BEGA VALLEY SHIRE COUNCIL

DEVELOPMENT DESIGN SPECIFICATION

D1

GEOMETRIC ROAD DESIGN (Urban and Rural)

Amendment Record for this Specification Part

This Specification is Council's edition of the AUS-SPEC generic specification part and includes Council's primary amendments.

Details are provided below outlining the clauses amended from the Council edition of this AUS-SPEC Specification Part. The clause numbering and context of each clause are preserved. New clauses are added towards the rear of the specification part as special requirements clauses. Project specific additional script is shown in the specification as italic font.

The amendment code indicated below is 'A' for additional script 'M' for modification to script and 'O' for omission of script. An additional code 'P' is included when the amendment is project specific.

Amendment Sequence No.	Key Topic addressed in amendment	Clause No.	Amendment Code	Author Initials	Amendment Date
EXAMPLE 1	*Provision for acceptance of nonconformance with deduction in Payment*	*XYZ.00*	*AP*	*KP*	*2/6/97*
1	Additional State Authorities reference documents	D1.03	A	JW	2/4/03
2	Drawing Requirements –Rural cross-sections and A2 plan sheets	D1.06	M	JW	14/4/03
3	Figures deleted	D1.07	O	JW	2/4/03
4	Road Network – delete maximum length of access street	D1.08	O	JW	14/4/03
5	Road gradients	D1.10	M	JW	2/4/03
6	Vertical Curves – kerb and gutter at sag points.	D1.12	A	JW	14/4/03
7	Carriageway widths in Table D1.5 and notes	D1.14	M	JW	2/4/03
8	Property Access – driveway gradings	D1.16	M	JW	14/4/03
9	Intersection Design – RTA Road Design Guide	D1.17	M	JW	14/4/03
10	Cul-de-sac arrangements	D1.17	M	JW	3/4/03
11	RTA Guide to Roundabouts	D1.18	M	JW	3/4/03

12	Car parking – clauses 5 – 17 deleted	D1.20	O	JW	3/4/03
13	Bus Routes	D1.21	A and O	JW	3/4/03
14	General Standards for Rural Roads – sealed and unsealed roads	D1.22	A and O	JW	3/4/03
15	Sight Distances – 90 and 100 km/h	D1.23	A	JW	3/4/03
16	RTA Road Design Guide	D1.24 D1.25 D1.28	M	JW	3/4/03
17	Carriageway widths	D1.27	M	JW	3/4/03

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CLAUSE PAGE

DEVELOPMENT DESIGN SPECIFICATION D1
GEOMETRIC ROAD DESIGN (Urban and Rural)

GENERAL

D1.01 SCOPE

1. This section sets out the specifications developed specifically for the design of subdivision roadworks using principles of street design to ensure safety and improved amenity and to reduce pedestrian/vehicular conflicts.

Subdivision Roadworks

2. A fundamental requirement of the design process is for designers to determine the vehicle speed which is deemed acceptable for a particular subdivision or section of road. The concept of designing to regulatory street speeds is contrary to the current principles of subdivision road design.

Acceptable Vehicle Speed

3. All relevant design principles must be integrated in the development of the road network. A careful balance is required between maximising amenity, safety and convenience considerations and those related to the drivers' perception of driving practice.

Integrated Design Principles

4. The words "street" and "road" are interchangeable throughout all parts of this Specification.

5. For the purpose of this Specification the definition of terms used to define the components of the road reserve shall be in accordance with AS 1348.1 and AMCORD.

Road Reserve Component Definitions

AS 1348.1 terms:

Carriageway - That portion of the road or bridge devoted particularly to the use of vehicles, inclusive of shoulders and auxiliary lanes.

Footpath - The paved section of a pathway (verge).

Pathway - A public way reserved for the movement of pedestrians and of manually propelled vehicles (AMCORD verge).

Pavement - That portion of a carriageway placed above the subgrade for the support of, and to form a running surface for, vehicular traffic.

Shoulder - The portion of the carriageway beyond the traffic lanes and contiguous and flush with the surface of the pavement.

AMCORD term:

Verge: - That part of the road reserve between the carriageway and the road reserve boundary. It may accommodate public utilities, footpaths, stormwater flows, street lighting poles and plantings.

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, 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.

(b) Australian Standards

AS 1348.1	-	Road and traffic engineering – Glossary of terms, Road design and construction.
AS 2890.1	-	Parking facilities: Off-street car parking.
SAA HB69.14	-	Guide to traffic engineering practice - Bicycles.
AS/NZS 3845	-	Road safety barrier systems.

(c) State Authorities

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

(d) Other

AUSTROADS RURAL ROAD DESIGN, 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.

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

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 the Council and other relevant authorities prior to or during the preparation of design. Designers should in addition to requirements of this Specification ascertain specific requirements of these authorities as they relate to the designs in hand. ***Council, Other Authorities***

2. Public consultation on designs shall be provided where such action is required by Council's current policy. ***Public Consultation***

3. The Designer shall obtain service plans from all relevant public utility authorities and organisations whose services may exist within the area of the proposed development. These services are to be plotted on the relevant drawings including the plan and cross-sectional views. ***Public Utilities***

D1.05 PLANNING CONCEPTS

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. ***Road Hierarchy***

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

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

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

5. Distinct landmark features such as watercourses, mature vegetation or ridge lines should be emphasised within the structural layout so as to enhance the legibility. ***Landmark Features***

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. ***Introduced Features***

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

8. There will be special constraints and costs associated with the design of roads through or adjacent to land known to be salt affected. Early planning shall consider ***Salinity Prevention,***

avoiding detrimental interference with land known to be salt affected. Adjustments in horizontal and vertical line shall be considered to avoid recharge of subsurface water within or adjacent to the road reserve. Consultation with the relevant land and water resource authority shall be mandatory under the above circumstances.

Early Planning, Mandatory Consultation

9. Appropriate native deep-rooted species should be selected for plantings in association with road reserve works. Plantations should be of sufficient size and density, multiple row belts and relatively close spacings are recommended, to be effective in their desired role of lowering the groundwater table.

Landscaping, Salinity Prevention

D1.06 DRAWING REQUIREMENTS

(a) Reduction Ratios

1. 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 (urban or rural) 1:200 Natural (rural)

(b) Drawing Sheets

1. Separate sheets should be provided for

a. Cover sheets
b. Plan views
c. Longitudinal sections
d. Cross sections
e. Structural details
f. Standard drawings

(c) Drawing Presentation

1. Drawings are to be presented on A1 or A2 sheets unless otherwise authorised. They are to be clear and legible and prepared in consistent lettering and style. Council has the authority to refuse drawings that do not meet these drafting requirements. Drawings copied from other works will not be accepted. All drawings 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, drawings 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.

Clear and Legible, Permanent Record, Legal Document

2. The scope and sequence of drawing sheets shall comply with the example provided in Annexure DQS-B of the Specification for QUALITY ASSURANCE REQUIREMENTS FOR DESIGN.

Compliance

(d) Certification

1. Drawings shall bear the signature of the design consultant and shall where required by the Council be certified as complying with the appropriate design specifications (D1 to D12). The certificate shall be in the format detailed in Annexure DQS-A of the Specification for QUALITY ASSURANCE REQUIREMENTS FOR DESIGN. ***Design Consultant***

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. A typical hierarchy is shown on Figure D1.1. ***Functionality***

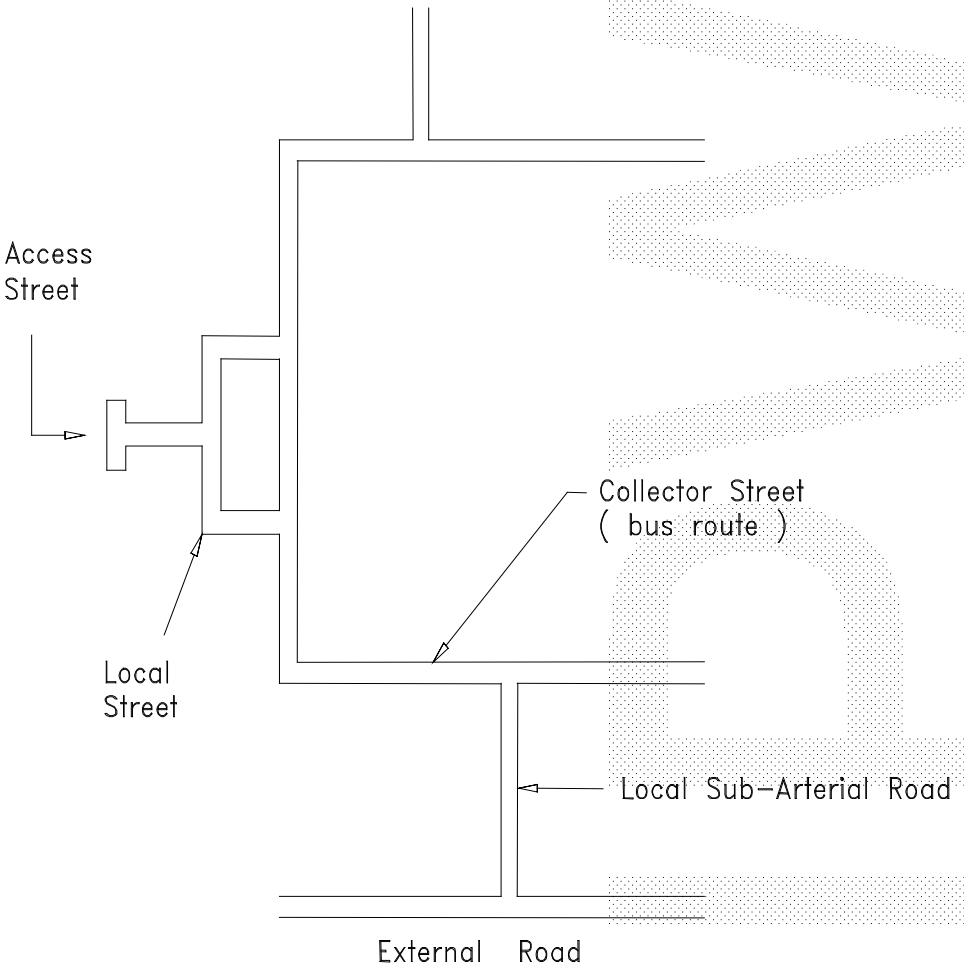

Figure D1.1 - Typical Road Hierarchy

2. Four distinct levels of roads are:

- Access Street
- Local Street
- Collector Street
- Local Sub-Arterial Road.

Access Street

3. The lowest order road (access street) having as its primary function, residential space - amenity features which facilitate pedestrian and cycle movements, and where vehicular traffic is subservient in terms of speed and volume, to those elements of space, amenity, pedestrians and cyclists.

Local Street

4. The next level road (local street) as a local residential street 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 access streets.

Collector Street

5. The second highest order road (collector street) has a residential function but also carries higher volumes of traffic collected from lower order streets. A reasonable level of residential amenity and safety is maintained by restricting traffic volumes and speeds, however, amenity and resident safety do not have the same priority as access or local streets.

Local Sub-Arterial Road

6. The highest order road (local sub-arterial road) within a residential development should have as its main function the convenient and safe distribution of traffic generated by the development. Direct access should not be provided for single dwelling allotments but access can be provided to multi-unit developments and non-residential land uses. The local sub-arterial should serve only the development and should not attract through traffic.

D1.08 ROAD NETWORK

1. The design features of each type of road convey to the driver its primary functions and encourage appropriate driver behaviour (refer Figure D1.2 to D1.5).

Compatibility

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

Access Street

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

Local Sub-Arterial

4. The length of local sub-arterial within a development should be minimised.

5. The time required for drivers to travel on all streets within the development should be minimised. ***Travel Time***

6. Where access streets form part of a pedestrian or bicycle network, access links should provide suitable connectivity with adjoining access streets or open space systems so as to ensure such pedestrian and bicycle network are functionally efficient. ***Pedestrian or Bicycle Network***

7. The road network should ensure that no road links with another road which is more than two levels higher or lower in the hierarchy. In exceptional circumstances roads may link with others that are more than two levels apart, however, no access street or local street should have access to an access-controlled arterial road. ***Road Links***

8. Connections between internal roads should be T-junctions or controlled by roundabouts. ***Internal Road Connections***

9. The road layout should conform to the requirements of the external road network and satisfy the transport provisions of an outline development plan. ***Transport Provisions***

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

D1.09 DESIGN SPEED

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 sub-arterial 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. ***RTA Guidelines***

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. Attention should be given to ensuring that potentially hazardous features are visible to the driver and adopting traffic engineering measures which will help a driver avoid errors of judgement. ***Low Speeds*** ***Hazardous Features***

3. Generally the following design speeds should be adopted:

Access Street	25 km/h
Local Street	40 km/h
Collector Street	60 km/h
Local Sub-Arterial Road	60/80 km/h

4. The need for road safety barriers shall be assessed and designed in accordance with AS/NZS 3845. ***Road Safety Barriers***

D1.10 LONGITUDINAL GRADIENT

1. A general minimum gradient of 1.0 per cent should be adopted. In very flat conditions it may be reduced to 0.5 per cent. Variable crossfall may be used to produce ***Flat Terrain***

the required grade in the gutter. Maximum recommended grades are shown in Table D1.1.

Table D1.1

	Access	Local	Collector	Local Sub-Arterial	Rural
Desirable maximum percentage	10	12	10	8	10
Absolute maximum percentage*	10	16	12	10	15

* maximum length 150 m on straight alignment.

2. Longitudinal grade of the minor street on the approach to an intersection 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 minor side street is undesirable if vehicles have to stand waiting for traffic in the major road. ***Intersections***

3. Turning circles in cul-de-sacs on steep grades should have grades less than 5 per cent. ***Cul-de-Sacs***

4. All residential streets with grassed swale drains in lieu of kerb and gutter shall have a longitudinal gradient between 2.0 per cent and 5.0 per cent. ***Grassed swale drains***

D1.11 HORIZONTAL CURVES AND TANGENT LENGTHS

1. The horizontal alignment of a road is normally in a series of tangents (straights) and curves which may be connected by transition curves. The choice of the horizontal alignment is normally determined from the design speeds for a particular street within the road hierarchy as described in Clause D1.09. Designers should ensure that, for a given design speed, the minimum radius of curvature utilised is such that drivers can safely negotiate the curve. Curves which progressively tighten produce an uncomfortable sense of disorientation and alarm. Sudden reverse curves which drivers cannot anticipate also have a potential to cause similar conditions. ***Speed/Radius Relation***

2. Where speed restriction is provided by curves in the street alignment the relationship between the radius of the curve and the desired vehicle speed is given in Table D1.2(a). ***Speed Restriction***

3. To determine appropriate lengths for tangents between speed restrictions, which may be curves, narrow sections or other obstructions, Table D1.2(b) is recommended. ***Tangent Length***

4. Sight distance on curves is determined by formula, values of which are tabulated in RTA Road Design Guide.

Table D1.2(a)
Speed/Radius Relationship

Desired Vehicle Speed (km/h)	Curve Radii (m) on Road Centreline	
	Curvilinear Alignment (no tangents)	Isolated Curve Alignment (with tangent sections)
20	15	10
25	20	15
30	30	20
35	50	30
40	90	40
45	105	50

50	120	60
55	140	70
60	160	80

Table D1.2(b)
Speed/Tangent Length Relationship

Desired Vehicle Speed in Curve	**Maximum Advisable Tangent Length (m) between Curves or Restrictions Appropriate to a Selected Design Speed.**						
	DESIGN SPEED						
(km/h)	**25**	**30**	**35**	**40**	**45**	**50**	**60**
20 or less	40	75	100	120	140	155	180
25	-	45	75	100	120	140	165
30	-	-	45	80	100	120	150
35	-	-	-	50	80	100	135
40	-	-	-	-	55	80	120
45	-	-	-	-	-	60	105

NOTE:
Tables D1.2(a) and D1.2(b) are derived from AMCORD.

D1.12 VERTICAL CURVES

Criteria

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 second's 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.

Riding Comfort

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 0.05g for desirable riding comfort, and 0.10g for minimum riding comfort. The minimum length for sag vertical curves are shown in Table D1.3.

Table D1.3 Minimum Length of Sag Vertical Curves

	Local access (m)	Collector (m)	Local Sub-Arterial (m)
Minimum vertical curve	25	35	50
Absolute minimum vertical curve (to be applied at road junctions only)	6	12	20

Side Road Junctions

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

Sag Curves

4. Drainage poses a practical limit to the length of sag curves and a maximum

length (in metres) of 15 times the algebraic sum of the intersecting vertical grades (expressed as a percentage) 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. Changes of grade of kerb and gutter of up to 3 per cent at sag points can be accepted without vertical curves where necessary to achieve satisfactory drainage.

Horizontal and Vertical Alignment Coordination

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 following principles should be applied:

- The design speed of the road in both horizontal and vertical planes should be of the same order.
- Combined horizontal and vertical stopping sight distance and minimum sight distance should be considered three dimensionally.
- Sharp horizontal curves should not be introduced at or near the crest of a vertical curve. A horizontal curve should leave the vertical curve and be longer than the vertical curve.
- A short vertical curve on a long horizontal curve or a short tangent in the gradeline between sag curves may adversely affect the road's symmetry and appearance.

D1.13 SUPERELEVATION

Low Design Speed, Crowned Pavement

1. The use of superelevation in association with horizontal curves is an essential aspect of geometric design of roads with design speeds in excess of 60 km/h. Local access roads which are designed for speeds of 40 km/h or less and with curves of 60m radius or less generally have the pavement crowned on a curve instead of superelevation. Design standards for such curves have little meaning as drivers usually cut the corners and rely on friction to hold them on a curved path. As the radius of the curve falls, friction becomes more important than superelevation.

High Design Speed

2. The maximum superelevation for urban roads of higher design speeds should be 6 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.

Criteria

3. In general, curve radii larger than the minimum and superelevation rates less than the maximum should be used where possible. The minimum radius of curves is determined by the design speed, the minimum superelevation (or maximum adverse crossfall) at any point on the circular portion of the curve, and the maximum coefficient of side friction which allows safe lane changing. This is 0.15 where there is positive superelevation and 0.12 where there is adverse crossfall. The coefficient of side friction depends upon the type and condition of tyres, the pavement, and on speed.

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

Table D1.4 Minimum Radius of Curvature

Design Speed km/h		60	70	80
Minimum Superelevation (%)	5	145	195	255
	4	150	205	265
	3	160	215	280
	2	170	230	300
	1	180	245	315
Maximum Crossfall (%)	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.)

Transitions, Offset Crowns

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

Cross Section Provisions

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

Table D.1.5 Characteristics of Roads in Residential Subdivision Road Networks

Road Type	Maximum Traffic Volume (vpd) See note 1	Maximum Speed (km/h) See note 2	Carriageway Width (m)	Parking Provisions Within Road Reserve	Kerbing	Footpath Requirement See note 3	Verge Width (each side)	Minimum Road reserve width (m)
Access Street See note 4	150	25	6.0 See note 7	Carriageway	Layback	1.2m wide footpath on one side	4.5 m	15.0
See note 6			6.0 See note 7	Carriageway	Flush with grassed swale drains	1.2m wide footpath on one side	Minimum 4.5 m See note 5	20.0
Local Street not bus route	1,000	40	8.0 See note 7	Carriageway	Layback	1.2m wide footpath on one side	3.5 m	15.0
See note 6			8.0 See note 7	Carriageway	Flush with grassed swale drains	1.2m wide footpath on one side	Minimum 4.5 m See note 5	20.0
Collector Street or bus route	3,000 (with access to residential allotments)	50	9.0	Carriageway	Layback or barrier	1.2m wide footpath on one side	3.5 m	16.0
Local Sub-Arterial Road	6,000 (no access to single dwelling residential allotments	60	11.0	Carriageway	Barrier	1.2m wide footpath on one side	4.5 m	20.0.

Derived from AMCORD

NOTES:

1. For single dwelling allotments apply traffic generation rate of 10 vehicles per day (vpd)/allotment (equivalent to approximately one vehicle per hour (vph) in the peak hour) unless a lower rate can be demonstrated. Lower rates can be applied to multi-unit dwellings based on locally derived rates.

2. See Clauses D1.09 and D1.11 on designing for specific operating speeds.

3. A minimum of one footpath on one side of the street to be constructed initially with provision to construct a second footpath if required by residents in the future.

4. The access street standard is only to be used in zones 2(a), 2(v) and low density precincts in zone 2(e), and only at gradients less than or equal to 10 percent. The minimum road standard in other situations is the local street standard.

5. Minimum width required to provide for pedestrians, services, drainage, landscape and preservation of existing trees.

6. All residential streets with grassed swale drains in lieu of kerb and gutter shall have a longitudinal gradient between 2.0 per cent and 5.0 per cent.

7. Cul-de-sacs shall have a circular turning area with a kerb radius of 10 metres to provide for garbage trucks and other heavy vehicles. This kerb radius may be reduced to 6.5 metres where two adjacent cul-de-sac turning areas are linked by a 3.5 metre wide heavy duty concrete driveway not more than 100 metres long, so that garbage trucks and other heavy vehicles can travel along both streets as a single loop and without needing to reverse at any point. Driveways linking cul-de-sacs shall be fully contained in road reserves not less than 6.0 metres wide and must have clear lines of sight from each end to the other.

2. The carriageway width must allow vehicles to proceed safely at the operating speed intended for that level of road in the network and with only minor delays in the peak period. This must take into consideration the restrictions caused by parked vehicles where it is intended or likely that this will occur on the carriageway. Vehicles include trucks, emergency vehicles and, on some roads, buses. (Refer to Clause D1.21 for bus routes.) ***Operational Aspects***

3. The safety of pedestrians and cyclists where it is intended they use the carriageway must also be assured by providing sufficient width. ***Pedestrians, Cyclists***

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

5. The design of the carriageway should discourage drivers from travelling above the intended speed by reflecting the functions of the road in the network. In particular the width and horizontal and vertical alignment should not be conducive to excessive speeds. ***Discourage Speeding***

6. Appropriate verge width should be provided to enable the safe location, construction and maintenance of required footpaths and public utility services (above or below ground) and to accommodate the desired level of streetscaping. Wherever possible electricity, telephone and gas services should be located in common trenches. ***Verge Width***

Sight Distance Across Verge

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

8. Stopping sight distances and junction or intersection sight distances, provided by the verge, should be based on the intended speeds for each road type.

D1.15 CROSSFALL

1. Desirably, roads should be crowned in the centre. Typical pavement crossfalls on straight roads are:

Pavement Type	*Crossfall*
Bituminous seal coat	3 per cent
Bituminous concrete pavement	2.5 per cent
Cement concrete pavement	2 per cent

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

Offset Crown Lines

2. There are many factors affecting levels in urban areas which force departures from these crossfalls. Differences in level between road alignments can be taken up by offsetting crown lines or adopting one way crossfalls. Sustained crossfalls should not exceed 4 per cent, although up to 6 per cent may be used where unavoidable. The rate of change of crossfall should not exceed: 6 per cent per 30m for through traffic; 8 per cent per 30m for free flowing turning movements; or 12 per cent per 30m for turning movements for which all vehicles are required to stop.

Rate of Change

Precedence

3. The crossfall on a collector or local sub-arterial road should take precedence over the grade in minor side streets. Standard practice is to maintain the crossfall on the major road and adjust the minor side street levels to suit. The crossfall in side streets should be warped quickly either to a crown or a uniform crossfall depending on the configuration of the side street. A 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.

D1.16 VERGES AND PROPERTY ACCESS

Criteria

1. A suitable design for the verge will depend on utility services, the width of footpath, access to adjoining properties, likely pedestrian usage and preservation of trees. Low level footpaths are undesirable but may be used if normal crossfalls are impracticable. Crossfalls in footpath paving should not exceed 2.5 per cent, in accordance with AUSTROADS Guide to Traffic Engineering Practice, Part 13, Pedestrians. Longitudinal grade usually parallels that of the road and this may be steeper than 5 per cent.

Options

2. Differences in level across the road between road reserve boundaries may be accommodated by:

- Cutting at the boundary on the high side and providing the verge at normal level and crossfall.
- Battering at the boundary over half the verge width with the half against the kerb constructed at standard crossfall.
- A uniform crossfall across the carriageway.
- The lower verge being depressed below the gutter level.

3. The above measures can be used singularly or combined. The verge formation

should extend with a 0.5m berm beyond the road reserve boundary.

4. The Designer shall design a vehicular driveway centreline profile for the property access and check this design using critical driveway gradings, available from Council, to ensure that vehicles can use the driveway satisfactorily. ***Driveway Profile***

D1.17 INTERSECTIONS

1. The design of intersections or junctions should allow all movements to occur safely without undue delay. Projected traffic volumes should be used in designing all intersections or junctions on local sub-arterial roads. ***Traffic Volumes***

2. Intersection design for the junction of subdivision roads with existing state rural or urban roads and national highways should generally be in accordance with the RTA Road Design Guide. ***State Roads, National Highways***

3. Intersections with state roads or national highways are to be designed, approved and constructed in accordance with the requirements of the RTA. ***Approval of State Road Authority***

4. Where major intersections are required to serve a development complete reconstruction of the existing road pavements will be necessary where the speed environment and irregularity of the existing road pavement may endanger the safety of traffic in the locality. ***Existing Road Pavement***

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 lines at the intersection do not impose undue driving difficulties.
- The vertical grade lines at the intersection will allow for any direct surface drainage.
- Two minor side streets intersecting a major street in a left-right staggered pattern should have a minimum centreline spacing of 50m to provide for a possible right-turn auxiliary lane on the major street..
- A right-left manoeuvre between the staggered streets is preferable, avoiding the possibility of queuing in the major street.

6. Adequate stopping and sight distances are to be provided for horizontal and vertical curves at all intersections. ***Sight Distance***

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

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

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

- For intersection turning movements involving local sub-arterial roads, the "design semi-trailer" with turning path radius 15.0m.

- For intersection turning movements involving local streets or collector streets, but not local sub-arterial roads, the "design single unit" bus with turning path radius 13m.

- For intersection turning movements on access streets but not involving local sub-arterial roads, collector streets or local streets, the garbage collection vehicle used by the local authority.

- The turning area at the head of cul-de-sac access streets shall be circular. The minimum kerbline radius shall be 10.0 metres and the turning area shall be configured to permit the garbage collection vehicle to turn around in a single movement. This kerb radius may be reduced to 6.5 metres where two adjacent cul-de-sac turning areas are linked by a 3.5 metre wide heavy duty concrete driveway not more than 100 metres long, so that garbage trucks and other heavy vehicles can travel along both streets as a single loop and without needing to reverse at any point. Driveways linking cul-de-sacs shall be fully contained in road reserves not less than 6.0 metres wide and must have clear lines of sight from each end to the other. Ideally the turning area should be offset to the right or left of the centreline of the approaching street. The kerb transitions between the cul-de-sac turning area and the adjacent road shall have a minimum radius of 20.0 metres.

10. Turning radii at intersections or driveways on local sub-arterial road accommodate the intended movements without allowing desired speeds to be exceeded. ***Turning Radii***

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

D1.18 ROUNDABOUTS

1. Roundabouts are to be approved by the Council and the Roads Traffic Authority. ***Approval***

2. Roundabouts should generally be designed in accordance with the requirements of the RTA publication Guide to Roundabouts. Designs adopting alternative criteria will be considered on their merits. Roundabout design should generally comply with the following: ***Criteria***

- entry width to provide adequate capacity

- adequate circulation width, compatible with the entry widths and design vehicles eg. 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

1. Traffic calming devices are to be approved by the Council. ***Approval***

2. Calming devices such as thresholds, slowpoints, speed humps, chicanes and ***Criteria***

splitter islands should be designed in accordance with the requirements of the publication AUSTROADS Guide to Traffic Engineering Practice - PART 10, Local Area Traffic Management, (LATM). Devices designs should generally comply with the following:

(a) Streetscape

- reduce the linearity of the street by segmentation
- avoid continuous long straight lines (eg. kerb lines)
- enhance existing landscape character
- maximise continuity between existing and new landscape areas

(b) Location of Devices/Changes

- devices other than at intersections should be located to be consistent with streetscape requirements
- existing street lighting, drainage pits, driveways, and services may decide the exact location of devices
- slowing devices are optimally located at spacings of 100-150m.

(c) Design Vehicles

- emergency vehicles must be able to reach all residences and properties
- local streets with a 'feeding' function between arterial roads and minor local streets might be designed for a AUSTROADS Design Single Unit Truck/Bus
- where bus routes are involved, buses should be able to pass without mounting kerbs and with minimised discomfort to passengers
- in newly developing areas where street systems are being developed in line with LATM principles, building construction traffic must be provided for.

(d) Control of Vehicle Speeds

- maximum vehicle speeds can only be reduced by deviation of the travelled path. Pavement narrowings have only minor effects on average speeds, and usually little or no effect on maximum speeds
- speed reduction can be achieved using devices which shift vehicle paths laterally (slow points, roundabouts, corners) or vertically (humps, platform intersections, platform pedestrian/school/bicycle crossings)
- speed reduction can be helped by creating a visual environment conducive to lower speeds. This can be achieved by 'segmenting' streets into relatively short lengths (less than 300m), using appropriate devices, streetscapes, or street alignment to create short sight lines

(e) Visibility Requirements (sight distance)

- adequate critical sight distances should be provided such that evasive action may be taken by either party in a potential conflict situation. Sight distances should relate to likely operating speeds
- sight distance to be considered include those of and for pedestrians and cyclists, as well as for drivers

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

(f) Critical Dimensions

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

- pavement narrowings
  - single lane 3.50m between kerbs
  - 3.75m between obstructions
  - two lane 5.50m minimum between kerbs

- bicycle lanes (including adjacent to pavement narrowings) - 1.2m absolute minimum (1.0m in special circumstances in accordance with AUSTROADS Guide to Traffic Engineering Practice – PART 14, Bicycles.)

- plateau or platform areas
  - 75 mm to 150 mm height maximum, with 1 in 15 ramp slope

- width of clear sight path through slowing devices

  - 1.0m maximum

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

- dimensions of mountable areas required for the passage of large vehicles to be determined by appropriate turning templates.

D1.20 PARKING

1. The parking requirements for normal levels of activity associated with any land use should be accommodated on-site. ***On-Site***

2. All on-site parking should be located and of dimensions that allow convenient and safe access and usage. Refer to Council's Parking Code

3. Adequate parking should be provided within the road reserve for visitors, service vehicles and any excess resident parking since a particular dwelling may generate a high demand for parking. Such parking is to be convenient to dwellings. ***Road Reserve Parking***

4. 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. ***Obstruction***

D1.21 BUS ROUTES

1. Bus routes will normally be identified by Council. It is important that the road hierarchy adequately caters for buses. The main criteria in determining the location of bus routes is that *no more than 5% of residents should have to walk in excess of 400 metres* to catch a bus. Normally roads above the local street in the hierarchy are designed as bus routes. ***Criteria***

2. Bus stops shall be located to minimise inconvenience to existing and future ***Bus stops***

residents and, where practical, bus stops should be adjacent to public reserves.

3. Roads forming bus routes shall be arranged in loops to allow buses to travel in a continuous forward direction. Where the staging of road construction results in temporary dead end roads being traversed by bus services, suitable temporary turning areas must be provided that are sufficiently large to enable those buses to turn around without reversing. ***Continuous forward travel***

4. Barrier kerb shall be provided at identified bus stops to provide a reduced step height into buses. ***Barrier kerb***

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 home sites and hobby farms types of developments.

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 AUSTROADS Guide to the Geometric Design of Rural Roads. ***Design Speed***

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

4. Where the table drain is likely to scour a RTA Type SH dish drain, or similar structure is to be constructed along the invert. Also for grades of less than 0.8%, the inverts of the drain are to be lined to prevent siltation. ***Table Drain***

5. All rural subdivisions should be designed to restrict access to major roads.

6. Public roads in rural residential subdivisions shall be constructed as two lane sealed roads.. ***Sealed Roads***

7. Unsealed roads may be constructed for rural right of carriageway accesses or for the upgrading of existing rural roads where specifically authorised in development consent conditions. ***Unsealed roads***

8. Unsealed roads shall be designed to the geometric standards set out in this specification and in the documents referred to in this specification. ***Unsealed roads***

D1.23 SIGHT DISTANCES

1. Stopping and minimum sight distances. Stopping sight distance should be provided at all points on the road. The stopping distance is measured from an eye height of 1.15m to an object height of 0.20m, using a reaction time of 1.5 seconds. A minimum sight distance measured from a height of 1.15m to a height of 1.15m is preferable for speeds of 60 km/h and over. Tables are provided in the RTA Road Design Guide. ***Stopping Distance*** ***Sight Distance***

2. Stopping distance is the sum of the braking distance and the distance the vehicle travels during a reaction time of 1.5 seconds, and may be calculated using the following ***Braking Distance***

formula:

$$d = 0.42V + \frac{V^2}{254f}$$

Where d = stopping distance (m)
V = speed of vehicle (km/h)
f = coefficient of longitudinal friction

(Source: AUSTROADS Guide to the Geometric Design of Rural Roads,)

3. Recommended sight distances (based on the RTA Road Design Guide and adjusted to include lower speeds and minimum sight distances using the above formula) are shown in Table D1.7.

Table D1.7 Stopping Sight Distance

Travel Speed km/h	Coefficient of * longitudinal friction	Stopping sight distance (m)	Intermediate sight distances (m)
40	0.52	33	**
50	0.50	46	**
60	0.47	60	180
70	0.45	80	220
80	0.43	100	260
90	0.41	120	300
100	0.39	150	380

* bituminous or concrete surfaces
** not applicable at lower speeds

4. These figures may apply on crest vertical curves only where there are straight alignments. Adjustments should be calculated for steep grades.

D1.24 HORIZONTAL AND VERTICAL ALIGNMENT

Criteria

1. Horizontal and vertical curves are to be designed generally to the requirements ofRTA 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

Criteria

1. Intersections should generally be designed in accordance with the publicationRTA Road Design Guide. The type of intersection required will depend on existing and planned connecting roads.

Sight Distance

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

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

ESD relates to the driver entering the intersection from a minor road and ability to observe the roadway layout and assess traffic gaps.

SISD relates to an overall check that vehicles utilising the intersection have sufficient visibility to allow reaction and deceleration so as to provide adequate stopping distance in potential collision situations.

Tabulated speed/sight distance requirements together with detailed explanations for each of the sight distance criteria are given in RTA Road Design Guide. Repositioning of an intersection may be required to obtain conformance with the sight distance criteria.

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

Staggered-T Intersections

D1.26 PLAN TRANSITIONS

1. A plan transition is the length over which widening and shift is developed from the "tangent-spiral" point to the "spiral-curve" point; ie, the length between the tangent and the curve. In urban road design it is often impracticable to use plan transitions as kerb lines are fixed in plan and any shift requires carriageway widening. Widening on horizontal curves compensates for differential tracking of front and rear wheels of vehicles; overhang of vehicles; and transition paths. Where proposed roads are curved, the adequacy of carriageway width should be considered.

Widening and Shift on Curves

2. Abrupt changes in crossfall, can cause discomfort in travel and create a visible kink in the kerb line or edge of pavement. A rate of change of kerb line of no more than 0.5 per cent relative to the centreline 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. Drainage problems can arise with superelevation transitions which may require extra gully pits and steeper gutter crossfalls. Where crossfalls change at intersections, profiles of the kerb line should be drawn. Calculated points can be adjusted to present a smooth curve.

Crossfall Changes

D1.27 CARRIAGEWAYS

1. Carriageway widths for rural roads should generally be as shown in Table D1.8.

Table D1.8 Rural Road Widths

Type	Design traffic	Pavement Width	Reserve Width and status	Maximum Gradient
Gravel driveway	Up to 3 lots	4.0m gravel	Up to 20 m easement	15%
Sealed driveway	Up to 3 lots	3.0m seal with 2 x 0.5m shoulders	Up to 20 m easement	20%
Class 1 road	Up to 3 lots	4.0m gravel	20m public road	15%
Class 2 road	< 150 vehicles per day	6.4m gravel	20m public road or easement	15%
Class 3 road	> 150 vehicles per day	8.0m gravel	20m public road	15%
Class 4 road	< 1000 vehicles per day	6.0m seal plus 2 x 1.0 m sealed shoulders	20m public road	15%
Class 5 road	> 1000 vehicles per day	7.0m seal plus 2 x 1.0 m sealed shoulders	20m minimum public road	15%

D1.28 SUPERELEVATION

1. Use of maximum superelevation will be considered where the radius of the curve in approaching the minimum speed environment. Reference should be made to RTA

Design Speed

Road Design Guide for superelevation calculation. At low and intermediate ranges of design speed (ie below 80 km/h) it is desirable to superelevate all curves at least to a value equal the normal crossfall of straights.

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 of determine the level and extent of any protection works prior to proceeding to final design stage.

Roadside Drainage and Table Drains

SPECIAL REQUIREMENTS

D1.30 RESERVED

D1.31 RESERVED

D1.32 RESERVED

BEGA VALLEY SHIRE COUNCIL

DEVELOPMENT DESIGN SPECIFICATION

D2

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 containing asphalt layers other than thin asphalt wearing surfaces;

   (c) rigid pavements (ie. cement concrete pavements);

   (d) concrete or clay segmental pavements.

3. Consideration to the design of unsealed (gravel) pavements will only be given for minor rural subdivisions/developments in isolated rural areas where the access to the subdivision is via an existing unsealed road. ***Unsealed 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
C254	-	Segmental Paving
C255	-	Bituminous Microsurfacing

(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-SR41 - Australian Road Research Board, Special Report No. 41 - A Structural Design Guide for Flexible Residential Street Pavements, 1989.

Cement and Concrete Association of Australia.
CACA - T51 - Concrete Pavement Design for Residential Streets, 1997.

Concrete Masonry Association of Australia.
CMAA - T44 - Concrete Segmental Pavements - Guide to Specifying, 1997
CMAA - T45 - Concrete Segmental Pavements - Design Guide for Residential Access Ways and Roads, 1997.
CMAA - T46 - Concrete Segmental Pavements - Detailing Guide, 1997.

Clay Brick and Paver Institute
- Design Manual 1 - Clay Segmental Pavements, A Design and Construction Guide for Sites Subjected to Vehicular and Pedestrian Traffic, 1989.

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:

(a) Design Traffic

(b) Subgrade Evaluation

(c) Environment

(d) Pavement and Surfacing Materials

(e) Construction and Maintenance Considerations

D2.05 DESIGN TRAFFIC

1. The design traffic shall be calculated based on the following minimum design lives of pavement:-

Minimum Pavement Design Life

(a) Flexible, Unbound Granular - 25 years

(b) Flexible, Containing one or more bound layers - 25 years

(c) Rigid (Concrete) - 40 years

(d) Segmental Block - 25 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 for the subdivision and any future developments linked to that subdivision. For interlocking concrete segmental pavements, the simplification of replacing ESA's with the number of commercial vehicles exceeding 3 tonne gross contained in CMAA - T45 is acceptable up to a design traffic of 10^6. Beyond this, ESAs should be calculated.

Equivalent Standard Axles

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

Traffic Data

4. In general, reference should be made to ARRB-SR41 for the calculation of design traffic volumes up to 10^6 ESAs and AUSTROADS Pavement Design for design traffic volumes approaching or exceeding 10^6 ESAs.

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.

Guide to Design ESAs

Street Type:		**Design ESA's - 25 year design life**
Urban Residential	- Access Street	6×10^4
	- Local Street	3×10^5
	- Collector Street	1×10^6
	- Local Sub-Arterial	2×10^6
Rural Residential	-	3×10^5
Commercial and Industrial		5×10^6

D2.06 SUBGRADE EVALUATION

1. Except where a mechanistic design approach is employed using AUSTROADS Pavement Design, the measure of subgrade support shall be the California Bearing Ratio (CBR). Where a mechanistic design approach using linear elastic theory is employed for flexible pavements, the measure of subgrade support shall be in terms of the elastic parameters (modulus, Poisson's ratio).

California Bearing Ratio

2. The following factors must be considered in determining the design strength/stiffness of the subgrade:

Design Considerations

(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.

Design CBR Considerations

3. The subgrade Design CBR adopted for the pavement design must consider the effect of moisture changes in the pavement and subgrade during the service life, and hence consideration must be given to the provision of subsurface drainage in the estimation of equilibrium in-situ CBRs, and hence in the design of the pavement structure. Warrants for the provision of subsurface drainage are given in Specification for SUBSURFACE DRAINAGE DESIGN. If subsurface drainage is not provided, then the Design CBR adopted must allow for a greater variability in subgrade moisture content during the service life of the pavement, and hence a Design Moisture Content above the Optimum Moisture Content.

Calculation of Design CBR

4. 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 subsurface drainage (or lack of), climatic zone, and soil type if appropriate (as per the guidelines in ARRB SR41) to give an estimated equilibrium in-situ CBR. The Design CBR for each subgrade area is computed by using the appropriate formulae as follows:

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

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

= C - 1.3S

Where C is the mean of all estimated CBRs, and
S is the standard deviation of all values.

Field Confirmation

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.

Summary of Results

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.

D2.07 ENVIRONMENT

Moisture and Temperature

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-SR41, and to NAASRA (Now AUSTROADS) - Guide to Control of Moisture in Roads.

Moisture Considerations

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 and salinity problems
(d) Relative permeability of pavement layers
(e) Whether shoulders are sealed or not
(f) Pavement type (boxed or full width)

Evaluate Design CBR

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 or modulus) at the highest moisture content likely to occur during the design life, ie the Design Moisture Content. The provision of subsurface drainage may, under certain circumstances, allow a lower Design Moisture Content, and hence generally higher Design CBR.

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) Bound (cemented) granular materials

(c) Asphaltic Concrete

(d) Cement Concrete

2. Surfacing materials can also be classified into essentially five categories or types:- ***Surfacing Classification***

(a) Sprayed bituminous seals (flush seals)

(b) Asphaltic concrete and bituminous microsurfacing (cold overlay)

(c) Cement Concrete

(d) Concrete Segmental Pavers

(e) Clay Segmental Pavers

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

4. 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.

8. Concrete and clay segmental pavers shall satisfy the requirements of the Construction Specification for SEGMENTAL PAVING.

9. Bituminous microsurfacing (cold overlay) shall satisfy the requirements of the Construction Specification for BITUMINOUS MICROSURFACING.

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) Use of boxed or full width construction
(c) Available equipment of the Contractor
(d) Use of stabilisation
(e) Aesthetic, environmental and safety requirements
(f) Social considerations
(g) Construction under traffic
(h) Use of staged construction
(i) Ongoing and long-term maintenance costs

These factors are further discussed in AUSTROADS Pavement Design.

PAVEMENT THICKNESS DESIGN

D2.10 PAVEMENT STRUCTURE - GENERAL

Minimum Pavement Thickness

1. The pavement thickness, including the thickness of surfacings, shall not be less than 250mm for roads in which kerb and guttering is to be constructed, 200mm for unkerbed roads and 150mm for carparks.

5. 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 100mm, Base 100mm
(b) Rigid pavement: Subbase 100mm, Base 150mm

Subbase Extent

3. The subbase layer shall extend a minimum of 150mm behind the rear face of any kerbing and/or guttering.

Base 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 a minimum of 150mm behind the rear face of the kerbing and/or guttering.

Unkerbed Roads

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

Carparks

6. The pavement designer shall make specific allowance for traffic load concentrations within carpark areas (eg entrances/exits).

Drainage

7. The pavement designer shall make provision for pavement layer drainage on the assumption that during the service life of the pavement ingress of water will occur.

D2.11 UNBOUND GRANULAR FLEXIBLE PAVEMENTS (BITUMINOUS SURFACED)

1. Unbound granular flexible pavements with thin bituminous 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-SR41, using Figure 7 (95% confidence limit curves).

2. For design traffic above 10^6 ESAs, the design shall be in accordance with AUSTROADS Pavement Design.

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, 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-SR41, using Figure 7 (95% confidence limit curves).

D2.13 RIGID PAVEMENTS

1. Rigid (concrete) pavements, with design traffic up to 10^6 ESAs shall be designed in accordance with either CACA -T51 or AUSTROADS Pavement Design.

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

D2.14 CONCRETE SEGMENTAL PAVEMENTS

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

2. For design traffic above 10^6 estimated commercial vehicles exceeding 3T gross the design shall be in accordance with AUSTROADS Pavement Design, with the calculation of design traffic in terms of ESAs.

D2.15 CLAY SEGMENTAL PAVEMENTS

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

2. For design traffic above 10^6 ESAs and up to 10^7 ESAs the design shall involve consideration of both Design Manual 1 - Clay Segmental Pavements and AUSTROADS Pavement Design, with the thicker and more conservative design of each of the two methods adopted.

3. For design traffic above 10^7 ESAs, the pavement shall be designed in accordance with AUSTROADS Pavement Design.

SURFACING DESIGN

D2.16 CHOICE OF SURFACE TYPE

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

(a) Urban Residential streets - Access Street and Local Street, and Rural Residential streets:

- primer seal plus two coat flush seal

  or

- primer seal, plus one coat flush seal, plus bituminous microsurfacing

  or

- primer seal, plus asphalt.

(b) Urban Residential streets - Collector and Local Sub-Arterial:

- primer seal, plus one coat flush seal, plus bituminous microsurfacing

or

- primer seal, plus asphalt

(c) Commercial and Industrial streets:

- primer seal, plus asphalt

2. At intersection approaches and cul-de-sac turning circles on residential streets with flush seals, either bituminous microsurfacing or asphalt surfacing shall be provided within the vehicle braking and turning zones. ***Braking and Turning Zones***

3. Variations to these requirements may be approved by Council in special circumstances. ***Approval***

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***

3. Two-coat flush seals shall be double-double seals, comprising a minimum of two coats binder and two coats of aggregate. The preferred seal types are: ***Two- Coat Flush Seals***

1st coat	14mm
2nd coat	7mm

4. Single coat flush seals shall be allowable if bituminous microsurfacing (or ***Single Coat***

asphaltic concrete) is to be applied as the finished surface. The preferred seal type is either 14mm or 10mm. ***Flush Seal***

D2.18 BITUMINOUS MICROSURFACING (COLD OVERLAY)

1. Bituminous microsurfacing, also referred to as 'cold overlay', shall be designed to provide a nominal compacted thickness of not less than 8mm. ***Minimum Thickness***

2. As a minimum, a 7mm primer seal and a single coat flush seal shall be indicated on the Drawings below the bituminous microsurfacing. ***Primer Seal and Single Coat Seal***

D2.19 ASPHALTIC CONCRETE

1. In urban residential access and local streets, rural or light trafficked commercial streets (design traffic up to approximately 3 x 10^5 ESAs), the asphalt mix design shall be either a 'high-bitumen content' mix or the ARRB Gap-graded mix in accordance with ARRB-SR41 and the Construction Specification for ASPHALTIC CONCRETE. ***Light to Medium Traffic***

2. In urban residential collector and sub-arterial roads, medium to heavily trafficked commercial streets and in all industrial roads, the asphalt mix design shall be a dense graded mix in accordance with the Construction Specification for ASPHALTIC CONCRETE. ***Medium to Heavy Traffic***

3. Asphaltic concrete surfacings shall be designed to provide a nominal compacted layer thickness of not less than 25mm on light to medium trafficked residential, rural and commercial streets, and 40mm on medium to heavily trafficked residential, rural or commercial roads and on all industrial and classified roads. ***Minimum Thickness***

4. As a minimum, a 7mm or 10mm primer seal shall be indicated on the Drawings below the asphalt surfacing. ***Primer Seal***

D2.20 SEGMENTAL PAVERS

1. Concrete segmental pavers shall be 80mm thick, shape Type A, and designed to be paved in a herringbone pattern. ***Size and Shape***

2. Clay segmental pavers shall be 65mm thick, Class 4, and designed to be paved in a herringbone pattern.

3. The edges of all paving shall be designed to be constrained by either kerbing and/or guttering, or by concrete edge strips. ***Edge Constraint***

DOCUMENTATION

D2.21 DESIGN CRITERIA AND CALCULATIONS

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

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

SPECIAL REQUIREMENTS

Unsealed pavements

D2.22 UNSEALED ROADS

1. The pavement thickness for carriageways (for public roads, rights of carriageway and driveways) that are not intended to be sealed shall be designed as for unbound granular flexible pavements in conformity with this specification **plus** an additional thickness of 50mm to allow for surface erosion.

2. The pavement thickness shall not be less than 200mm.

3. Where the in-situ subgrade materials conform to the material requirements for NGS20 or NGS40, the minimum thickness of pavement material may be reduced to 150mm.

D2.23 RESERVED

D2.24 RESERVED

D2.25 RESERVED

BEGA VALLEY SHIRE COUNCIL

DEVELOPMENT DESIGN SPECIFICATION

D3

STRUCTURES BRIDGE DESIGN

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 associated with roads (eg major culverts, retaining walls, major sign support structures)
- Small earth dams, detention basins
- Structures used for public safety (road safety barriers, pedestrian safety rails, street lighting)
- Temporary works

Such structures may be of concrete, timber or steel constructions, but with emphasis placed on low maintenance.

D3.02 OBJECTIVE

Design Life

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.

D3.03 BASIS OF DESIGN

Safety Quality Qualifications

1. The design shall be based on scientific theories, experimental data and experience, interpreted statistically as far as possible. The safety and service performance of a structure depends also on the quality control exercised in fabrication, supervision on site, the control of unavoidable imperfections and the qualifications, experience and skill of all personnel involved. Adequate attention shall therefore be given to these factors. In addition, adequate management control and supervision by experienced engineers shall be required at all stages of design and construction to prevent the occurrence of gross errors.

2. Specifications shall be notated on the Drawings with sufficient detail to ensure that the above described strategies are able to be effectively implemented at the construction stage.

D3.04 REFERENCE AND SOURCE DOCUMENTS

(a) Council Specifications

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

(b) Australian Standards

AS1158	-	The lighting of urban roads and other public thoroughfares (SAA Public Lighting Code)
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/NZS 3845	-	Road safety barrier systems
AS4100	-	Steel structures

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 AND PEDESTRIAN BRIDGES

1. Bridge design shall only be carried out by properly qualified persons whose Association of Consulting Engineers Australia (ACEA) listing includes structural design of bridges in its claimed area of competency. Such designers shall submit evidence of these qualifications to Council prior to approval of any bridge design. ***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 Developer's cost, if directed. ***Design Checking***

3. The AUSTROADS Bridge Design Code shall be used for all bridge design.

4. Bridges shall have low maintenance finishes. Adequate precautions shall be taken for protection of the materials used in the bridge design; for example, timber and steel require special consideration. Heavy debris and bed loads may be characteristic of some streams so that large spans with slender piers are encouraged. If overtopping is permitted, pedestrian safety rails and road safety barriers are usually omitted. Flood depth indicators and appropriate signposting will be provided in such cases. ***Finishes*** ***Debris, Overtopping***

5. Preventative maintenance is a key issue affecting the design life of the structure. The Drawings 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 Drawings. ***Design Life Maintenance***

6. Hydraulic design of bridges shall be in accordance with the requirements for major structures in the Specification for STORMWATER DRAINAGE DESIGN. ***Hydraulic Design***

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

8. 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 or likely provision for public utilities in bridges. These should be concealed for aesthetic reasons. ***Public Utilities***

D3.06 PROVISION FOR PEDESTRIANS ON ROAD 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 pedestrian safety rails at the external edge. ***Minimum Provision***

2. Council may require the provision of separate pedestrian footpaths in other situations should the anticipated traffic warrant it. ***Separate Footpaths***

3. Disabled access shall be considered in the design. ***Disabled Access***

4. Urban bridge approaches should be lit in accordance with AS1158. ***Lighting***

D3.07 STRUCTURES OTHER THAN BRIDGES, ASSOCIATED WITH ROADS

1. Public utility structures, major culverts, major sign support structures, retaining walls, and the like will be designed by a competent, practicing engineer, accredited in the design of such structures. The design shall be in accordance with the AUSTROADS code, all relevant Australian Standards, and the requirements of any utility owners that may be relevant.

D3.08 SMALL EARTH DAMS/DETENTION BASINS

1. Small earth dams shall 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. Refer also to the Retarding Basin and Stormwater Detention sections in the Specification for STORMWATER DRAINAGE DESIGN.

2. Childproof fencing shall be nominated where it is a requirement of relevant statutory regulations, Australian Standards or Council Specifications and where unacceptable risk exists due to the location of the dam/basin in relation to the urban nature of the area. ***Fencing***

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

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

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

D3.09 STRUCTURES USED FOR PUBLIC SAFETY

1. Since the requirement of road safety 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. ***Barriers and Rails***

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

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

Lighting

4. Bridge crossings in urban and rural residential areas shall be provided with streetlighting in accordance with AS 1158. 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 and designed in accordance with the AUSTROADS Bridge Design Code. A construction programme, indicating the sequence of events leading to the implementation and removal of the temporary structures shall be specified on the Drawings.

SPECIAL REQUIREMENTS

D3.11 RESERVED

D3.12 RESERVED

D3.13 RESERVED

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CLAUSE **PAGE**

BEGA VALLEY SHIRE COUNCIL

DEVELOPMENT DESIGN SPECIFICATION

D4

SUBSURFACE DRAINAGE DESIGN

CONTENTS

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***

2. In the areas with a history of salinity problems, subsurface drainage may be prescribed to keep the groundwater table lower in the strata so as to avoid progressive deterioration of the health of topsoil and upper layers due to salinity levels increased by rising and/or fluctuating groundwater tables. ***Salinity Prevention***

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 and fill areas. ***Subsoil Drains***

2. Foundation drains are intended for the drainage 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.
AS/NZS 1477	-	Unplasticised PVC (UPVC) pipes and fittings for pressure applications.

(c) 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 and fill areas.

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 shall 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, isolated springs or salt affected areas.

(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-pavement 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.

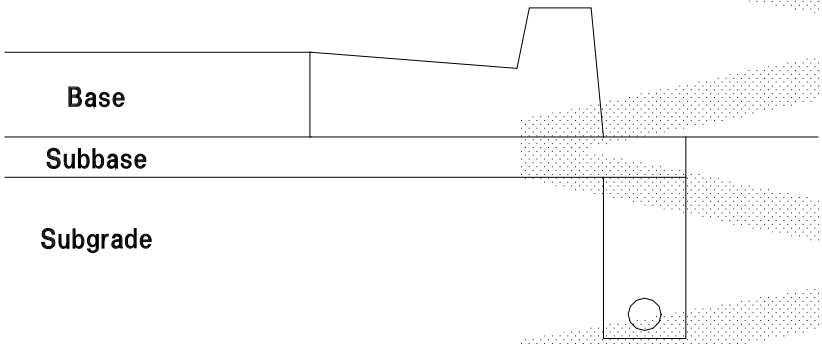

Figure D4.1 - Typical Subsoil Drain

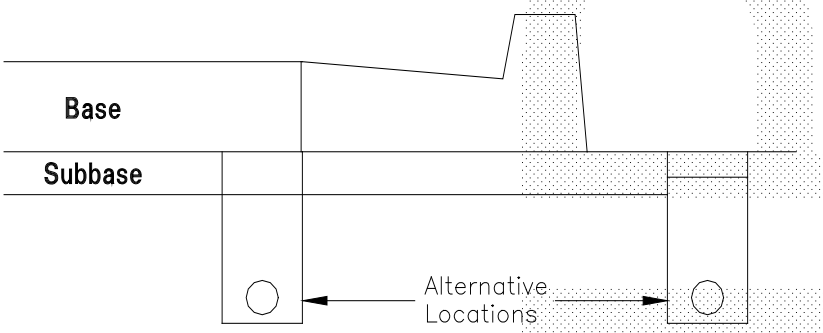

Figure D4.2 - Typical Subpavement Drain

2. In kerbed roads, the two acceptable alternative locations for the line of the trench are directly behind the kerbline. Pavement layers must extend to at least the line of the rear of the trench. ***Kerbed Roads***

3. 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***

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

5. 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***

6. Outlets shall be spaced at maximum intervals of 150 metres into gully pits or outlet headwalls. As a salinity prevention measure and where practical, discharge shall be on the downhill side of the embankment or in the cut-fill area so as to reduce the risk of recharge to the subsurface water table. Unless otherwise authorised, where subsurface drains outlet through fill batters, unslotted plastic pipe of the same diameter as the main run shall be specified. A small precast concrete headwall shall be installed at the drain outlet with a marker post to assist maintenance and protect the end of the pipe. ***Outlets, Salinity Prevention***

7. 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***

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

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

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

D4.08 LAYOUT, ALIGNMENT AND GRADE

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

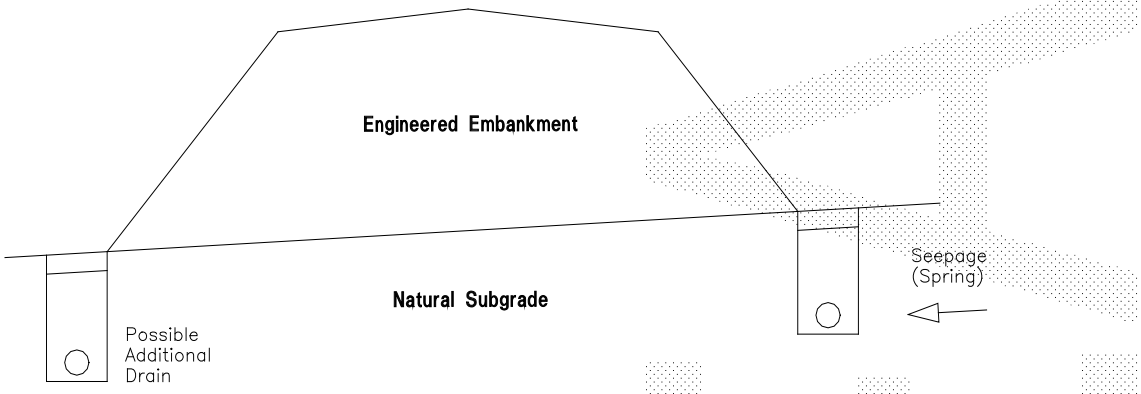

Figure D4.3 - Foundation Drains

2. The minimum desirable design grade shall be 1.0%. 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 the result of the geotechnical survey along the proposed road formation alignment. ***Geotechnical 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 conform with the requirements of AS2439.1. The appropriate class of pipe shall be selected on the basis of expected live loading at the surface. Joints, couplings, elbows, tees and caps shall also comply with AS2439.1.

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

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

D4.11 INTRA PAVEMENT DRAIN PIPE

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

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

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

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 trenches (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. 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, SUBSURFACE DRAINAGE GENERAL.

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

DOCUMENTATION

D4.14 DRAWINGS AND CALCULATIONS

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

SPECIAL REQUIREMENTS

D4.15 RESERVED

D4.16 RESERVED

D4.17 RESERVED

D4.18 RESERVED

BEGA VALLEY 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 Volume 1, Book 8 of Australian Rainfall & Runoff, 1998 (AR&R); 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 stormwater or surface water applications.
AS 2032 - Code of practice for installation of uPVC pipe systems.
AS/NZS 2566.1 - Buried flexible pipelines, structural design.
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 (AR&R) - A guide to flood estimation. Reprinted edition 1998.

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.

HYDROLOGY

D5.04 DESIGN RAINFALL DATA

1. Design Intensity-Frequency-Duration (IFD) Rainfall - IFD relationships shall be derived in accordance with Volume 1, Book 2, of AR&R, for the particular catchment under consideration. ***I-F-D Relationships***

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

3. Where design IFD rainfalls are provided for specific locations these are provided in Council's current Handbook of Drainage Design Criteria.

Average Recurrence Intervals

4. Design Average Recurrence Interval (ARI) - For design under the "major/minor" concept, the design ARIs to be used are given below.

5. Recurrence intervals for minor events depends on the zoning of the land being serviced by the drainage system. The minor system design ARIs are detailed below:-

- 10 years for commercial/industrial area "minor" systems
- 5 years for residential area "minor" systems
- 5 years for rural residential area "minor" systems
- 1 year for parks and recreation area "minor" systems.

Easements in Private Property

6. 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

Catchment Definition

1. The catchment area of any point is defined 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.

2. Where no detailed survey of the catchment is available, 1:4000 orthophoto maps are to be used to determine the catchments and to measure areas. Where 1:4000 orthophotomaps are not available, 1,25000 scale topographic maps shall be used.

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

D5.06 RATIONAL METHOD

1. Rational Method calculations to determine peak flows shall be carried out in accordance with Volume 1, Book 8, of AR&R 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.

Runoff Co-efficients

3. Co-efficients of Run-off shall be calculated as per Volume 1, Book 8, Section 1.5 of AR&R and full details of co-efficients utilised shall be provided.

4. Details of Co-efficients of Run-off for specific locations are given in Council's current Handbook of Drainage Design Criteria. These can be used in lieu of more detailed calculations.

5. The time of concentration 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. ***Times of Concentration***

6. 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. ***Different Flow Characteristics***

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. ***Flow Paths to Pits***

9. Surface roughness co-efficients "n" shall generally be derived from information in Volume 1, Book 8 of AR&R. 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	0.30
Flow across Residential (2a)	0.21
Flow across Residential (2b)	0.11
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 are met, summaries of calculations are provided and details are given of all program input and output. A sample of a summary sheet for hydrological calculations is given in Council's current Handbook of Drainage Design Criteria. ***Alternative Models***

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

D5.08 HYDRAULIC GRADE LINE

1. Hydraulic calculations shall generally be carried out in accordance with AR&R and shall be undertaken by a qualified person experienced in hydrologic and hydraulic design. The calculations shall substantiate the hydraulic grade line adopted for design of the system and shown on the drawings. Summaries of calculations are added to the plan and details of all calculations are given including listings of all programme input and output. A sample of a summary sheet for hydraulic calculations is given in the Council's current Handbook of Drainage Design Criteria. ***Qualified Person*** ***Calculations***

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 20% probability event is 2.5 metres maximum. Wider flow widths may be approved on roads with flat grades. ***Gutter Flow Widths***

2. Minimum conduit sizes shall be as follows: ***Conduit Sizes***

- Pipes - 375mm diameter.
- Box culverts - 600mm wide x 300mm high.

3. Minimum and maximum velocity of flow in stormwater pipelines shall be 0.6m/sec and 6m/sec respectively. ***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 upstream side of allotments. ***Spacing***

2. Other pits shall be provided:

- To enable access for maintenance.
- At changes in direction, grade, level or class of pipe.
- At junctions.

3. The maximum recommended spacing of pits where flow widths are not critical are given in Table D5.1 below:

	Pipe Size (mm)	Spacing (m)
Generally	less than 1200	100
	1200 or larger	150
In tidal influence	all	100

Table D5.1 Pit Spacing

4. Kerb inlet lengths to side 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 ***Inlet Capacity***

maximum of 4.0m where the grade is less than 10%.

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 Volume 1, Book 8 of AR&R.

Allowance for Inlet Blockage

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 D5.2 below:-

Condition	Inlet Type	Percentage of Theoretical Capacity Allowed
Sag	Side entry	80%
Sag	Grated	50%
Sag	Combination	Side inlet capacity only Grate assumed completely blocked
Sag	"Letterbox"	50%
Continuous Grade	Side entry	80%
Continuous Grade	Grated	50%
Continuous Grade	Combination	90%

Table D5.2 Allowable Pit Capacities

D5.11 HYDRAULIC LOSSES

Pit Losses

1. The pressure change co-efficient "Ke" shall be determined from the appropriate charts given in AR&R, Sangster et al (Missouri charts), Hare equations or relevant deriviatives.

2. Allowable reduction in "Ke" due to benching is given in Hare or relevant deriviatives.

3. Computer program default pressure change co-efficient "Ke" shall not be acceptable unless they are consistent with those from the charts referred to in D5.11.1. The chart used and relevant co-efficients 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

4. Bends may be permissible in certain circumstances and discussions with Council regarding their use is required prior to detailed design. Appropriate values of pit pressure change co-efficient at bends shall be sourced from recognised published technical literature.

Intersection with other services

5. Stormwater drainage systems shall be designed to ensure that other service conduits do not intersect with stormwater pits or pipelines unless specifically authorised by Council.

6. 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.

Pipe Junction Losses

7. Construction of a junction without a structure should be avoided where possible. Permission to do this is required by Council prior to detailed design. Where this is unavoidable the pressure change co-efficients Ku, for the upstream pipe and Kl, for the lateral pipe, shall be determined from AR&R, Sangster et al (Missouri charts), Hare equations or relevant deriviatives..

Contraction/ Expansion Losses

8. Going from larger upstream to smaller downstream conduits is not permitted without approval of Council prior to detailed design. In going from smaller to larger pipes benching shall be provided in pits to enable a smooth flow transition. Losses in sudden expansions and contractions shall be taken into account in the hydraulic design.

Pipe Friction Losses

9. 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 co-efficients being 0.6mm for concrete pipes and 0.06mm for FRC pipes.

D5.12 MAJOR SYSTEM CRITERIA

Surcharging

1. Surcharging of drainage systems which would provide for water depth above the top of kerb will not be permitted except:

(a) Surcharging of drainage system for storm frequencies greater than 5% probability may be permitted across the road centreline where the road pavement is below the natural surface of the adjoining private property.

(b) Flow across footpaths will only be permitted in situations specifically approved by Council, where this will not cause flooding of private property.

Velocity/ Depth Criteria

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.

Freeboard

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

In Roadways:-

(a) 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.

(b) 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.

In Stormwater Surcharge Paths:-

(c) 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.

In Open Channels:-

(d) A minimum freeboard of 0.5m shall be provided between the 100 year flood level and floor levels on structures and entrances to underground car parks.

Roadway Capacities

4. Flow capacities of roads should be calculated using Technical Note 4 in Volume 1, Book 8 of AR&R.

D5.13 OPEN CHANNELS

Safety

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.

2. Design of open channels shall be in accordance with Volume 1, Book 8, of AR&R. Open channels will be designed to contain the major system flow less any flow that is contained in the minor system, with an appropriate allowance for blockage of the minor system.

Channel Roughness

3. Friction losses in open channels shall be determined using Mannings "n" values given below:-

Mannings "n" Roughness Co-efficients for open channels shall generally be derived from information in Volume 1, Book 8 of AR&R. Mannings "n" values applicable to specific channel types are given below:-

Concrete Pipes or Box Sections	0.011
Concrete (trowel finish)	0.014
Concrete (formed without finishing)	0.016
Sprayed Concrete (gunite)	0.018
Bitumen Seal	0.018
Bricks or pavers	0.015
Pitchers or dressed stone on mortar	0.016
Rubble Masonry or Random stone in mortar	0.028
Rock Lining or Rip-Rap	0.028
Corrugated Metal	0.027
Earth (clear)	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 in accordance with Volume 1, Book 8, of AR&R.

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 altered channels) will require low flows to be contained within a pipe system or concrete lined channel section at the invert of the main channel. Subsurface drainage shall be provided in grass lined channels to prevent waterlogging of the channel bed. The width of the concrete lined channel section shall be the width of the drain invert or at least sufficiently wide enough to accommodate the full width of a tractor.

Hydraulic Jumps

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

D5.14 MAJOR STRUCTURES

Afflux

1. All major structures in urban areas, including bridges and culverts, shall be designed for the 100 year ARI storm event without afflux. 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 0.3m 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.

3. 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 the Specification for STRUCTURES BRIDGE DESIGN.

Culverts

4. Culverts (either pipe or box section) shall be designed in accordance with charts published by the Concrete Pipe Association of Australasia, 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 Volume 1, Book 3 of AR&R. Sensitivity to storm pattern should be checked by reversing these storm patterns.

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.

Routing

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

High Level Outlet

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.

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

Salinity Prevention

6. Wherever practical and certainly in areas known to be affected by high water tables and/or salinity of groundwater, retarding basins shall be designed to be water retentive so that surface drainage water does not leak to the subsurface, recharging groundwater.

Low Flow Provision

7. 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 anti-seepage collars installed where appropriate.

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

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

10. 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.
- No basin spillway is to be located directly upstream of urban areas.
- Submission of design Drawings to the Dam Safety Committee is required where any of these guidelines are not met or Council specifically requires such submission.

STORMWATER DETENTION

D5.16 STORMWATER DETENTION

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. ***Re-development***

2. Location of basins for stormwater detention, stormwater treatment or sedimentation purposes shall avoid areas that are known to be permanent or seasonal groundwater discharge areas. This action reduces the likelihood of recharge into the groundwater. ***Salinity Prevention***

3. Stormwater detention facilities shall be designed to satisfy the performance criteria identified in relevant development consent conditions, and in most cases, to limit the stormwater discharge rates from the development site to flow rates similar to those occurring from the site prior to its development.

INTERALLOTMENT DRAINAGE

D5.17 INTERALLOTMENT DRAINAGE

1. Interallotment Drainage shall be provided for every allotment which does not drain directly to its frontage street or a natural watercourse.

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 concentrated drainage from buildings and paved areas on each allotment for flow rates having a design ARI the same as the "minor" street drainage system.

4. In lieu of more detailed analysis, the following areas of impervious surface are assumed to be contributing runoff to the interallotment drain:- ***Impervious Area***

Development Type	% of Lot Area
• Residential (2a)	40
• Residential (2b)	70
• Industrial	80
• Commercial	90

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

7. Pipes - Minimum Grade - The interallotment drainage shall have a minimum longitudinal gradient of 1.0% . ***Grade***

8. Interallotment Drainage Pipe Standards - The interallotment drainage shall be constructed from rubber ring jointed pipes of either fibre reinforced concrete drainage pipe, reinforced concrete pipe, or UPVC pipe which shall conform respectively to the requirements of AS 4139, AS 4058 and AS 1254. In public road and recreation reserves where vehicle loads may be encountered, reinforced concrete pipe only, shall be used. Pipelines shall have a diameter not less than 150mm. ***Pipe Type***

9. Interallotment Drainage Pipe - Relationship to Sewer Mains - Where interallotment drainage and sewer mains are laid adjacent to each other they are to be spaced 1.5 metres between pipe centrelines (where the pipe inverts are approximately equal). ***Sewer***

10. Where there is a disparity in level between inverts the spacing is to be submitted for approval.

11. Where sewer mains are in close proximity to interallotment drainage lines they are to be shown on the interallotment drainage plan.

12. Interallotment drainage systems shall be designed to minimise the number of allotments using each easement so that maintenance responsibilities are as simple as possible. As a general rule, each interallotment drainage easement should serve no more than two allotments, except where no feasible alternative exists.

D5.18 CONDUITS

1. Conduits and materials shall be in accordance with the standards detailed in Council's current Handbook for Drainage Design Criteria. ***Materials***

2. 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. ***Bedding and Cover***

3. Conduit jointing shall be in accordance with Council's current Handbook for Drainage Design Criteria. ***Jointing***

4. 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. ***Location***

5. Bulkheads shall be designed on drainage lines where the pipe gradient exceeds 5 per cent. The design details shall address the size, and position in the trench as well as spacing along the line. ***Bulkheads***

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 included in Council's current Standard Engineering Drawings. Safety and safe access are important considerations in pit design. Step irons shall be detailed where required and grates shall be of “bicycle safe” design. .

D5.20 STORMWATER DISCHARGE

1. Stormwater discharge shall be located so as to avoid recharging groundwater and creating or worsening salinity degradation of adjacent land. Stormwater discharge shall be located to avoid areas with high groundwater tables, groundwater discharge areas or salt affected land. The Designer shall meet requirements of the appropriate land and water resources authority with regard to the salinity levels of discharge to natural watercourses. ***Salinity Prevention***

2. Scour protection at culvert or pipe system outlets shall be constructed in accordance with guidelines set down in Council's current Handbook of Drainage Design Criteria unless outlet conditions dictate the use of more substantial energy dissipation arrangements. ***Scour Protection***

3. 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***

4. 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 Developer 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, Adjoining Owners***

5. Where the drainage is to discharge to an area under the control of another statutory authority eg, Public Works, the design requirements of that Statutory Authority are also to be met. ***Other Authorities' Requirements***

6. 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 Easement***

7. 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. ***Recreation Reserves***

D5.21 TRENCH SUBSOIL DRAINAGE

1. Subsoil Drainage shall be provided in pipe trenches in accordance with the general requirements in the BVSC Development Construction Specification for PIPE DRAINAGE.

DOCUMENTATION

D5.22 DRAWINGS

1. Catchment Area Plans shall be drawn to 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. ***Catchment Areas***

2. The Drainage System Layout Plan shall be drawn to 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. ***Drainage System Layout***

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

4. The Drainage System Longitudinal Section shall be drawn to a scale of 1:500 horizontally and 1:50 vertically and shall show pipe size, class and type, pipe support type in accordance with AS 3725 or AS 2032 as appropriate, pipeline and road chainages, pipeline grade, hydraulic grade line and any other information necessary for the design and construction of the drainage system. ***Longitudinal Section***

5. Open Channel Cross Sections shall be drawn to a scale of 1:100 natural and shall show the direction in which the cross sections should be viewed. Reduced levels are to be to Australian Height Datum (AHD), unless otherwise approved by Council where AHD is not available. ***Open Channels***

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

7. Work-as-Executed Drawings shall be submitted to Council upon completion of the drainage construction and prior to the issue of the subdivision certificate. The detailed Drawings may form the basis of this information, however, any changes must be noted on these Drawings. ***Work-as-Executed Drawings***

D5.23 EASEMENTS AND AGREEMENTS

1. Evidence of any Deed of Agreement necessary to be entered into as part of the drainage system will need to be submitted prior to any approval of the engineering Drawings. Easements will need to be created prior to the issue of the subdivision certificate.

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

D5.24 SUMMARY SHEETS

1. A copy of a Hydrological Summary Sheet providing the minimum information set out in Council's current Handbook of Drainage Design Criteria is required. ***Hydrology***

2. A copy of a Hydraulic Summary Sheet providing the minimum information set out in Council's current Handbook of Drainage Design Criteria is required. ***Hydraulics***

D5.25 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.

SPECIAL REQUIREMENTS

D5.26 RESERVED

D5.27 RESERVED

D5.28 RESERVED

BEGA VALLEY SHIRE COUNCIL

DEVELOPMENT DESIGN SPECIFICATION

D6

SITE REGRADING

CONTENTS

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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 stormwater drainage design, geometric road design and erosion control and stormwater management.

Familiarity with other Specifications Required

D6.02 OBJECTIVES

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

- 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 Drainage Design
D7	-	Erosion Control and Stormwater Management

(b) Australian Standards

AS 3798	-	Guidelines on earthworks for commercial and residential developments
AS 2870.1	-	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 underground stormwater piping has been installed

(c) Allow improved runoff from flat ground

(d) Regrade excessively steep slopes that would preclude economical construction of dwelling foundations

(e) Allow effective recreational use or give reasonable access

The Designer 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 Designer 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 (ARI).

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 abutting the 100 year ARI flood levels shall be site regraded to a minimum level of 0.5 metres above the 100 year ARI flood levels. In doing so, the Designer shall ensure that other areas are then not affected by flooding. The site shall be identified on the Drawings with appropriate notation of site specific requirements.

Inundation Areas

2. 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

3. 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.

Piped Gullies or Depressions

4. 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.

Dams and Water Courses

5. 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 Drawings. 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 Drawings.

Flat Ground

6. The finished level of any building area shall be designed to ensure a desirable surface grading of 1.5% (1% minimum) oriented in the direction of the drainage system designed to cater for its catchment.

Steep Slopes

7. 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 Drawings.

Salinity Prevention

8. In known salt affected areas, or areas found to be salt affected by the geotechnical investigations, the Designer shall evaluate the existing conditions as they relate to the proposed development. The Designer shall also take advice from the relevant land and water resource authority and advise the Developer, in the preliminary design report, of areas requiring action to prevent salinity development. Appropriate regrading strategies aimed at lowering the groundwater table should also be included in the preliminary design report together with primary measures to prevent extension of salinity problems.

D6.06 GENERAL STANDARD OF LOT PREPARATION

Clearing

1. Special requirements will apply where necessary but generally lots are to be cleared of low scrub, fallen timber, debris, stumps, large rocks and any trees which in the opinion of Council are approaching the end of their functional life or are dangerous or will be hazardous to normal use of the development. Prior consultation with Council's Tree Preservation Officer is necessary. Such requirements shall be shown on the Drawings.

Disposal

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 Drawings.

Overfilling Area of Trees

3. In areas to be filled over butts of trees, 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 Drawings.

Preservation of Trees

4. Selected trees shall be preserved by approved means to prevent destruction normally caused by placement of conventional filling or other action within the tree drip zone. The Tree Preservation Officer shall be consulted for advice and all specific requirements noted on the Drawings.

D6.07 STANDARD OF FILL FOR LOTS

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

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

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

5. All areas where filling has been placed are to be dressed with clean arable topsoil, fertilised and sown with suitable grasses. This work shall be carried out in accordance with the Construction Specification for LANDSCAPING. ***Top Dressing***

D6.08 TEMPORARY DIVERSION DRAINS

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

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

Control measures will include, but not be limited to:

(a) Provision of trench stops every 30m along a trench, with provision for overtopping to be directed to the kerb.

(b) Placement of "blue metal" bags along kerb and gutter at maximum 30m spacings.

(c) Placement of "blue metal" bags around downstream drainage pits.

The requirements identified in the Design Specification for EROSION CONTROL AND STORMWATER MANAGEMENT should be addressed for any additional requirements.

D6.09 CONCURRENCE WITH THE ENVIRONMENTAL PROTECTION AUTHORITY (EPA)

1. The Designer is recommended to refer to the EPA with regard to any items requiring specific consideration when preparing a site regrading plan. Such plans may need to incorporate sediment/siltation/erosion/salinity control devices with specific reference to the stage at which these are to be provided. The responsibility shall rest with the Designer/ Developer to make enquiries with EPA and subsequently obtain Council approval to proposed measures. ***Specific Considerations***

D6.10 WORK AS EXECUTED DRAWINGS

1. The Designer shall annotate on the site regrading plan, the site specific detail to ***Site Specific***

be shown on the Work-as-Executed Drawings. Such detail shall include geotechnical report certifying the works to be suitable for the intended purpose and any other certifications, testing and survey data, as required in this Specification. ***Details***

D6.11 CARTAGE OF SOIL

1. The Designer shall refer to Council for acceptable haul roads with applicable load limits. This detail shall be required to be shown on the site regrading plan. 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***

2. 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."

D6.12 EFFECT ON ADJOINING PROPERTIES

1. Where it is proposed to divert or direct piped stormwater into adjoining properties, drainage easement rights are to be created over the adjoining lots in accordance with the Specification for STORMWATER DRAINAGE DESIGN. ***Stormwater Easement***

2. A written agreement shall also be sought to carry out construction work on adjoining properties and all such agreements are to be submitted to Council. ***Construction Agreement***

SPECIAL REQUIREMENTS

D6.13 RESERVED

D6.14 RESERVED

D6.15 RESERVED

BEGA VALLEY SHIRE COUNCIL

DEVELOPMENT DESIGN SPECIFICATION

D7

EROSION CONTROL AND STORMWATER MANAGEMENT

CLAUSE **CONTENTS** **PAGE**

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. Limit/minimise the amount of site disturbance. ***Site Disturbance***

2. Isolate the site by diverting clean upstream "run-on" 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

DQS	-	Quality Assurance Requirements for Design
D5	-	Stormwater Drainage Design
C211	-	Control of Erosion and Sedimentation
C273	-	Landscaping

(b) NSW State Legislation

Protection of the Environment Operations Act, 1997
Dams Safety Act, 1978
Soil Conservation 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 (DOH)
- Managing Urban Stormwater, Soils and Construction, 3rd Ed. Aug. 1998.

Roads and Traffic Authority (RTA)
- Erosion and Sedimentation Design Considerations.

Soil Conservation Service (SCS)
- 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.

D7.04 PLANNING AND CONCEPT DESIGN

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

2. A concept design shall be submitted with the development application to Council for all developments. This will assist in assessing the impact of the development on the site. ***Concept Design Submission***

3. The Development Consent will nominate that either an Erosion and Sediment Control Plan (ESCP) or a Soil and Water Management Plan (SWMP) is required for the detailed design. In general, a ESCP is required for sites of less than 2500 square metres of disturbed area and a SWMP for areas greater than 2500 square metres. Reference should be made to the DOH publication Managing Urban Stormwater, Soils and Construction. ***Development Consent Nomination***

D7.05 DETAILED DESIGN

1. After development consent is given, a ESCP/SWMP shall be submitted to Council as part of the detailed engineering design for approval and receipt of a Construction Certificate. This plan shall give all details for erosion, sediment and pollution controls and shall be site specific and not a generalisation of erosion control philosophy. It also forms part of the contract specifications for a contractor to comply with during construction. ***Site Specific***

2. The ESCP/SWMP 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. All Drawings shall be in accordance with the minimum drafting requirements in the Specification for QUALITY ASSURANCE REQUIREMENTS FOR DESIGN.

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 run-on around areas to be disturbed
- revegetation program
- procedures for maintenance of erosion and sediment control
- details for staging of works

3. No site works shall commence prior to receipt of the Construction Certificate. All works are to be carried out in accordance with the approved ESCP/SWMP. Its implementation must be supervised by personnel with appropriate qualifications and/or experience in soil conservation on construction sites. ***Approval***

4. The ESCP/SWMPand its associated control measures shall be constantly monitored, reviewed and modified as required, by the Developer, to correct any deficiencies. Council has the right to request changes if, in its opinion, the measures that have been put in place are inadequate. ***Additional Works***

5. If required, examples of proposed subdivisions or developments detailing locations of water quality structures, sediment and erosion control devices may be obtained from Council and used as a guide when preparing an ESCP/SWMP. ***Example Design***

EROSION CONTROL

D7.06 BUFFER ZONES

1. Buffer zones are corridors of vegetation 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 performance 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 landscape plan shall incorporate as much existing native vegetation as possible.

3. The "no access" fence locations shall be shown on the ESCP/SWMP. 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 even pipelines and may be permanent or temporary. ***Diversion Types***

2. Such techniques are used to divert the upstream run-on 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 used to convey such run-on through the development site, and discharge the flow to a formal drainage point/dissipater 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:-

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

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

5. Diversion works are designed to carry peak flows at non-erosive velocities in bare soil, vegetated or lined drains/banks. ***Peak Flows***

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. ***Non-Erosive Linings***

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

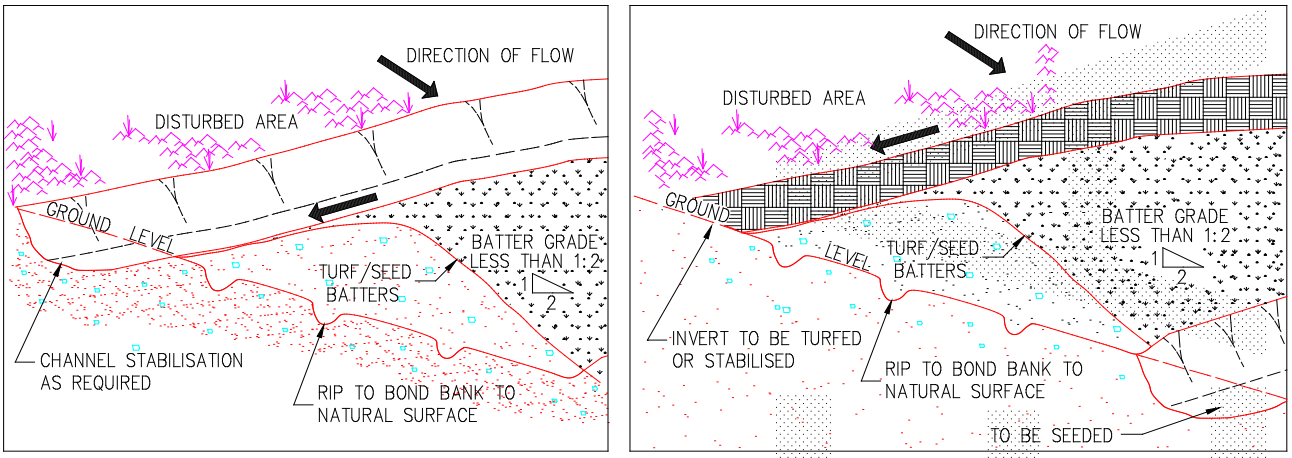


Figure D7-1 - Diversion Drains/Banks

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

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

Location

2. Stockpile sites shall be located:

   (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 the Construction Specification for LANDSCAPING for seed mix).

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 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 stabilised 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 manproof fence with lockable gates.

   (g) An all weather 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. Wet basins shall be flocculated by dosing with gypsum and pumped.

(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) In areas known to be affected by high groundwater tables and/or salinity of groundwater, basins shall be designed to be water retentive so that surface drainage water does not leak to the subsurface, recharging groundwater.

6. Permanent wet basin designs slightly vary from the above. Refer to the Stormwater Management Section of this Specification. ***Permanent Wet Basins***

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 the 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 for 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 and 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. Cattle grids shall be a minimum length of 7 metres. ***Cattle 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***

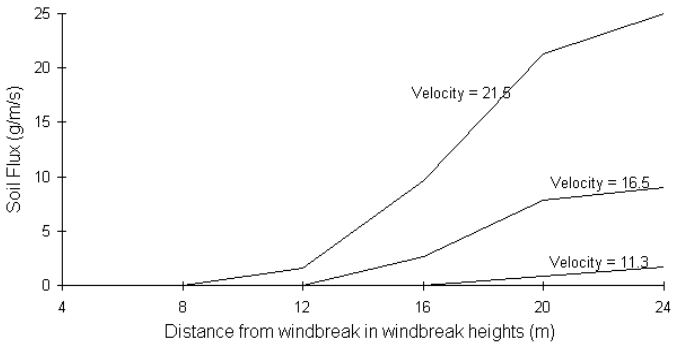
D7.15 WIND EROSION/DUST CONTROL

1. Research has demonstrated average dust emission rates of over 2½ tonnes 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. The clearing of vegetation and preparation of building pads is to be undertaken in the last stages of the development when the majority of the site has been effectively revegetated. ***Site Clearing***

2. 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***

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

4. Where a majority of the lot is disturbed the following minimum controls or measures shall be undertaken, but not limited to: ***Lot Control***

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

   (b) Sediment traps/barriers to be provided to all on-site and 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 the Superintendent. ***Necessary Controls***

2. Where increased 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 transported 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 and to the satisfaction of the owner. ***Reinstated***

STORMWATER MANAGEMENT

D7.18 GENERAL

Main Components

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:-

(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).

Excess Nutrients

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.

First Flush

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.

D7.19 WET RETENTION BASINS/PONDS

Maximise Infiltration

1. Basins designed for water quality control should maximise the extent of settling. In general quiescent conditions and infiltration should be maximised.

Location and Size

2. A wet retention basin can be located either on-line or off-line as shown in Figure D7-3. Its capacity however needs to be considerably greater if it is located on-line. The wet retention basin usually has some form of energy dissipation at the inlet or a sufficient length-to-width ratio (greater than 2:1) to prevent short circuiting of flow across the pond, although its shape may vary considerably. It should be located such that the basin does not locally raise the subsurface water table under circumstances that might lead to a salinity problem. The pond may vary in size, but it usually has a minimum surface area of about 1 per cent of the total catchment area. At a depth of 2.5 metres, this provides a storage volume approximately equal to the maximum total run-off from a 1 in 1 year storm. Basins may be installed as smaller multiple units (in series) or as large single units.

Basin Efficiency

3. Other design guides that will make the basin efficient in removing particles and provide for public safety, include the following.

(a) The minimum depth should be not less than 1.5 metres with an average depth of 2.5 metres. This discourages macrophyte growth in the deeper portions of the pond and also the breeding of mosquitos.

(b) The basins should have side slopes of approximately 1 in 8. This provides for safety and encourages microphyte growth around edges facilitating nutrient uptake.

(c) The maximum velocity through the pond based on a 1 in 1 year storm should not exceed 0.3 metres per second (at 2.5 metres depth, this is the maximum practical flow velocity at which optimum sediment removal can be achieved).

(d) A minimum freeboard of 0.3 metres should be provided between a restricted discharge outlet for the pond and a storm overflow weir. This discharge outlet should be designed so that the weir overtops on average three times per year.

(e) Inlet and outlet structures should be located at extreme ends of the basin, with short circuiting of flow further minimised by the use of baffles.

Construction and Maintenance

4. Basins should be constructed prior to the commencement of any site clearing or construction works, and should be de-silted when the level of sediment reduces the average water depth to less than 1.5 metres.

Outlet Design

5. (a) It may be desirable for the designer of an urban retention basin to incorporate an outlet device that enables dewatering of the basin. This simplifies de-silting, enabling earthmoving equipment to be used for de-silting operations.

Access Track

(b) An all weather access track shall be provided to the basin for maintenance works.

Trash Racks

6. It is generally necessary to incorporate a gross solids trap and trash rack facility on major discharges into the retention basin. This prolongs the life of the basin and prevents the accumulation of litter.

Buffer Zones

7. Basins should be surrounded by buffer zones, typically comprising grassed foreshores of not less than 20 metres between the nearest development and the basin. This allows for some infiltration of drainage from developments, permits the drainage authority scope to develop aesthetic surrounds and reduces the likelihood of over the fence dumping of rubbish.

Particle Settling

8. The settling velocity of particles should service as the basis for design. This, of course, can only be found by conducting standard settling tests or from a knowledge of local soil characteristics. The surface area of the required basin can then be determined from design settling velocities (Randall et al 1982).

Basin Classification

9. Wet retention basins are regarded as impoundments and normal dam safety requirements should be met. A dam may be prescribed under the Dams Safety Act, 1978, depending on the recommendations of the NSW Dams Safety Committee. A dam is normally prescribed if it is:

(a) 10 metres or more in height and has a storage capacity of more than 20 megalitres; or

(b) 5 metres or more in height and has a storage capacity of 50 megalitres or more.

Dam Safety Committee

10. If the wet retention basin is a prescribed dam, the Dams Safety Committee will maintain an interest in the dam, will seek information from its owner and will require that reports be prepared on the dam and submitted to the Committee.

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 65mm 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 all 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***

5. Trash racks shall be checked periodically and all debris and silt removed. ***Maintenance***

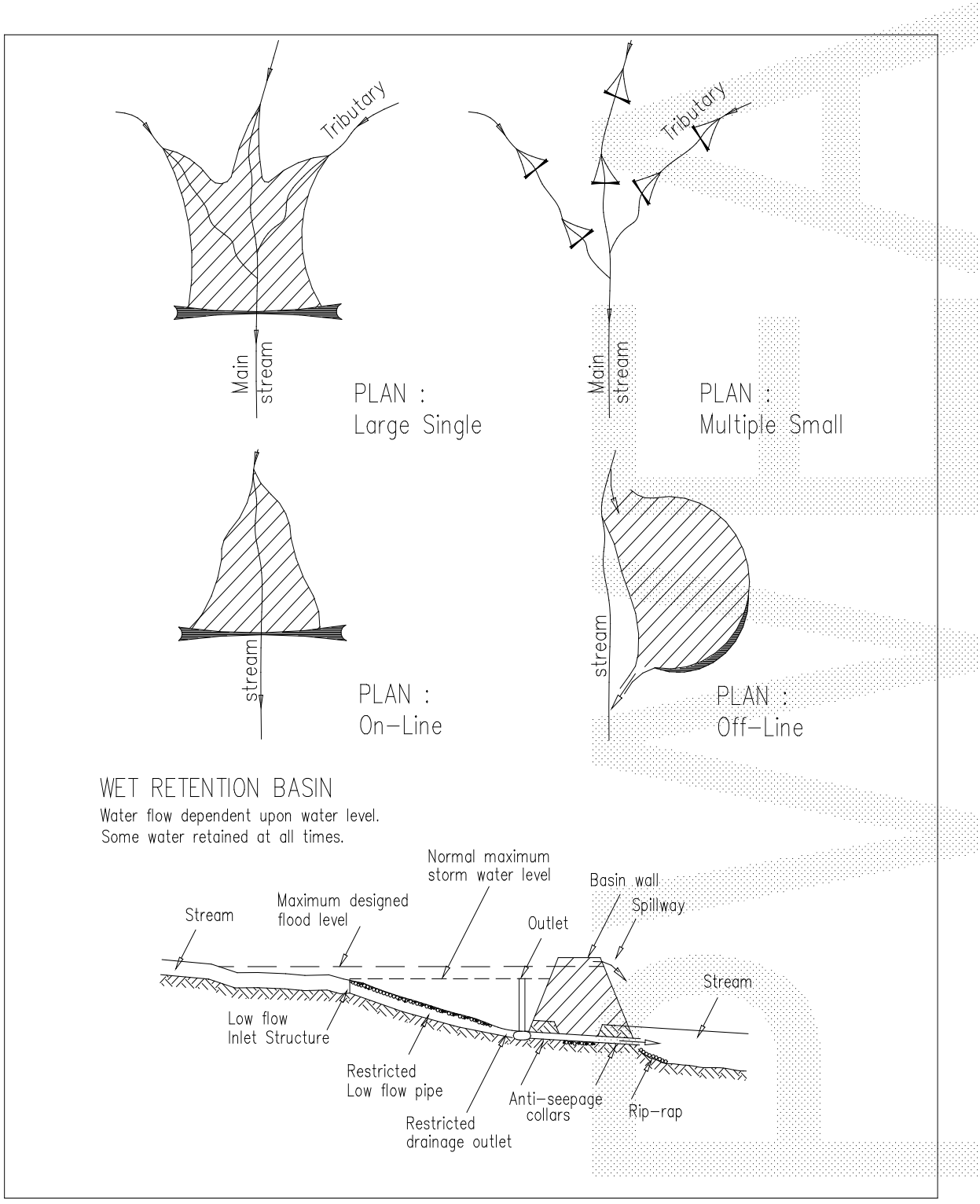


Figure D7-3 - Configuration and Design of Wet Retention Basins

D7.21 GROSS POLLUTANT TRAPS

Description

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.

Applications

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.

Definition

3. GPTs can be defined as major or minor:

   (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 traps can be located at heads of major floodways and/or where stormwater discharges into floodways or water bodies.

Sediment Interception

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.

Capacity

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

Maintenance Requirement

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

D7.22 WETLANDS

Depth and Batters

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 25 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.

SEPP No 14

2. Where wetlands are natural, the provisions of State Environmental Planning Policy No 14 - Coastal Wetlands, should be consulted. This policy protects wetlands from clearing, construction of levees, draining and filing, but does not prevent wetlands being used for run-off control, provided safeguards and operation control ensures their continued viability.

Efficiency

3. 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. Care shall be taken to avoid situations that recharge the groundwater and elevate the water table so as to develop local salinity problems.

Water Levels

4. 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.

Short Circuiting

5. 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.

Wetland Protection

6. 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.

Buffer Zones

7. Wetlands need to be surrounded by a buffer at least 20 metres wide in order to:-

   (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.

Native Vegetation

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

Results

9. Work in the ACT indicates rates of removal of phosphorous and particles in wetlands are higher than for wet retention basins.

Surface Area

10. 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.

Microphyte Types

11. 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.

Revegetation

12. 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.

Aesthetic Feature

13. 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.

Insect Problems

14. 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.

Wildlife Refuge

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

Native Fish

16. 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.

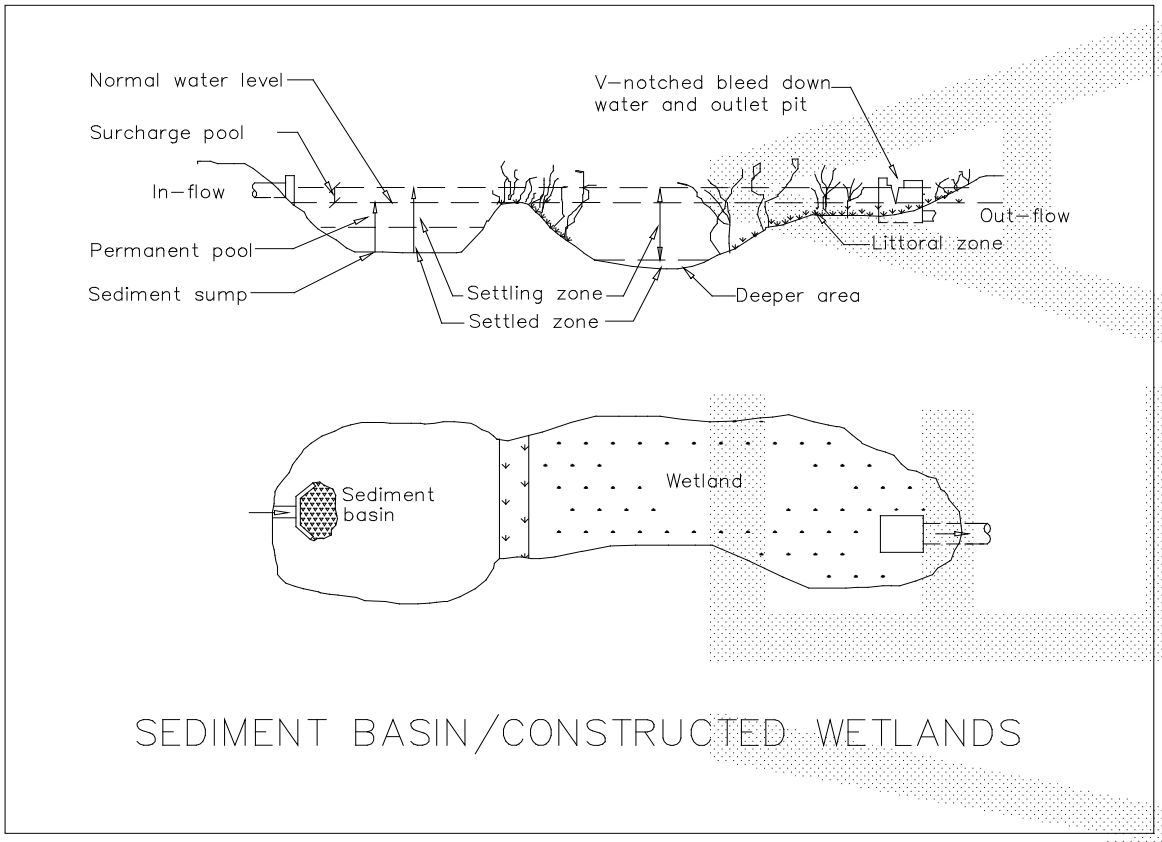


Figure D7-4 - Sediment Trap/Constructed Wetland

SPECIAL REQUIREMENTS

D7.23 RESERVED

D7.24 RESERVED

D7.25 RESERVED

BEGA VALLEY SHIRE COUNCIL

DEVELOPMENT DESIGN SPECIFICATION

D9

CYCLEWAY AND PATHWAY DESIGN

DESIGN SPECIFICATION D9
CYCLEWAY AND PATHWAY DESIGN

CLAUSE **CONTENTS** **PAGE**

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 including users with disabilities and limited mobility.

Safety

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 2156.1 - Walking tracks, Classification and signage
AS 2156.2 - Walking tracks, Infrastructure design
AS 2890.3 - Bicycle parking facilities
SAA HB69.14 - Guide to traffic engineering practice – Bicycles
AS Collection 005 Access and mobility – People with disabilities

(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 must 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 Subdivision Code 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 Code and Bicycle Plan

- The Designer should be familiar 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.

3. The Designer shall incorporate all the requirements for disabled access as appropriate for pathway design in accordance with any Council Policy or Development Control Plan on Access and Mobility and AS Collection 005.

Disabled Access

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 Use Bicycle/Pedestrian Pathway
Separated 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:

Exclusive Pedestrian Pathways
Shared Use Bicycle/Pedestrian Pathways

Footpaths

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 Subdivision Code and typically related to road cross section detailing.

Land Reserves

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.

D9.07 PROVISIONS FOR CYCLEWAYS AND PATHWAYS AT STRUCTURES

Bridges Underpasses

1. Designers shall consider the best way to provide 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 reference and source documents provide information on:

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

etc.

D9.08 SIGNAGE AND PAVEMENT MARKING

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

Compliance

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 1742.9 Bicycle facilities.

D9.09 END OF JOURNEY FACILITIES

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

Facilities

2. Such facilities could include:

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

Parking

3. Bicycle parking installation design should meet appropriate criteria discussed in the AUSTROADS Guide and be fabricated to meet AS 2890.3.

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.

Table D9.1 Minimum Design Standards

	Cycleway	Pathway	Shared Use Pathway
Path Width	2.0m	1.2m	2.0m
Formation Width	3.0m	2.0m	3.0m
Crossfall min. max.	1:40 1:20	1:40 1:20	1:40 1:20
Grade max.	2% for 450m 5% for 90m 10% for 30m	NA	2% for 140m 3% for 70m 4% for 40m 5% for 30m

D9.11 DOCUMENTATION

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 off-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. All Drawings shall be in accordance with the minimum drafting requirements in the Specification for QUALITY ASSURANCE REQUIREMENTS FOR DESIGN.

SPECIAL REQUIREMENTS

D9.12 RESERVED

D9.13 RESERVED

D9.14 RESERVED

BEGA VALLEY SHIRE COUNCIL

DEVELOPMENT DESIGN SPECIFICATION

DQS

QUALITY ASSURANCE REQUIREMENTS FOR DESIGN

QUALITY ASSURANCE REQUIREMENTS FOR DESIGN

DQS.01 SCOPE

1. This Design Specification sets out the process for quality assurance of Designs required by Council for development consents. The requirements are applicable to all design work whether undertaken by the Developer, the Developer's Project Manager, Consultant or a Sub-consultant. ***Quality Assurance***

2. The Specification refers to Engineering Design processes. Requirements which refer to the Concept Design of developments are generally covered in Council's Subdivision Code. The requirements of the Subdivision Code are a prerequisite to the quality requirements for Engineering Design provided in this Specification (DQS). ***Prerequisite***

3. The Specification refers also to engineering design processes for developments that do not involve subdivision.

DQS.02 OBJECTIVES

1. This Specification aims to set standards and document requirements for the execution and recording of design processes in order that the infrastructure associated with any development is designed to be fit for service and of a standard reasonably maintainable when it is accepted by Council as a community asset. ***Maintenance***

2. It is also an objective that these qualities be readily demonstrable by clear records of key design processes and that data relevant to the upkeep of the assets is available to Council's management. ***Records***

DQS.03 REFERENCE AND SOURCE DOCUMENTS

(a) Council Specifications

All Specifications for Design and Construction
Council's Codes and Policies

(b) Australian Standards

AS/NZS 3905.2	Guide to quality system Standards AS/NZS 9001, AS/NZS 9002 and AS/NZS 9003 for construction.
AS/NZS 3913	Quality manuals - Guide to preparation.
AS/NZS ISO 8402	Quality management and quality assurance - Vocabulary.
AS/NZS ISO 9001	Quality systems - Model for quality assurance in design, development, production, installation and servicing.
AS/NZS ISO 9004.1	Quality management and quality system elements - Guidelines.

(c) Other

Environmental Planning and Assessment Act 1979 (EP&A Act)
Local Government Act (1993)
Technical Publications used as Engineering Standards (eg; AR&R)
Interim Policies and Guidelines

DQS.04 CERTIFICATION

1. A Construction Certificate under section 109C of the EP&A Act is required before construction of subdivision work may commence. These Certificates can be issued by the consent authority (usually Council) or an accredited certifier. ***Construction Certificate***

2. Where a Construction Certificate is not required (eg; ancillary works for other developments) engineering designs shall be submitted to Council for approval. ***Other approvals***

3. The Developer shall present all engineering drawings to Council or an accredited certifier, as appropriate, for approval. Each set of drawings shall be accompanied by a Certification Report which will be signed by the Developer's Engineer or Surveyor. The Certification Report will comprise the certificate and check lists set out in Annexure DQS-A. ***Certification Report***

2. Certification Reports shall be required with preliminary drawings and shall require resubmission with updates when final drawings are submitted. Certification is not required with sketch plans or concept plans. ***Certification of Preliminary Drawings***

3. The Certification Report shall indicate on check lists any aspects of design which do not meet requirements or tolerances set out in Council's Design and Construction Specifications and Subdivision Codes. ***Design Non-conformance***

DQS.05 MINIMUM DRAFTING REQUIREMENTS

1. Design drawings shall be definitive and clearly set out so as to present the design concepts in such a way that the project can be understood, specified for construction and satisfactorily built. ***Criteria***

2. All design drawings should be clearly numbered by the designer with separate sheets numbered as part of a set. All drawing sheets shall have an allocated space in the bottom right hand corner for an assigned number provided by Council (18 characters). ***Sheet Numbers***

3. The information shown on the drawings shall be logically collected on discrete sheets to avoid illogical and onerous effort in cross referencing between sheets in order to find information. Drawings should not be overcrowded with information and should not rely on colour printing or colour wash to impart information. Drawings should be on A1 or A2 size sheets and be suitable for black and white copying and photo reduction to A3 paper size without loss of clarity. ***Logical Drawing Sheets***

4. Annexure DQS-B provides guidelines for grouping information in design drawings.

DQS.06 DESIGNER'S QUALIFICATIONS

1. A Civil Engineer deemed to be suitably experienced by Council and qualified so as to be accepted as a member of the Institution of Engineers, Australia or a Registered Surveyor deemed to be suitably experienced by Council shall be accepted as qualified to prepare plans for roadworks, drainage works, water supply, sewerage works (excluding pumping stations), canal works (excluding flood control structures and bridges). ***Engineer Surveyor***

2. A Civil Engineer qualified as detailed above shall be accepted as qualified to prepare plans for bridges, retaining walls, miscellaneous structures, buildings, pumping stations and flood control structures. ***Structural Design by Engineer***

DQS.07 RECORDS

1. The Designer shall retain appropriate design records in a format such that they

can be understood readily by design staff with no prior knowledge of the particular design.

2. Calculations which can readily be re-done need not be kept once the construction maintenance period of the project has expired. ***Calculation Record Retention***

3. A design file shall be maintained by the Developer or the Developer's Consultant containing records of calculations, approvals and decisions, geotechnical data and other design data which could be relevant in reviewing aspects of the design or planning future maintenance responsibilities. ***Design File to be kept***

4. Particular requirements apply to hydrological and hydraulic design data. (Refer to Council's Stormwater Drainage Design Specification). ***Hydrologic, Hydraulic Design***

5. Copies of records will be made available to Council on request and without charge.

DQS.08 AUDIT

1. Council shall have the right of audit of all processes and documents related to the project design. The Developer and the Developer's Consultant shall provide Council's Officers all reasonable assistance in inspecting records of designs submitted to Council for acceptance. ***Provide Assistance***

2. In order to provide for such audit, access to the premises of the Developer or the Developer's Consultant will be provided to Council on a 24 hour notice basis. ***Notice of Access***

CONTENTS

ANNEXURES

ANNEXURE DQS-A

BEGA VALLEY SHIRE COUNCIL
DESIGN CERTIFICATION REPORT

Project Title: _____

DA/BA No: _____

Consultant's Drawing No: _____

Name of Consultant: _____

Name and Address of Developer: _____

_____

I certify that the subject drawings represent a design for which the attached design check lists provide a valid record.

I certify that this Design has been carried out in accordance with current standards of good industry practice and in accordance with Bega Valley Shire Council's Design Specifications, Subdivision Code and specific instructions received with the exception of departures cited in the attached design check lists for Council's advice.

I certify that this Design is in strict compliance with the development consent conditions and where a variance to the consent is found, written confirmation has been received from Council approving of the variance prior to the lodgement of Design Drawings (this includes designs for staged construction).

I certify that all structural elements of the Design have been designed by a competent qualified practising Civil or Structural Engineer.

Contact Phone: _____

Contact Postal Address: _____

_____

_____

_____

_____
Design Engineer/Surveyor Date

_____
Qualifications

AUS-SPEC #1

Design Check List 1 BASE PLOT OF EXISTING FEATURES

		Check Completed By *(initials)*	Date	Not Applicable *(tick)*
1.1	Initial plot verified by site inspection for existing drainage.		/ /	☐
1.2	Initial plot verified by site inspection for existing property descriptions, boundaries and accesses.		/ /	☐
1.3	Initial plot of contours verified as representative of site terrain.		/ /	☐
1.4	Trees and significant environmental features affected by development are clearly indicated and annotated.		/ /	☐
1.5	Features significant to heritage considerations within the development boundaries are clearly indicated and annotated.		/ /	☐
1.6	Existing public and private property likely to be affected by these Designs are clearly indicated and annotated.		/ /	☐
1.7	Survey and bench-marks clearly indicated and annotated.		/ /	☐

DEPARTURES FROM COUNCIL OR STATE ROAD AUTHORITY NORMAL REQUIREMENTS OR SPECIAL FEATURES TO BE NOTED:

Design Check List 2 HORIZONTAL ROAD ALIGNMENT

		Check Completed By *(initials)*	Date	Not Applicable *(tick)*
2.1	Alignment compatible with design speed.		/ /	☐
2.2	Alignment is adequate in relation to clearance of roadside hazards.		/ /	☐
2.3	Driver and pedestrian sight distance is adequate.		/ /	☐
2.4	Conflict with existing services is minimised.		/ /	☐
2.5	Road widths and lanes meet Councils requirements and design traffic requirements.		/ /	☐
2.6	Alignment of bridges suits road alignment.		/ /	☐
2.7	Pedestrian, bicycle and parking requirements are met.		/ /	☐
2.8	Provision for large vehicles such as buses, garbage trucks and emergency vehicles is adequate.		/ /	☐
2.9	Intersection layouts meet turning requirements of design traffic including emergency vehicles.		/ /	☐
2.10	Pavement width tapers and merges are adequate.		/ /	☐
2.11	Pedestrians and prams are catered for.		/ /	☐
2.12	Conflict with existing public utility services has been identified and resolved.		/ /	☐
2.13	Horizontal road alignment has been provided in accordance with any conditions of development consent.		/ /	☐
2.14	Horizontal road alignment setout data is clearly defined and tabulated.		/ /	☐

DEPARTURES FROM COUNCIL OR STATE ROAD AUTHORITY NORMAL REQUIREMENTS OR SPECIAL FEATURES TO BE NOTED:

Design Check List 3 VERTICAL ROAD ALIGNMENT

		Check Completed By *(initials)*	Date	Not Applicable *(tick)*
3.1	Grades meet maximum and minimum requirements.		/ /	☐
3.2	Vertical clearances to bridges and services meet standards.		/ /	☐
3.3	Vertical sight distance is adequate for drivers and pedestrians.		/ /	☐
3.4	Cover to drainage structures or services is adequate.		/ /	☐
3.5	Vertical alignment is adequate for disposal of surface drainage from properties and from road.		/ /	☐
3.6	Grades are satisfactory for 1:100 year flood levels.		/ /	☐
3.7	Vertical alignment is compatible with property access.		/ /	☐
3.8	The gradient on an intersecting road is not significantly greater than the cross slope of the through pavement and no greater than 3% at give way and stop signs.		/ /	☐
3.9	Sight distance is acceptable for all accesses to roundabouts.		/ /	☐
3.10	Alignment coordination with horizontal alignment is in accordance with the AUSTROADS design guides as referenced in the AUS-SPEC specifications.		/ /	☐
3.11	Conflict with existing public utility services has been identified and resolved.		/ /	☐
3.12	Vertical road alignment setout data is clearly defined on the longitudinal sections.		/ /	☐

DEPARTURES FROM COUNCIL OR STATE ROAD AUTHORITY NORMAL REQUIREMENTS OR SPECIAL FEATURES TO BE NOTED:

Design Check List 4 ROAD CROSS SECTIONS

		Check Completed By *(initials)*	Date	Not Applicable *(tick)*
4.1	Typical cross sections have complete dimensions.		/ /	☐
4.2	Typical cross sections have kerb & gutter, road safety barrier and surface drainage indicated.		/ /	☐
4.3	Batter slopes are indicated and batter treatment is indicated where appropriate.		/ /	☐
4.4	Property boundaries, service allocations and location of known existing underground services and pathway treatments are indicated.		/ /	☐
4.5	Sufficient cross sections are shown to define all variations and width transitions.		/ /	☐
4.6	Cross sections are of sufficient width to fully assess impact of road level on adjoining property.		/ /	☐
4.7	Stability of embankment slopes, batters and retaining walls has been verified as satisfactory.		/ /	☐
4.8	Cross section reference level conforms with vertical road alignment.		/ /	☐

DEPARTURES FROM COUNCIL OR STATE ROAD AUTHORITY NORMAL REQUIREMENTS OR SPECIAL FEATURES TO BE NOTED:

Design Check List 5 ROAD AND INTERALLOTMENT DRAINAGE

		Check Completed By *(initials)*	Date	Not Applicable *(tick)*
5.1	Drawings indicate existing surface drainage.		/ /	☐
5.2	Hydrological data is the most current available.		/ /	☐
5.3	Hydrologic and hydraulic design calculations are complete and fully recorded and available for audit.		/ /	☐
5.4	Underground drainage and structures do not conflict with services.		/ /	☐
5.5	The designed drainage lines are compatible with existing incoming lines and outgoing lines.		/ /	☐
5.6	The length of line, type of pipe, size, class and bedding requirements are indicated for each drainage line on the schedule of drainage elements.		/ /	☐
5.7	Height of fill over drainage lines is within allowable limits.		/ /	☐
5.8	Drainage is provided for local depressions eg median areas or areas adjacent to fills.		/ /	☐
5.9	The effect of headwater and back-up water on private property has been assessed.		/ /	☐
5.10	Subsurface drainage has been provided when required and clearly located by line and level, with details provided..		/ /	☐
5.11	The need for batter drains has been considered for fills and cuttings.		/ /	☐
5.12	The height and energy level of downstream drainage has been considered.		/ /	☐
5.13	Drainage structures and flowpaths are located so as to ensure safe vehicular and pedestrian transit.		/ /	☐

		Check Completed By *(initials)*	Date	Not Applicable *(tick)*
5.14	Drainage structure number, setout, type and pipe details indicated on the drainage plans and schedule of drainage elements.		/ /	☐
5.15	Emergency flowpaths are located so as to minimise impact on private property.		/ /	☐
5.16	Road drainage has been provided in accordance with any conditions of development consent.		/ /	☐
5.17	Interallotment drains have been designed in accordance with Council's Specification and/or Australian Rainfall and Runoff (Edition 1987).		/ /	☐
5.18	Appropriate land stabilisation and velocity controls have been implemented to pipe systems, open channels and embankments.		/ /	☐
5.19	For allotments affected by flood controls, the floor height controls are to be compatible with road and drainage levels.		/ /	☐

DEPARTURES FROM COUNCIL OR STATE ROAD AUTHORITY NORMAL REQUIREMENTS OR SPECIAL FEATURES TO BE NOTED:

Design Check List 6 SIGNS AND MARKINGS

		Check Completed By *(initials)*	Date	Not Applicable *(tick)*
6.1	Sign types, sizes, locations and support structure details are shown on the drawings in accordance with AS 1742 (All parts).		/ /	☐
6.2	Pavement linemarking and pavement marking type and setout is indicated on the drawings to meet the requirements of AS 1742.2.		/ /	☐
6.3	Signs and linemarking have been designed in accordance with any conditions of development consent.		/ /	☐

DEPARTURES FROM COUNCIL OR STATE ROAD AUTHORITY NORMAL REQUIREMENTS OR SPECIAL FEATURES TO BE NOTED:

Design Check List 7 PAVEMENT DESIGN

		Check Completed By *(initials)*	Date	Not Applicable *(tick)*
7.1	The pavement design and surface treatment is shown clearly on the drawings and any variations are indicated on appropriate cross sections.	_____	/ /	☐
7.2	The pavement design complies with Council's Pavement Design Specification.	_____	/ /	☐
7.3	Pavement design is in accordance with any conditions of development consent.	_____	/ /	☐
7.4	Geotechnical data is assessed as adequate and is held on the design file.	_____	/ /	☐

DEPARTURES FROM COUNCIL OR STATE ROAD AUTHORITY NORMAL REQUIREMENTS OR SPECIAL FEATURES TO BE NOTED:

Design Check List 8 BRIDGE/MAJOR CULVERT DESIGN

		Check Completed By *(initials)*	Date	Not Applicable *(tick)*
8.1	The design has been performed by a competent practising Civil or Structural Engineer.		/ /	☐
8.2	Geotechnical data is assessed as adequate and is held on the design file.		/ /	☐
8.3	The type and functional dimensions of the bridges meet AUSTROADS Bridge Design Codes 1992, AS 3600, AS 1684, AS 1170, AS 4100.		/ /	☐
8.4	The type and class of all materials are indicated on the drawings.		/ /	☐
8.5	Records of all significant design calculations are available for audit.		/ /	☐
8.6	The design complies with any conditions of development consent.		/ /	☐

DEPARTURES FROM COUNCIL OR STATE ROAD AUTHORITY NORMAL REQUIREMENTS OR SPECIAL FEATURES TO BE NOTED:

Design Check List 9 EROSION/AND SEDIMENTATION CONTROL PLANS

		Check Completed By *(initials)*	Date	Not Applicable *(tick)*
9.1	Both short term and long term erosion control plans have been prepared using the guidelines within Council's Design Specification D7 and Construction Specification C211.	_____	/ /	☐
9.2	Erosion and sedimentation control has been designed in accordance with any conditions of development consent.	_____	/ /	☐

DEPARTURES FROM COUNCIL OR STATE ROAD AUTHORITY NORMAL REQUIREMENTS OR SPECIAL FEATURES TO BE NOTED:

Design Check List 10 WATER RETICULATION

		Check Completed By *(initials)*	Date	Not Applicable *(tick)*
10.1	The design has been performed by a practising registered Civil Engineer or registered Surveyor.		/ /	☐
10.2	The survey has been performed by a practising registered Surveyor.		/ /	☐
10.3	Geotechnical data is assessed as adequate and is held on the design file.		/ /	☐
10.4	The type and functional dimensions of the reticulation meet NSW Department of Public Works and Services guidelines, the appropriate Australian Standards and is compatible with the Water Reticulation Code of Australia WSA 03-1999.		/ /	☐
10.5	The type and class of all materials, fittings, joints, and special requirements for crossings and protection are indicated on the drawings.		/ /	☐
10.6	Records of all significant design calculations are available for audit.		/ /	☐
10.7	The design meets the requirements of all Statutory Authorities.		/ /	☐
10.8	The design complies with any conditions of development consent.		/ /	☐

DEPARTURES FROM COUNCIL OR STATE ROAD AUTHORITY NORMAL REQUIREMENTS OR SPECIAL FEATURES TO BE NOTED:

Design Check List 11 SEWERAGE SYSTEM

		Check Completed By *(initials)*	Date	Not Applicable *(tick)*
11.1	The design has been performed by a practising registered Civil Engineer or registered Surveyor.		/ /	☐
11.2	The survey has been performed by a practising registered Surveyor.		/ /	☐
11.3	Geotechnical data is assessed as adequate and is held on the design file.		/ /	☐
11.4	The type and functional dimensions of the reticulation meet NSW Department of Public Works and Services guidelines, the appropriate Australian Standards and is compatible with the Sewerage Code of Australia WSA 02-1999.		/ /	☐
11.5	The type and class of all materials, fittings, joints, and special requirements for crossings and protection are indicated on the drawings.		/ /	☐
11.6	Records of all significant design calculations are available for audit.		/ /	☐
11.7	The design meets the requirements of all Statutory Authorities.		/ /	☐
11.8	The design complies with any conditions of development consent.		/ /	☐

DEPARTURES FROM COUNCIL OR STATE ROAD AUTHORITY NORMAL REQUIREMENTS OR SPECIAL FEATURES TO BE NOTED:

ANNEXURE DQS-B

EXAMPLE COMPILATION OF DRAWINGS

A. ROADWORKS PLANS

An example of the sequence of drawing sheets acceptable to Council in the compilation of a full set of Roadworks Drawings is set out as follows.

Sheet №	TOPIC
1	Development Consent Number Locality Sketch and Index of Sheets.
2	General Subdivision Plan with contour details and a clear indication of the extent of work.
3	Typical Road Cross Sections showing road widths, pavement (design) configuration, batter slopes, kerb and gutter types.
4.	Plan and Longitudinal Section of each road showing setout data and all utility services.
5.	Drainage Plan and Schedule of Drainage Elements (Pipe lines and structures).
6.	Drainage Profiles.
7.	Drainage Structure Details.
8.	Road Cross Sections.
9.	Intersection Layout Details.
10.	Pavement Marking and Signposting.
11.	Erosion and Sedimentation Control Plans (short term and long term treatment).
12.	Structure Details – Bridges, Retaining Walls, etc.
13.	Water Reticulation Arrangement
14.	Sewerage Reticulation Arrangement
15.	Sewer Profiles
16.	Water and Sewage Pump Station Details, Water Service Reservoir Details

NOTE
1. Any one set of Roadworks Plans may require more than 1 sheet for each of the topics listed and may also require supplementary sheets for site specific details.
2. Scales are required to be nominated on all drawings and north points shown on all plan views.

BEGA VALLEY SHIRE COUNCIL

HANDBOOK OF DRAINAGE DESIGN CRITERIA

SUPPLEMENT TO DEVELOPMENT DESIGN SPECIFICATION D5 **STORMWATER DRAINAGE DESIGN**

COUNCIL'S HANDBOOK FOR DRAINAGE DESIGN CRITERIA

This handbook includes co-efficients, design requirements, material standards, and summary sheets for calculations so as to control the data and processes that the Consultant shall use in designs submitted to Council.

The following list contains the requirements that are presented in the Handbook of Drainage Design Criteria and the clauses in D5 - STORMWATER DRAINAGE DESIGN where references are cited to the Handbook.

Design IFD rainfalls for specific locations and individual zonings. **D5.04**

Where Council has prepared Intensity/Frequency/Duration (IFD) profiles for specific localities, they are attached at the end of this handbook. In other localities specific IFD relationships shall be determined in accordance with Volume 1, Book 2 of AR&R 1998.

Percentages impervious for specific locations and individual zonings. **D5.06**
Run off co-efficients for specific locations and individual zonings.

Percentages impervious shall be calculated for each specific location and zoning. The impervious surface proportions specified in D5.17 may be assumed only for the purpose of design of the interallotment drainage system.

Run off coefficients for urban areas can be taken from Table 1 below.

Equation 1.12 in Volume 1, Book 8 of AR&R

$$C^{1}_{10} = 0.1 + 0.0133 \times ({}^{10}I_{1} - 25)$$

Area	**A**	Tathra											
	B	Eden, Cobargo, Bermagui, Merimbula											
	C	Candelo, Bemboka, Bega											
			Fraction Impervious Area										
			0	0.1	0.2	0.3	0.4	0.5	0.6	0.7	0.8	0.9	1
A		C_{10}	.4	.45	.5	.55	.6	.65	.7	.75	.8	.85	.9
	F_y=0.95	C_5	.38	.43	.47	.52	.57	.62	.66	.71	.76	.81	.85
	F_y=1.05	C_{20}	.42	.47	.53	.58	.63	.68	.73	.79	.84	.89	.95
	F_y=1.20	C_{100}	.48	.54	.6	.66	.72	.78	.84	.9	.96	1	1
B		C_{10}	.55	.59	.62	.66	.7	.73	.76	.79	.83	.87	.9
	F_y=0.95	C_5	.52	.56	.59	.63	.66	.69	.72	.75	.79	.83	.85
	F_y=1.05	C_{20}	.58	.62	.65	.69	.73	.77	.8	.83	.87	.91	.94
	F_y=1.20	C_{100}	.66	.71	.74	.79	.84	.88	.91	.95	1	1	1
C		C_{10}	.5	.54	.58	.62	.67	.71	.74	.78	.82	.86	.9
	F_y=0.95	C_5	.47	.51	.55	.59	.64	.67	.7	.74	.78	.82	.85
	F_y=1.05	C_{20}	.52	.57	.61	.65	.7	.74	.78	.82	.86	.9	.94
	F_y=1.20	C_{100}	.6	.65	.7	.74	.8	.85	.89	.94	.98	1	1

Table 1 Runoff Co-efficients (Urban)

Sample summary sheet for hydrological calculations. **D5.07**

Hydrological calculations shall be presented in the form of the example given in Technical Note 6 of Volume 1, Book 8 of AR&R.

Sample summary sheet for hydraulic calculations. **D5.08**

Hydraulic calculations shall be presented in the form of the example given in Technical Note 9 of Volume 1, Book 8 of AR&R.

Conduit and material standards and jointing details. **D5.18**

See Development Construction Specifications C221 Pipe Drainage and C222 Precast Box Culverts.

Typical pit designs, and other pit design requirements. **D5.19**
Lists of Standards or Codes relevant to pit design.

See BVSC Standard Drawings.

Guidelines for scour protection at outlets. **D5.20**

All outlets shall be provided with suitable headwalls and scour protection measures to ensure that soils and watercourses downstream are not exposed to stormwater flows at velocities likely to cause erosion.

Intensity, Frequency, Duration relationships

1. Cobargo

Cobargo													
	Map 1	Intensity 2 year, I hour duration						38.00					
	Map 2	Intensity 2 year, I2 hour duration						9.00					
	Map 3	Intensity 2 year, 72 hour duration						2.75					
	Map 4	Intensity 50 year, I hour duration						84.00					
	Map 5	Intensity 50 year, I2 hour duration						19.00					
	Map 6	Intensity 50 year, 72 hour duration						6.80					
	Map 7	Skewness						0.15					
	Map 8	Factor F2						4.23					
	Map 9	Factor F50						15.71					
LPIII Rainfall intensities for Standard ARI's and Durations													
Duration	**5m**	**6m**	**10m**	**20m**	**30m**	**1h**	**2h**	**3h**	**6h**	**12h**	**24h**	**48h**	**72h**
ARI													
1	91	85	70	51	41.6	28.5	19.2	15.2	10.2	6.79	4.36	2.73	2.02
2	118	111	91	67	55	37.6	25.3	20.0	13.3	8.91	5.78	3.65	2.72
5	154	145	120	89	73	51	34.2	27.0	17.9	11.9	7.90	5.13	3.88
10	176	166	138	103	85	60	40.1	31.5	20.8	13.8	9.28	6.10	4.66
20	206	194	162	121	101	71	47.4	37.3	24.6	16.3	11.1	7.36	5.66
50	245	231	194	146	122	87	58	45.4	29.9	19.7	13.6	9.13	7.08
100	276	261	219	167	139	100	66	52	34.0	22.3	15.5	10.5	8.23

2. Bermagui

Bermagui													
	Map 1	Intensity 2 year, I hour duration						38.00					
	Map 2	Intensity 2 year, I2 hour duration						7.80					
	Map 3	Intensity 2 year, 72 hour duration						2.30					
	Map 4	Intensity 50 year, I hour duration						86.50					
	Map 5	Intensity 50 year, I2 hour duration						17.30					
	Map 6	Intensity 50 year, 72 hour duration						5.80					
	Map 7	Skewness						0.12					
	Map 8	Factor F2						4.22					
	Map 9	Factor F50						15.72					
LPIII Rainfall intensities for Standard ARI's and Durations													
Duration	**5m**	**6m**	**10m**	**20m**	**30m**	**1h**	**2h**	**3h**	**6h**	**12h**	**24h**	**48h**	**72h**
ARI													
1	91	85	70	51	41.6	28.5	18.5	14.3	9.13	5.86	3.72	2.30	1.69
2	118	111	91	67	55	37.7	24.4	18.8	12.1	7.73	4.95	3.09	2.28
5	155	146	121	90	74	52	33.5	25.8	16.4	10.5	6.86	4.37	3.27
10	177	167	139	104	86	61	39.3	30.2	19.3	12.3	8.11	5.23	3.94
20	208	196	164	124	103	73	47.0	36.1	22.9	14.6	9.72	6.32	4.79
50	248	234	196	149	124	89	57	44	27.9	17.8	12.0	7.85	5.99
100	280	265	223	170	142	102	66	50	31.9	20.3	13.7	9.09	6.97

3. Bemboka

Bemboka													
	Map 1	Intensity 2 year, I hour duration						34.00					
	Map 2	Intensity 2 year, I2 hour duration						8.60					
	Map 3	Intensity 2 year, 72 hour duration						2.85					
	Map 4	Intensity 50 year, I hour duration						73.50					
	Map 5	Intensity 50 year, I2 hour duration						19.00					
	Map 6	Intensity 50 year, 72 hour duration						6.40					
	Map 7	Skewness						0.19					
	Map 8	Factor F2						4.23					
	Map 9	Factor F50						15.65					
LPIII Rainfall intensities for Standard ARI's and Durations													
Duration	**5m**	**6m**	**10m**	**20m**	**30m**	**1h**	**2h**	**3h**	**6h**	**12h**	**24h**	**48h**	**72h**
ARI													
1	82	77	63	45.9	37.3	25.4	17.4	13.9	9.43	6.41	4.28	2.79	2.12
2	107	100	82	60	48.9	33.5	23.0	18.4	12.5	8.48	5.66	3.70	2.81
5	141	132	109	80	66	45.3	31.2	24.9	17.0	11.6	7.76	5.07	3.86
10	162	152	126	93	76	53	36.5	29.2	19.9	13.6	9.12	5.97	4.55
20	189	178	148	110	90	63	43.4	34.8	23.7	16.2	10.9	7.13	5.44
50	228	215	179	133	110	77	53	42.6	29.1	19.9	13.4	8.78	6.70
100	259	244	203	152	125	88	61	48.7	33.3	22.8	15.3	10.1	7.71

4. Bega

Bega													
	Map 1	Intensity 2 year, I hour duration							36.00				
	Map 2	Intensity 2 year, I2 hour duration							8.20				
	Map 3	Intensity 2 year, 72 hour duration							2.55				
	Map 4	Intensity 50 year, I hour duration							83.00				
	Map 5	Intensity 50 year, I2 hour duration							18.00				
	Map 6	Intensity 50 year, 72 hour duration							6.25				
	Map 7	Skewness							0.15				
	Map 8	Factor F2							4.23				
	Map 9	Factor F50							15.70				
LPIII Rainfall intensities for Standard ARI's and Durations													
Duration	**5m**	**6m**	**10m**	**20m**	**30m**	**1h**	**2h**	**3h**	**6h**	**12h**	**24h**	**48h**	**72h**
ARI													
1	85	80	66	48.0	39.1	26.8	17.9	14.1	9.29	6.15	3.99	2.52	1.88
2	112	105	86	63	52	35.6	23.7	18.6	12.3	8.11	5.29	3.37	2.52
5	149	140	116	86	71	49.3	32.7	25.6	16.7	11.0	7.30	4.73	3.58
10	172	162	135	100	83	58	38.4	30.0	19.7	12.9	8.63	5.64	4.29
20	203	191	159	120	99	70	46.1	36.0	23.4	15.3	10.3	6.81	5.21
50	244	230	193	145	121	86	57	44	28.6	18.6	12.7	8.44	6.50
100	276	261	219	166	138	99	65	51	32.8	21.3	14.6	9.78	7.56

5. Tathra

Tathra													
	Map 1	Intensity 2 year, I hour duration							38.00				
	Map 2	Intensity 2 year, I2 hour duration							7.80				
	Map 3	Intensity 2 year, 72 hour duration							2.25				
	Map 4	Intensity 50 year, I hour duration							86.00				
	Map 5	Intensity 50 year, I2 hour duration							16.50				
	Map 6	Intensity 50 year, 72 hour duration							5.40				
	Map 7	Skewness							0.14				
	Map 8	Factor F2							4.23				
	Map 9	Factor F50							15.77				
LPIII Rainfall intensities for Standard ARI's and Durations													
Duration	**5m**	**6m**	**10m**	**20m**	**30m**	**1h**	**2h**	**3h**	**6h**	**12h**	**24h**	**48h**	**72h**
ARI													
1	91	85	70	51	41.5	28.4	18.5	14.3	9.15	5.89	3.71	2.27	1.66
2	118	111	91	67	55	37.6	24.4	18.8	12.0	7.72	4.90	3.03	2.22
5	155	146	121	90	74	52	33.4	25.6	16.2	10.3	6.67	4.22	3.14
10	178	168	140	105	87	61	39.1	29.9	18.9	12.0	7.84	5.00	3.74
20	208	196	164	124	103	73	46.5	35.5	22.4	14.1	9.30	5.99	4.51
50	249	235	197	149	125	89	57	43.1	27.0	17.0	11.3	7.38	5.60
100	281	266	224	170	142	102	65	49.2	30.8	19.3	13.0	8.50	6.48

6. Candelo

Candelo													
	Map 1	Intensity 2 year, I hour duration						33.00					
	Map 2	Intensity 2 year, I2 hour duration						7.90					
	Map 3	Intensity 2 year, 72 hour duration						2.40					
	Map 4	Intensity 50 year, I hour duration						77.50					
	Map 5	Intensity 50 year, I2 hour duration						17.50					
	Map 6	Intensity 50 year, 72 hour duration						5.90					
	Map 7	Skewness						0.17					
	Map 8	Factor F2						4.22					
	Map 9	Factor F50						15.71					
LPIII Rainfall intensities for Standard ARI's and Durations													
Duration	**5m**	**6m**	**10m**	**20m**	**30m**	**1h**	**2h**	**3h**	**6h**	**12h**	**24h**	**48h**	**72h**
ARI													
1	79	74	61	44.1	35.8	24.4	16.5	13.1	8.78	5.90	3.79	2.38	1.76
2	103	97	80	58	47.6	32.6	22.0	17.4	11.6	7.80	5.05	3.19	2.37
5	139	131	108	80	66	45.5	30.5	24.0	15.9	10.6	6.97	4.48	3.37
10	163	153	127	94	77	54	36.2	28.4	18.8	12.5	8.28	5.36	4.05
20	193	182	151	113	93	65	43.4	34.1	22.5	14.9	9.95	6.49	4.93
50	236	222	185	139	115	81	54	42.1	27.7	18.2	12.3	8.07	6.17
100	269	254	212	160	133	94	62	48.7	31.9	20.9	14.2	9.37	7.19

7. Wolumla

Wolumla													
	Map 1	Intensity 2 year, I hour duration						36.00					
	Map 2	Intensity 2 year, I2 hour duration						7.60					
	Map 3	Intensity 2 year, 72 hour duration						2.30					
	Map 4	Intensity 50 year, I hour duration						82.00					
	Map 5	Intensity 50 year, I2 hour duration						17.40					
	Map 6	Intensity 50 year, 72 hour duration						6.00					
	Map 7	Skewness						0.16					
	Map 8	Factor F2						4.22					
	Map 9	Factor F50						15.75					
LPIII Rainfall intensities for Standard ARI's and Durations													
Duration	**5m**	**6m**	**10m**	**20m**	**30m**	**1h**	**2h**	**3h**	**6h**	**12h**	**24h**	**48h**	**72h**
ARI													
1	85	80	66	48.0	39.1	26.8	17.5	13.6	8.74	5.65	3.62	2.26	1.67
2	112	105	86	63	52	35.6	23.2	18.0	11.6	7.51	4.85	3.06	2.27
5	149	140	116	86	71	49.1	32.1	24.9	16.1	10.4	6.85	4.40	3.31
10	172	162	135	100	83	58	37.9	29.4	19.0	12.3	8.18	5.32	4.03
20	202	190	158	118	98	69	45.2	35.0	22.7	14.7	9.88	6.49	4.95
50	244	230	192	145	120	85	56	43.2	27.9	18.1	12.3	8.16	6.27
100	276	261	219	165	138	98	64	49.7	32.1	20.8	14.2	9.54	7.37

8. Merimbula

Merimbula													
	Map 1	Intensity 2 year, I hour duration						38.00					
	Map 2	Intensity 2 year, I2 hour duration						7.40					
	Map 3	Intensity 2 year, 72 hour duration						2.20					
	Map 4	Intensity 50 year, I hour duration						84.00					
	Map 5	Intensity 50 year, I2 hour duration						16.80					
	Map 6	Intensity 50 year, 72 hour duration						5.75					
	Map 7	Skewness						0.15					
	Map 8	Factor F2						4.22					
	Map 9	Factor F50						15.75					
LPIII Rainfall intensities for Standard ARI's and Durations													
Duration	**5m**	**6m**	**10m**	**20m**	**30m**	**1h**	**2h**	**3h**	**6h**	**12h**	**24h**	**48h**	**72h**
ARI													
1	89	84	69	51	41.4	28.5	18.2	13.9	8.75	5.52	3.51	2.18	1.60
2	117	110	91	67	55	37.6	24.0	18.4	11.6	7.32	4.69	2.94	2.17
5	154	145	120	89	73	51	32.7	25.1	15.9	10.1	6.61	4.23	3.17
10	176	166	138	103	85	60	38.5	29.5	18.7	11.9	7.89	5.11	3.86
20	206	194	162	121	101	71	45.7	35.1	22.3	14.2	9.51	6.23	4.74
50	246	232	194	147	122	87	56	43.0	27.3	17.4	11.8	7.82	6.00
100	277	262	220	167	140	100	64	49.4	31.4	20.0	13.6	9.12	7.03

9. Pambula

Pambula													
	Map 1	Intensity 2 year, I hour duration						39.00					
	Map 2	Intensity 2 year, I2 hour duration						7.50					
	Map 3	Intensity 2 year, 72 hour duration						2.25					
	Map 4	Intensity 50 year, I hour duration						83.50					
	Map 5	Intensity 50 year, I2 hour duration						17.30					
	Map 6	Intensity 50 year, 72 hour duration						5.90					
	Map 7	Skewness						0.16					
	Map 8	Factor F2						4.22					
	Map 9	Factor F50						15.75					
LPIII Rainfall intensities for Standard ARI's and Durations													
Duration	**5m**	**6m**	**10m**	**20m**	**30m**	**1h**	**2h**	**3h**	**6h**	**12h**	**24h**	**48h**	**72h**
ARI													
1	93	87	71	52	42.7	29.3	18.6	14.2	8.87	5.57	3.56	2.22	1.64
2	120	113	93	68	56	38.6	24.6	18.7	11.8	7.41	4.77	3.00	2.22
5	155	146	121	90	74	52	33.4	25.6	16.2	10.3	6.76	4.33	3.25
10	177	167	139	104	86	60	38.8	29.9	19.1	12.2	8.08	5.23	3.95
20	206	194	162	121	101	71	46.0	35.5	22.7	14.6	9.77	6.39	4.86
50	246	232	194	147	122	87	56	43.6	28.0	18.0	12.2	8.05	6.17
100	276	261	219	166	138	99	64	49.9	32.1	20.7	14.1	9.41	7.25

10. Wyndham

Wyndham													
	Map 1	Intensity 2 year, I hour duration						35.00					
	Map 2	Intensity 2 year, I2 hour duration						7.95					
	Map 3	Intensity 2 year, 72 hour duration						2.60					
	Map 4	Intensity 50 year, I hour duration						76.00					
	Map 5	Intensity 50 year, I2 hour duration						19.50					
	Map 6	Intensity 50 year, 72 hour duration						7.00					
	Map 7	Skewness						0.18					
	Map 8	Factor F2						4.22					
	Map 9	Factor F50						15.70					
LPIII Rainfall intensities for Standard ARI's and Durations													
Duration	**5m**	**6m**	**10m**	**20m**	**30m**	**1h**	**2h**	**3h**	**6h**	**12h**	**24h**	**48h**	**72h**
ARI													
1	83	78	64	46.9	38.2	26.2	17.3	13.6	8.87	5.82	3.85	2.49	1.88
2	109	102	84	61	50	34.5	23.0	18.0	11.9	7.83	5.20	3.38	2.56
5	144	135	111	82	68	46.8	31.6	25.0	16.7	11.2	7.54	4.96	3.79
10	165	155	129	96	79	55	37.4	29.6	19.9	13.4	9.10	6.05	4.65
20	193	182	151	113	93	65	44.5	35.5	24.0	16.3	11.1	7.46	5.76
50	232	219	182	136	112	79	55	43.7	29.8	20.4	14.1	9.49	7.37
100	264	249	208	156	129	91	63	51	34.7	23.8	16.5	11.2	8.71

11. Eden

Eden													
	Map 1	Intensity 2 year, I hour duration						40.00					
	Map 2	Intensity 2 year, I2 hour duration						7.20					
	Map 3	Intensity 2 year, 72 hour duration						2.20					
	Map 4	Intensity 50 year, I hour duration						82.50					
	Map 5	Intensity 50 year, I2 hour duration						17.00					
	Map 6	Intensity 50 year, 72 hour duration						5.50					
	Map 7	Skewness						0.16					
	Map 8	Factor F2						4.20					
	Map 9	Factor F50						15.76					
LPIII Rainfall intensities for Standard ARI's and Durations													
Duration	**5m**	**6m**	**10m**	**20m**	**30m**	**1h**	**2h**	**3h**	**6h**	**12h**	**24h**	**48h**	**72h**
ARI													
1	95	89	73	54	44.0	30.3	18.8	14.1	8.66	5.32	3.44	2.17	1.61
2	122	115	95	70	57	39.6	24.7	18.7	11.5	7.11	4.61	2.91	2.17
5	157	148	122	91	75	52	33.1	25.2	15.8	9.96	6.51	4.15	3.11
10	177	167	139	104	86	60	38.4	29.4	18.6	11.8	7.76	4.99	3.75
20	206	194	162	121	101	71	45.8	35.2	22.4	14.3	9.43	6.07	4.57
50	244	230	192	145	120	85	55	42.7	27.5	17.7	11.7	7.59	5.74
100	273	258	216	163	136	97	63	49.1	31.7	20.5	13.6	8.85	6.70