a) silt fences

(b) hay bales

(c) blue metal groynes/sausages

(d) filter fabric located beneath stormwater grates

(e) gabions

(f) or a combination of the above.

3. The choice of material and type of treatment will depend on the size of t he catchment the location and the structure being treated such as: ***Location of Structure***

(a surface inlet pits
(b) kerb inlet pits
(c) catch drain disposal areas
(d) culvert inlets and outlets
(e) minor construction/earthwork sites
(f) check dams/velocity reducers etc.

D7.13 LEVEL SPREADERS

1. Level spreaders are outlets or "sills" having a level cross section. They convert erosive channelised flows into non-erosive sheet flow. ***Convert Flows***

2. Level spreaders can only be used to dissipate flows from small catchments. The area below the outlet should be stable and of even cross section so that the water will not re-concentrate into channels. ***Location***

3. To reduce flow velocity before the spreader, the channel grade shall not exceed 1 per cent f or a minimum of 8 metres. The outlet or "sill" width depends on contributing catchment, slope and ground conditions. The minimum width should be four metres, and the maximum width 25 metres. Final discharge should be over a level surface, which may require stabilising by turfing or seeding and fertilising or perhaps lining with a geotextile fabric or something similar. ***Design Criteria***

D7.14 THE LOCATION OF SHAKEDOWN AREAS AND ACCESS STABILISATION

1. Access to construction sites shall be limited to a maximum of two locations. ***Number of Accesses***

2. Such access locations shall require Council approval. ***Location Approval***

3. Shakedown areas or access stabilisation shall comprise a bed of aggregate on filter cloth or a metal bar cattle grid located at any point where traffic enters or leaves a construction site. Stabilised accesses reduce or eliminate tracking of sediments onto public rights of way or streets. Should such tracking occur the contaminants must be swept off the road way each day or before rain. Clean off draw bars etc after dumping and before starting journey. ***Types***

4. If a shaker grid is used, this should be so placed as to ensure the vehicles when crossing the grid have sufficient speed to "shake the mud" or other contaminants such as gravel from the vehicle. It must not be placed where the vehicle is slowing to enter a roadway. Shaker grids shall be a minimum length of 7 metres. ***Shaker Grid***

5. A stabilised access comprises a vehicular pathway suitably constructed to facilitate the collection of any site debris in order to prevent such material leaving the site. Stabilised accesses are generally used on small sites. The entrance shall be at least 15 metres long with a minimum width of 3 metres for a one way entrance and 6 metres for a two way entrance. ***Stabilised Access***

6. Surface water flowing to the street entrance/exit must be piped under the access, or a berm constructed to direct surface flow away from the exit. ***Flow Control***

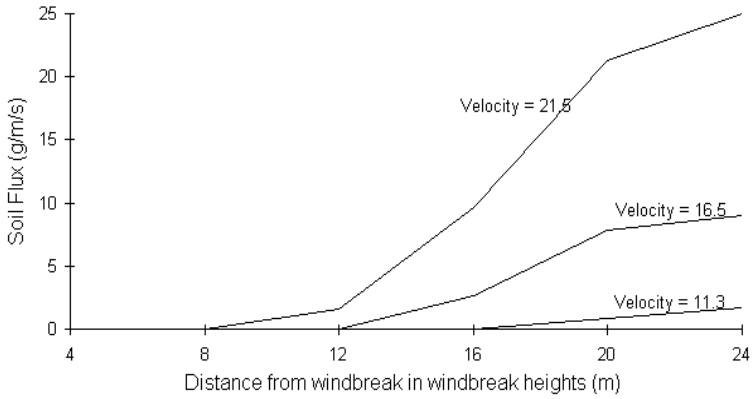
D7.15 WIND EROSION/DUST CONTROL

1. Research has demo nstrated average dust emission rates of over 2 ½tonnes per hectare per month at urban construction sites. This erosion rate is unacceptable. ***Erosion Rate***

2. Various measures are available to minimise such emissions, including:- ***Treatments***

(a) limiting the area of lands exposed to erosive forces through phasing works/progressive revegetation and/or provision of a protective ground cover and/or keeping the ground surface damp (not wet); and/or

(b) on building sites, installing a barrier fence on the windward side - effective to a distance of 15 times its height, assuming an acceptable soil flux of 5 grams per metre per second. See Figure D7-2..



Effect of distance from windbreak on soil loss, wind blowing at less than 90 to the windbreak.

Figure D7-2 - Pollution Control

D7.16 REQUIREMENTS FOR BUILDING SITES

1. When the development calls for the construction of a number of buildings, the sediment trap/s and other appropriate sediment controls shall remain operational. ***Development Control***

2. Cross/catch drains shall be installed on long or steep unpaved driveways, disposing run-off to stable areas. ***Driveway Control***

3. Where a majority of the lot is disturbed the following controls or measures shall be undertaken: ***Lot Control***

(a) Silt fences, located around the downstream sides of the lot.

(b) Sediment traps/barriers to be provided to all on-site a nd adjacent stormwater inlets.

(c) Only one site access to be provided. This may require treatment to prevent soil being tracked from the site.

(d) All subsurface drainage for roofing must be in place prior to the installation of the roof and gutter so downpipes can be immediately connected.

D7.17 EXTERNAL SITE REQUIREMENTS

1. Sediment control devices or stabilising works shall be provided outside construction sites where necessary or as directed by Council. ***Necessary Controls***

2. Where in creased stormwater run-off is likely to accelerate erosion of any downstream watercourse, the necessary remedial work shall be provided concurrently with other sediment and erosion requirements. ***Accelerate Erosion***

3. Where sediment is likely to be transpo rted from the site, all immediate downstream drainage inlets shall have appropriate controls installed. ***Downstream Controls***

4. If such works require entry onto private property, written permission shall be obtained prior to the entry and commencement of such works. ***Written Permission***

5. All disturbed areas on private property to be reinstated to original condition. ***Reinstated***

STORMWATER MANAGEMENT

D7.18 GENERAL

1. Most developments mean a change in land use and is usually accompanied by a decline in stormwater quality. This applies to the long term as well as during the short term construction phase. The main components required to enhance stormwater quality are as follows:- ***Main Components***

(a) Buffer Zones and Filter Strips, being grassed, or similarly treated areas to facilitate the natural assimilation of water pollutants and reduce run-off.

(b) Gross Pollutant Traps (GPT) designed to intercept litter and debris to maintain visual quality in downstream waterways, and to reduce the coarse sediment load on downstream water management structures.

(c) Wet Retention Ponds are permanent sediment ponds designed to allow particulate matter to settle out. They operate under both sedimentation and macrophyte regimes. Note that a large proportion of nutrients adhere to the sediments, and therefore settle out. Other nutrients are removed by macrophytic vegetation as part of the food chain.

(d) Wetland (Nutrient) Filter to enhance the removal of fine sediment and nutrients from stormwater run-off, and are largely dependent on biochemical removal mechanisms (ie, nutrients taken up as part of the plant food chain).

2. Excess nutrients (N,P) lead to eutrophication of waterways. This can cause uncontrolled growth of algae, water weeds etc, which can deplete oxygen levels, kill resident flora and fauna, and reduce recreational appeal. However waterways do have a natural capacity to assimilate nutrients in small to moderate amounts as initial flows have. ***Excess Nutrients***

3. It is essential to treat the "first flush" of stormwater as these initial flows from urban areas have relatively high pollutant loads. Such heavy pollution results from significant areas of impervious surfaces which do not assimilate pollutants such as dust, fertilisers, pesticides, detergents, etc to the same extent as occurs in more rural environments. ***First Flush***

D7.19 WITHDRAWN

D7.20 TRASH RACKS

1. Trash racks are usually permanent structures which intercept trash and other debris to protect the aesthetic and environmental quality of water. Where appropriate, construct them upstream of all permanent retarding basins and/or wetlands which have a capacity greater than 5,000 cubic metres, and elsewhere as required by Council.

Environmental Quality

2. Generally, their design criteria should ensure:- ***Design Criteria***

(a) vertical bar screens with bar spacing of 65 mm clear;

(b) the length of the rack is consistent with the channel dimension and cause minimal damage when overtopped;

(c) they are as large as practicable while considering al l other design criteria - a maximum height of 1.2 metres is suggested;

(d) a structure which remains stable in at least the 20 year ARI event, and is unlikely to cause flooding on adjacent lands as a result of the rack becoming completely blocked in the 100 year ARI event (analysis should include investigation of backwater effects and any consequent flooding);

(e) the structure drains by gravity to a dry condition; and

(f) adequate access for maintenance and which permits the use of mechanical equipment.

3. Where associated with outlet structures for small sediment basins or constructed wetlands, they can be relatively simple in design. ***Associated Structures***

4. Trash racks may be incorporated in the design of gross pollutant traps. ***Gross Pollutant Trap***

D7.21 GROSS POLLUTANT TRAPS

1. Gross pollutant traps (GPTs) are permanent structures used to trap coarse sediments, trash, litter, and other floating materials. Usually, they are located upstream of constructed wetlands and receiving waters. They consist of an energy dissipater at the upper end, concrete sediment trap and trash rack at the lower end. Sometimes a "mini" wetland is incorporated at the downstream end. ***Description***

2. These traps have restricted application and each should be justified on individual merits. They have high construction costs and are generally unable to trap silt and clay sized particles other than in relatively small storm events (eg, one year ARI, critical duration storm event). Nevertheless, in some specialised situations their use might be justified, especially where a significant proportion of the bed load consists of particles coarser than 0.04mm (sandy soils) and/or where their construction/maintenance cost can be justified when compared with more conventional sediment retention basins. ***Applications***

3. GPTs can be defined as major or minor: ***Definition***

(a) major gross pollutant traps can be located on major floodways and waterways to intercept medium to high flows; and

(b) minor, enclosed gross pollutant trap s can be located at heads of major floodways and/or where stormwater discharges into floodways or water bodies.

4. Design traps to intercept at least 75 per cent of sediment with a grain size of 0.04mm or greater under average annual runoff conditions. Further, ensure peak flow velocities are less than 0.3 metres per second in the 1 year ARI storm event, and taking into account any likely backwater effect from a blocked trash rack. ***Sediment Interception***

5. The structure should have sufficient capacity and stability to discharge the inlet flow with the trash rack fully blocked without flooding adjacent properties. ***Capacity***

6. Ensure GPTs are capable of gravity drainage to a dry condition for periodic cleaning and maintenance if at all possible. ***Maintenance Requirement***

D7.22 WETLANDS

1. Wetlands used for improvement of urban run-off quality can be either natural or artificial. They necessarily have to be shallow. Growth of emergent aquatic plants (reeds, etc) should be encouraged by using sideslopes of very low gradient (1 in 8 or less). A large percentage (greater than 50 per cent) of any permanent water should be less than 1 metre deep. The remainder of any open water should have a depth of not greater than 2 metres which will allow submerged plant growth. Figure D7.4 shows a typical wetland arrangement. ***Depth and Batters***

2. Wetlands, like retention basins, operate more effectively when higher contact time between the pollutants and the biota of the wetland is provided. Thus, like retention basins, wetlands will be more efficient when used in conjunction with upstream flow retardation basins that will maintain run-off closer to pre-development levels. ***Efficiency***

3. A structure should be included to allow manipulation of water levels in the wetland. This will enable control of microphyte, insect populations and facilitate dredging. ***Water Levels***

4. Where possible, small islands or shoals should be constructed in the upstream areas of the wetland to reduce water velocities, prevent short circuiting and promote aquatic plant growth. ***Short Circuiting***

5. The performance and life of wetlands, like wet retention basins, will suffer if they are not protected from trash and large particles. It is therefore recommended that trash racks/gross sediment/pollution traps be installed upstream of the wetland. ***Wetland Protection***

6. Wetlands need to be surrounded by a buffer at least 20 metres wide in order to:- ***Buffer Zones***

(a) Restrict access to maintenance vehicles by the installation of an all weather track with a lockable device.

(b) Acts as an infiltration area for surface run-off.

(c) Provide flood protection and secondary assimilation of pollutants.

7. These areas are best planted with vegetation native to the area, but they can be used as grassed areas and an aesthetic feature. ***Native Vegetation***

8. In designing wetlands, it is recommended that, as an interim guide, the surface area of the wetlands be a minimum of 0.5 per cent of the catchment which it serves. If wetlands are used in conjunction with wet retention basins, this percentage can be proportionately lowered by allowing for the surface area of the installed wet retention basin. ***Surface Area***

9. In open water zones, rooted emergent macrophytes appear to be more efficient than substrate microphytes (plants that are attached to the bottom of the water but which do not emerge). This is because the emergent aquatic plants act as an oxygen pump, taking oxygen from the atmosphere into their roots and eventually into the water and so making it available for bacteria and attached algae which grow on the roots on the emergent plants. In the crushed rock zones, emergent aquatic plants are the only types of macrophytes that will grow. These plants will also act as oxygen pumps, and facilitate biological uptake of nutrients and the breakdown of organic matter by bacteria which grow on their roots.

Microphyte Types

10. A variety of plant species should be planted in artificial wetlands to achieve efficient colonisation and maximise pollutant removal. Establishment of plants should be through transplantation of seedlings during spring and early summer.

Revegetation

11. Wetlands will serve other purposes than just improving a quality of urban run-off. They will serve to attract a large range of biota and bird habitat. In areas where they have been installed, they have become an aesthetic feature. Indeed, this may present problems as surrounding communities may resist efforts by the controlling authority to de-silt the wetland.

Aesthetic Feature

12. To minimise mosquito problems, limit expanses of water with more than 50 per cent shading and ensure no sections of water become isolated from the main body.

Insect Problems

13. Islands are highly beneficial as wildlife refuges, especially for bird s. Their design should consider the effects on changes in water tables.

Wildlife Refuge

14. Stock ponds with selected native fish to improve the water quality (not for sport), especially species which will control mosquito larvae and select zooplankton in preference to phytoplankton. Avoid use of fish which are bottom feeders.

Native Fish

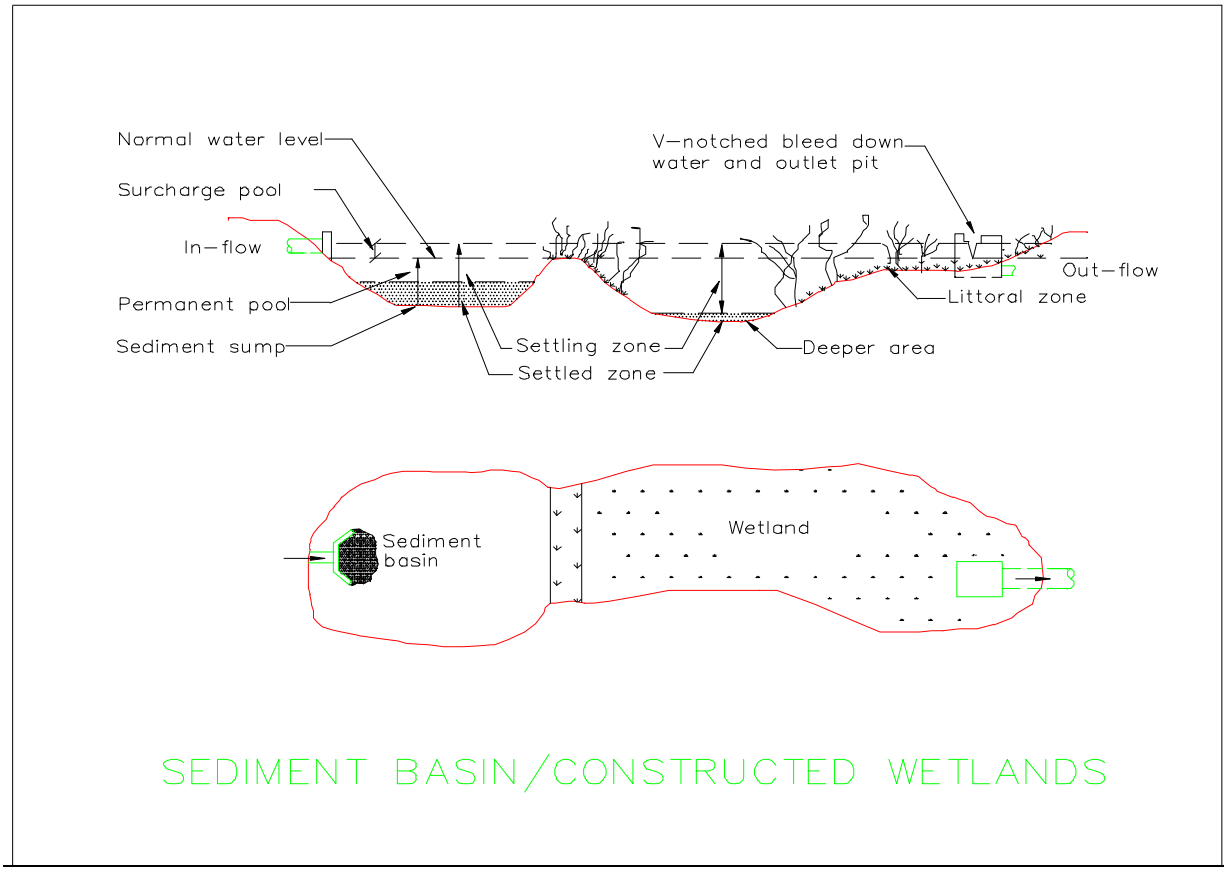


Figure D7-4 - Sediment Trap/Constructed Wetland

SPECIAL REQUIREMENTS

D7.23 RESERVED

D7.24 RESERVED

DEVELOPMENT DESIGN SPECIFICATION

D9

Modified 3

CYCLEWAY AND PATHWAY DESIGN

DESIGN SPECIFICATION D9
CYCLEWAY AND PATHWAY DESIGN

DEVELOPMENT DESIGN SPECIFICATION D9
CYCLEWAY AND PATHWAY DESIGN

GENERAL

D9.01 SCOPE

1. This specification sets out requirements to be used in the design of various types of cycleways and pathways.

2. All relevant design principles contained in the Austroads Guide referenced below must be integrated in the design of cycleways and associated infrastructure. This specification serves as a companion document to the Austroads Guide extended to incorporate basic requirements for pathways.

AUSTROADS

D9.02 OBJECTIVES

1. This specification aims to set standards and document requirements related to the provision of cycleways and pathways which encourage pedestrian activities and cycling for transportation and recreational purposes. Cycleways and pathways are to be safe and convenient and shall maintain a satisfactory level of service for all pathway users.

Safety and Level of Service

D9.03 REFERENCE AND SOURCE DOCUMENTS

(a) Council Specifications

D1 - Geometric Road Design

(b) Australian Standards

AS 1742 - Manual of uniform traffic control devices.
AS 2890.3 - Parking facilities - Bicycle parking facilities
AS 1428 Code of Practice of Design Rules for access by the disabled

(c) Other

AUSTROADS - Guide to Traffic Engineering Practice - PART 13 Pedestrians, PART 14 Bicycles.

- Planning and Designing for Bicycles - NAASRA (now Austroads) Technical Report June 1988.

Ministry of Transport, Victoria - State Bicycle Committee
- Planning and Design of Bicycle Facilities,

D9.04 CONSULTATION

1. The Designer is encouraged to consult with Council, the Developer's Landscape Architects/Designers and relevant authorities prior to and during the preparation of cycleway and pathway design.

Landscape Designers Public Authorities

D9.05 PLANNING CONCEPTS

1. Council will provide specific requirements for cycleways and pathways in Council's Residential Subdivision Development Control Plan (DCP) as well as in a regional or local strategic bicycle plan. The Designer will need to enquire about such documents and comply with requirements defined.

Subdivision DCP and Bicycle Plan

2. The Designer should familiarise himself with cycleway geometric design requirements in terms of:

Geometric Design

- width
- grade
- stopping sight distance
- change in grade
- horizontal curvature
- crossfall and drainage
- superelevation
- sight distance on horizontal curves

AUSTROADS Guide

These requirements are discussed in the AUSTROADS Guide.

D9.06 CYCLEWAY AND PATHWAY TYPES

1. Cycleways can be provided on road and off road. The Austroads Guide provides detailed descriptions, warrants, widths, pavement marking etc for the majority of these cycleways.

On Road Off Road

2. Common alternative cycleway types include:

On Road

Shared Parking/Bicycle Lanes
Wide Kerbside Lanes
Shared Traffic Lanes
Exclusive Bicycle Lane
Sealed Shoulder

Off Road

Shared Bicycle/Pedestrian Pathway
Segregated Pathway
Exclusive Cycleway

The AUSTROADS Guide provides advice on the suitability of pavement conditions, drainage pit grates etc for on road cycleways.

AUSTROADS Guide

3. Common pathway types include:

Common Types

- Exclusive Pedestrian Pathways
- Shared Bicycle/Pedestrian Pathways

By definition pedestrian pathways are "off road" in that pedestrian facilities routinely designed adjacent to roadways are termed footpaths and are designed to meet criteria outlined in Council's Residential Subdivision DCP and typically related to road cross section detailing.

Footpaths

4. Pathways by comparison diverge from the road alignment either within the road reserve or across land reserves. Pathways can be provided in conjunction with overland floodways or retention basins. ***Land Reserves***

D9.07 PROVISIONS FOR CYCLEWAYS AND PATHWAYS AT STRUCTURES

1. Designers shall consider the best way to cater for the uninterrupted movement of cyclists and pedestrians at proposed and existing structures wherever possible. Structures include bridges and underpasses over rivers, roads or railways. The Austroads Guide provides information on: ***Bridges Underpasses***

- acceptable widths and clearances
- types of cycleways and pathways
- handrails
- bicycle bridges
- approach ramps

  etc.

D9.08 SIGNAGE AND PAVEMENT MARKING

1. The Desi gner shall provide adequate signposting design for cycleways and pathways.

2. Signs and pavement marking will provide for the safe and convenient use of the facility. The signs and pavement marking will comply with AS 1742. ***Signs Pavement Marking***

D9.09 END OF JOURNEY FACILITIES

1. Consideration must be given to the design of adequate facilities at common destinations of bicyclists and pedestrians so as to encourage cycleway and pathway usage.

2. Such facilities could include: ***Facilities***

- seats
- standby areas
- secure bicycle parking
- picnic facilities

3. Bicycle parking installation design should meet appropriate criteria discussed in the Austroads Guide and be fabricated to meet AS 2890-3. ***Parking***

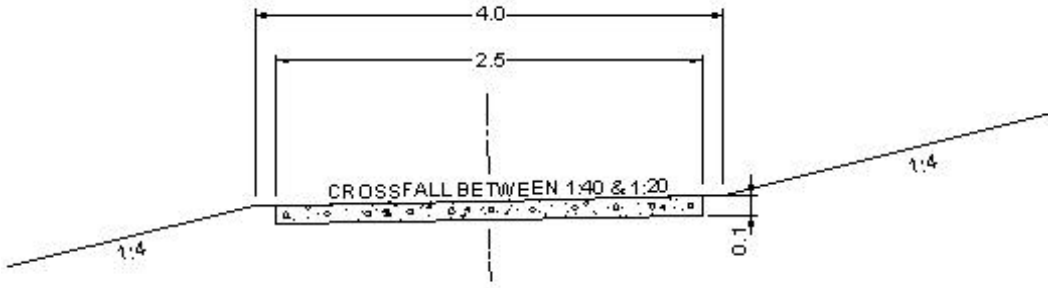
D9.10 MINIMUM DESIGN STANDARDS

1. Notwithstanding the guidelines provided in this specification and referenced documents the following minimum standards have been determined as shown in Table D9.1.

D9.11 WITHDRAWN

Table D9.1

	Pathway	Dual Use Cycleway Pathway
Path Width	1.2m	2.5m
Formation Width	2.0m	4.0m
Crossfall min. max.	1:40 1:20	1:40 1:20
Clearance Horiz.	1.2m	2.5m
Grade max.	See AS 1428	2% for 450m 5% for 90m 10% for 30m



TYPICAL CYCLE WAY CROSS SECTION
100mm CONCRETE WITH F72 STEEL MESH
NOT TO SCALE

SPECIAL REQUIREMENTS

D9.12 RESERVED

D9.13 RESERVED

D9.14 RESERVED

DEVELOPMENT DESIGN SPECIFICATION

D10

Modified 3

BUSHFIRE PROTECTION

CONTENTS

CLAUSE **PAGE**

DEVELOPMENT DESIGN SPECIFICATION D10
BUSHFIRE PROTECTION

GENERAL

D10.01 SCOPE

1. The work to be executed under this Specification consists of the design of bushfire protection facilities to protect life and property and bring a fire to a halt.

2. The specification contains procedures for the design of fire protection facilities. Designs shall be carried out to satisfy requirements of the Council and the guidelines published by the Department of Bushfire Services, May 1991. Consultation with Council's Fire Control Officer may be required.

D10.02 OBJECTIVES

1. This specification aims to outline the requirements that will minimise bushfire hazard in developments. The requirements are particularly pertinent to rural developments but should be an integral part of urbanised development as well. The concepts proposed need to be incorporated at an early stage of development design.

Rural Development
Urban Development

D10.03 REFERENCE AND SOURCE DOCUMENTS

(a) Council Specifications

C501 - Bushfire Protection (Perimeter Tracks)

(b) NSW Government Legislation

Environment Planning and Assessment Act 1979 - Section 94

(c) NSW Government Department Publications

Department of Bushfire Services (May 1991)
- Planning for Bushfire Protection. A Guide for Land Use Planners, Fire Authorities, Developer and Home Owner.

Department of Land and Water Conservation (formerly Land Management)
- Soil Conservation Service 1983. Guidelines for Planning, Construction and Maintenance of Tracks.

Ministry of Urban Affairs (formerly Environment) and Planning
- "Planning Guidelines for Subdivisions in Bushfire Prone Areas" 1985.

NSW Department of Urban Affairs (formerly Environment) and Planning
- "Circular 74: Planning in Fire Prone Areas" 1984.

(d) Other

Board of Fire Commissioners
- "Hazard Reduction for the Protection of Buildings in Bushland areas" 1984.

Bush Fire Council of NSW

- "Everyone's Guide to Bushfire Control" 1984.

- "Everyone's Guide to Bushfire Prevention in Urban Bushland Areas" 1986.

- "Everyone's Guide to Wild fire Prevention in Rural Areas" 1986.

Californian Department of Forestry
- "Fire Safety Guides for Residential Development in California" 1980.

Insurance Council of Australia.
- "Bushfire Safety in Urban Fringe Areas."

Luke, R.H. - "Before the Fires Start."

DESIGN CRITERIA

D10.04 GENERAL

1. Where a subdivision will abut unimproved timber in a bushfire prone area (as classified by Council), perimeter tracks are to be located immediately between the created allotment and the bushland within a minimum cleared width of 6m, and have a minimum formed width of 4m. Such roads shall be adequately drained to provide all weather access for fire fighting vehicles. ***Perimeter Tracks***

2. The perimeter track shall be contained within a 20m reservation whic h borders those allotments abutting the bushfire prone area. Such a reserve shall serve as a basis for fire protection measures to be undertaken and will not be considered as part of any public reserve dedication applicable to the subdivision. There shall be no development on the forest side of the perimeter track. ***20m Reservation***

3. Access is to be provided from the above described reservation from the local road system at regular intervals in a system of 'loops'. ***Access***

4. For those subdivisions receiving reticulated water, fire hydrants shall be situated at appropriate intervals or near where potential fire hazard areas exist as determined by Council. ***Fire Hydrants***

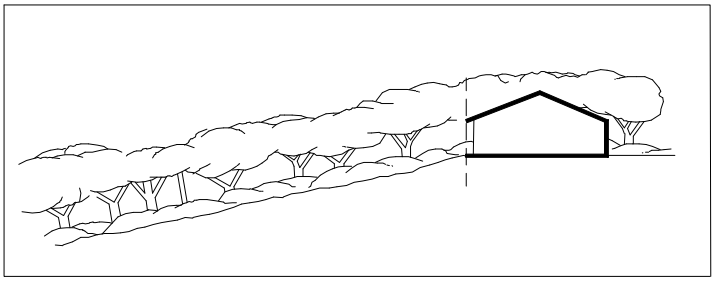
5. Council's Fire Control Officer shall be consulted for technical advice in relation to bushfire protection of subdivisions. ***Consultation***

6. Fire protection zones access tracks and perimeter tracks shall be clearly indicated on the subdivision plan. Erosion control features and revegetation requirements shall also be indicated in the subdivision plan.

7. Any clearing may require DLWC approval. Designer should consult with DLWC to determine whether approval is required under The Native Vegetation Act.

D10.05 FIRE PROTECTION ZONES

1. The provision of Fire Protection Zones (FPZs) can only occur as part of the development of the subdivision pattern. Each individual allotment shall have adequate space for the main building (usually a dwelling), an area of open space (front, back or side yard) and the FPZ (which may include part of the yard area and/or neighbouring properties). Figure D10.1 illustrates a typical FPZ. ***Part of Development***



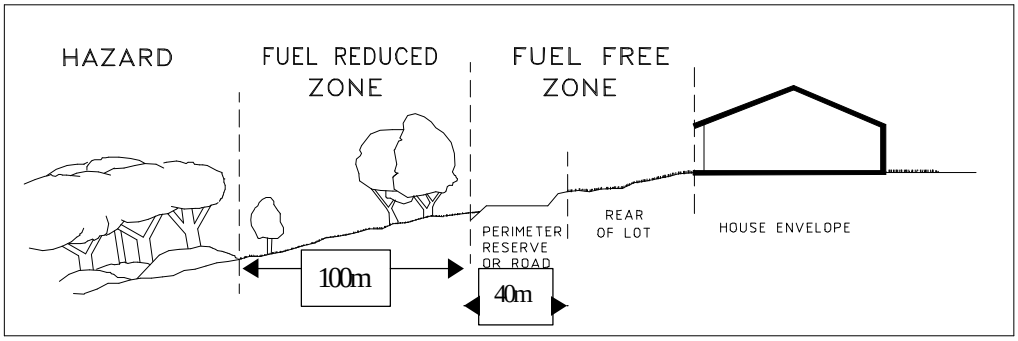


Figure D10.1
Fire Protection Zone

2. FPZs shall be required for any development fronting a bush fire hazard area, whether a single dwelling, a group of isolated dwellings or an urban subdivision. They act as a buffer zone between the development and the fuel. ***Buffer Zone***

3. The primary purpose of FPZs is to ensure that a progressive reduction of fuel occurs between the bush fire hazard and any combustible structures within the development. ***Reduction of Fuel***

4. Apart from its primary purpose the FPZ serves a number of other important purposes, dependent upon local fire fighting policy. The FPZ shall be designed to: ***Other Purposes***

(a) maximise the separation distance between high intensity fire and any structure, thereby reducing the radiation and direct flame contact;

(b) provide an area where embers can fall with minimal opportunity to create further fire outbreaks;

(c) provide a safe access to a structure for fire fighters by reducing the heat level from the main fire;

(d) provide a safe retreat for fire fighters; and

(e) provide a clear control line from which to begin back burning or hazard reduction operations.

Safety requirements sometimes dictate that fires are fought from the property itself rather than along the perimeter track.

5. The FPZ incorporates up to three separate components: ***Separate Components***

(a) Fuel Reduced Zone (FRZ); and

(b) Fuel Free Zone (FFZ) incorporating:

(i) a perimeter road or reserve (which incorporates an access track); and

(ii) a set-back (currently defined by minimum lot depths), which is usually part of the allotment.

D10.06 FUEL REDUCED ZONE

1. The FRZ is located adjacent to the hazard: ***Location***

Originally it would have been part of the bush fire hazard but has become an area where the fuel loadings are reduced through thinning of vegetation, mechanical clearing, hazard reduction burning or location of suitable developments such as playing fields or car parks (provided it is wide enough). ***Reduced Fuel Loadings***

2. Fuel loadings within the FRZ shall be kept to a level where the fire intensity expected will not impact on adjacent developments. In the absence of any policy to the contrary, 8 tonnes per hectare is to be adopted. ***Minimum Fuel Loadings***

3. The FRZ is to be included within the property being subdivided. ***Part of the Development***

4. For slopes greater than 18 degrees, the environmental consequences of ground clearing (erosion) may not be acceptable. Any clearing requires DLWC approval. ***Clearing Steep Slopes***

D10.07 FUEL FREE ZONE

1. The fuel free zone is located adjacent to, or is part of, the development and comprises a perimeter road and a set-back.

(a) Perimeter Road

(i) The perimeter road or access trail lies between the FRZ and the boundary of the allotments. ***Location***

(ii) The concept of a perimeter road requires that one side of the road has no fuel. Perimeter roads are not fire breaks in the same sense as used in fire fighting operations. Their main purpose relates to reduction of radiation and provision of access. Without a fuel source on the other side, perimeter roads can however prove very effective fire breaks. ***Concept***

(iii) The reserve shall be a minimum of 40m wide, with a 6m access track and passing bays every 200m. Passing bays are to be 10m wide and 15m long. ***Form***

(iv) In designing for a perimeter road or track, the distance required may not seem very great. Given that the probability of fire jumping a fire break increases as the width decreases, then areas where the highest intensity fires are likely should have fire breaks of greatest width. ***Design***

(v) Tracks shall be constructed to Soil Conservation Service (1983) guidelines.

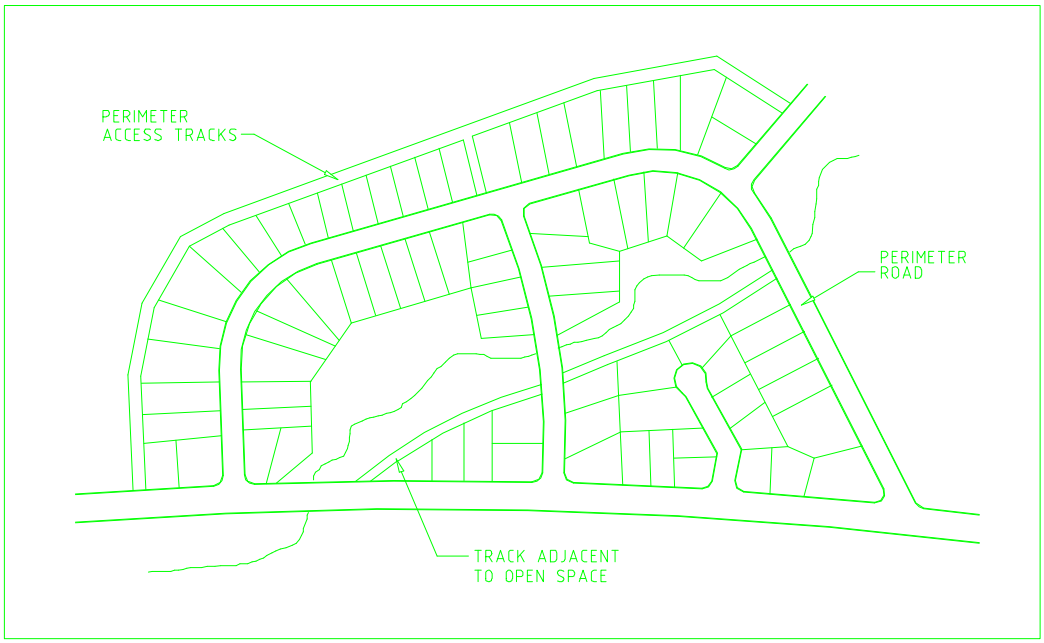


Figure D10.2
Perimeter Road Track

D10.08 MODIFICATIONS TO FUEL REDUCED AND FUEL FREE ZONES

1. Fire authorities would generally be reluctant to agree to modifications in the width of either the FRZ or the FFZ. If modifications were to be agreed, it would be after an examination of the particular cases rather than according to any formula.

Reluctance of Fire Authorities

2. Modifications would need to take account of adjacent or proposed development. Some difficulties arise where new development abuts existing development that is a fire hazard because of the nature of its usage (eg forests, parks etc). The general principle is that fire protection should be shared by both users which may require a certain level of negotiation outside the planning system.

Adjacent Development

3. Even without an extensive area of fuel outside the FRZ, intense fires can develop if the FRZ has not been hazard-reduced and if the fire begins as a line ignition from spotting embers.

4. Under adverse conditions fires moving up a slope may not be slowed by the presence of rocky outcrops and ledges, even though the continuity of the fuel bed may be broken.

D10.09 ACCESS TRACKS

1. The provision of adequate access tracks is also controlled by subdivision design.

Incorporated in Subdivision Design

Access tracks shall incorporate the following features.

(a) width, vertical clearances and any dips and crests which allow the two way movement of firefighting appliances;

b) construction stan dards of roads and any bridges which allow for the carrying of fully loaded fire appliances (28 tonnes or 8 tones per axle);

(c) curves which have a minimum inner radius of 12m and are minimal in number;

(d) maximum grades which do not exceed 15% (1:7) and preferably not more than 10% (1:10);

(e) clearly signposted roads;

(f) dead end roads which do not exceed 200 metres in length;

(g) dead ends which incorporate a minimum turning circle of 12.5m; and

(h) a subdivision road network which connects re gularly to any access tracks.

D10.10 STAGING WORKS

1. When considering the rate of development, planners shall provide for initial development to occur on the hazard perimeter of the development. A line of dwellings will tend to minimise the threat to the entire subdivision by limiting the hazard interface.

Initial Development on Hazard Perimeter

2. Scattered developments on the other hand, will allow a continuous network of fuel to threaten individual buildings until development is substantially underway.

Scattered Developments

3. For similar reasons, new developments should be 'tacked' onto old developments to minimise the hazard perimeter.

Minimise Hazard Perimeter

4. It is important that much of the bush fire protection is incorporated into the design of the development, rather than into individual allotments.

Incorporated in Subdivision Design

SPECIAL REQUIREMENTS

D10.11 RESERVED

D10.12 RESERVED

D10.13 RESERVED