Engineering and Works Services Standards and Specifications

Section 2

Designs and Plans for Roads, Earthworks, Paths and Storm Water Drainage

These Standards and Specifications have been adopted by Council, and are directed to Designers and Draft persons preparing plans for road reserve and drainage works. These Standards and Specifications will be maintained by the Director, Engineering and Works Services

Revision No	Date	Section Amended	Prepared	Reviewed
A	December 2009	All	Community Infrastructure	Infrastructure Development
B	June 2012	All	Engineering and Works Services	Development Control
C	January 2017	Section 3	Engineering and Works Services	Development Control
D	December 2020	Section 2.4 table 1.0 Engineering Drawings	Engineering and Works Services	Development Control

I n d e x

Glossary

Contractor	means the Company which has been awarded the contract for the construction of the sub divisional works.

1 General

1.1 Introduction

These Standards and Specifications have been adopted by the Council, and are directed to Designers and Draft persons preparing plans for road reserve and drainage works. These Standards and Specifications will be maintained by the Director, Engineering and Works Services and the power to ensure implementation and compliance is delegated to the City Engineer (Director, Engineering and Works Services).

It is acknowledged that accepted industry standards will change over time. In order to accommodate such changes, the contents of this Specification will be reviewed regularly.

1.2 Approval

Road, Path and Drainage Plans submitted for Approval must always be preceded by approval of Subdivision by the West Australian Planning Commission or by planning consent issued by the City for a development other than subdivision.

The City Director, Engineering and Works Services has delegated authority for the purposes of these specifications.

2 Design Requirements

2.1 Road Hierarchy

A road hierarchy to clearly indicate the priority of roads to the users shall be addressed, including appropriate standard signage, to maintain amenity appropriate to the zoning of the area and shall integrate with existing networks to enable the safe and orderly movement of vehicles, cyclists and pedestrians within, between and across the roads.

The development of the road hierarchy with recommendations of road reserve widths, road pavement widths, parking, paths, public transport and suitable traffic calming and or intersection control measures should be based on a Traffic Impact Study or suitable Traffic Assessment. Traffic Assessments should be based on the Western Australian Planning Commission - Transport Assessment Guidelines for Developers.

Where roads (new or upgraded) connect or cross roads controlled by Main Roads approval for the design and standard will be required by both the City and Main Roads.

Because the road hierarchy is set in the planning stages of road development, there is a need for practicing, qualified Engineers to be involved at the earliest stages of subdivision planning and design.

Road names are to be approved by the City before referral to the Geographic Names Committee (Landgate). Street signs will be standard letter and size shall generally be between 100 mm for access streets and 150 mm for intersections on larger roads or highways.

2.2 Roads

The application of Australian Standards to road design is required to provide minimum standards for the geometric elements of the road. Also of importance to the total efficiency of the road are other factors such as the co-ordination of vertical and horizontal alignments, fitting the road to the natural contours of the land, preservation of natural features and vegetation, and using other than minimum standards to provide a pleasing and aesthetic road vista. For Neighbourhood Connector roads, geometric design and function may be more important than the design of the individual alignment elements.

Access class roads are not regional traffic carriers and it is desirable to use alignment and traffic control devices to limit speeds and discourage traffic volume caused by through traffic.

The long-term maintenance is another important factor in road design. The road must be able to be maintained by the community at a reasonable cost. The design should reflect features that are reasonable to maintain by the whole community.

These factors should be borne in mind for urban, industrial, rural and special rural area road design.

Street lighting is required in all urban areas in accordance with the lighting categories in AS/NZS 1158.1.3 - road lighting Standards:

- Category V lighting - Visual requirement of motorists - eg traffic routes.
- Category P (1-12) - Visual requirements of pedestrians - eg paths.

Line marking and regulatory signage (both regulatory and information) is an important aspect of road safety. All line marking and signage is to be approved by Main Roads WA with endorsed plans forwarded to the City. All signage and line marking is to be installed at the expense of the developer.

2.3 Statutory Requirements

Planning and Development Act 2005 Part 10-Subdivision and development control, Division 4-Subdivision costs reads as follows:

> *"158. Expense of road or waterway construction and road drainage*
>
> *(4) The local government may require the person to employ a consulting engineer and clerk of works to design and supervise the construction and drainage and that person, when required to do so by the local government, is to carry out the requirement"*

The survey, taking of the levels and preparation of the design plans and layout of the proposed works, including drainage design together with calculations, design, location, size, etc. of drainage pipe works, manholes, gullies, kerbing and disposal of storm water, etc. must be performed by, or certified by, a practising person qualified by training and/or experience and capable of doing such works, and approved by the Director, Engineering and Works Services.

2.4 Plan Drafting Standards

Drawings detailing the design for the proposed development shall show all existing and proposed roads, paths, drains, contours and spot levels, services, survey pegs and marks, significant vegetation, fences, structures and buildings, and all new or proposed contours and spot levels, earthwork embankments, roads, verges, intersections, junctions, drainage, sumps, fencing, flood routes, paths and access ways, open space, retaining walls, underpasses and all other components of the project, including adjustment to existing facilities.

Drawings shall be prepared by persons qualified by training and/or experience to the standards required by the Director, Engineering and Works Services. Refer to Section 2.3 for Statutory Requirements.

Drawings shall in general be prepared in accordance with Australian Standard AS.1100 Part 101 - 1992 and 401 - 1984.

The datum to be used shall be the Australian Height Datum (AHD). Temporary bench marks related to AHD shall be clearly indicated on drawings.

Two (2) copies of drawings and specification standards shall be submitted for approval as preliminary plans. Amendments and variations will be marked by the City on all sets of drawings and specifications and a copy forwarded to the Consulting Engineer. Plans finally endorsed with an "Approved" stamp and the delegated City Officer's

signature will constitute final approved plans. One (1) set of drawings and specifications will be returned to the consultant/developer, these being the "approved specifications and construction drawings. Work shall not commence until all drawings and specifications are approved by the Director, Engineering and Works Services. In some instances the Director, Engineering and Works Services may permit commencement of earthworks only prior to formal approval of all drawings, provided drawings have been submitted and issues related to earthworks address (such as drainage and dust management plan) and further subject to any variations being undertaken that are specified on the approved drawings.

Where the specification to be used for the works has been previously approved by the Director, Engineering and Works Services, the above conditions relating to specifications may not apply. City specifications will apply to design and construction where applicable, at all times.

Road Plans

Roadwork drawings in urban, industrial and special rural areas shall be provided to the scales and required detail as scheduled in Table 1.0 - Engineering Drawings.

Earthworks and Contouring Plans, Finished Floor Levels

Earthworks and contour drawings shall be provided to the scale and required detail as scheduled in Table 1.0 - Engineering Drawings, and show existing vegetation, topsoil stripping and replacement, finished floor levels, retaining walls, batter slopes and stabilisation method/s. Minimum finished floor levels (FFL) shall be quoted on earthwork and lot layout plans. FFL shall be based on recommendations of the Department of Water and/or design of top water level for at least a 1:100 year return interval storm plus a freeboard of 500mm, and/or to address ocean surge levels (including Tsunamis) plus a freeboard of 300mm, where applicable; or be otherwise protected from ocean surge.

Storm Water Drainage Plans

Storm water drainage drawings for urban, industrial and rural areas shall be provided to the scales and required detail as scheduled in Table 1.0 - Engineering Drawings.

TABLE 1.0 - Engineering Drawings

Re-contouring and Earthworks		
Drawings	Scales	Detail (Minimum Requirement)
Layout Plan	Minimum 1:1000 Horizontally	(refer 2.4.8) All road and property existing and new boundaries; all existing and new contours with a maximum interval of 1 m between contours; shaded or detailed areas of cut and fill and total earth-worked or re-contoured area; levels along existing roads and property boundaries adjacent the re-contoured area. Retaining walls, re-vegetation and stabilisation measures.

Roadwork's		
Drawings	Scales	Detail (Minimum Requirement)
Concept Plan	Minimum 1:1,000 Horizontally	Lot dimensions, lot numbers, lot area, road reserve widths, road carriageway widths, horizontal curve radii.
Pre-calculation Plan	Minimum 1:1,000 Horizontally	Lot numbers, lot areas, lot dimensions, road reserve widths, truncations, road carriageway widths, horizontal curve radii and horizontal curve lengths.
Locality Plan	1:5,000	Existing roads and including major arterial roads, new roads, locality areas and any other significant features.
Layout Plan	Minimum 1:1,000 Horizontally	All existing road, new roads to be constructed, lots, numbers, boundaries and dimensions; easements - description and widths; road, property, outfall, drains and sumps; bench and survey marks and levels, share paths, footpaths and footways, significant vegetation - location and identification.
Longitudinal Plan, Profile and Cross Sections	Minimum 1:1,000 Horizontally Minimum 1:100 Vertically	All information as for layout plan plus: - Chainages or Stations on roads, natural surface levels on road centre lines and boundary lines, finished levels on centre lines and fence lines, all horizontal curve data, all vertical curve data and finished levels at least at every 20 m and at change points on the horizontal and vertical curves.
Intersection, Junction, Roundabouts, Slow Points and Entry Statements	Minimum 1:250 Horizontally (Intersections, Junctions and Roundabouts. Minimum 1:500 Horizontally (Slow Points)	All lot boundaries, footpaths and footways; channelisation, island and median details, kerbing details, ramps, cycleways and drainage details.
Details	To the standard Engineering Drawing Scales	As required - gully, manhole signs, guideposts, bollards, barriers, fencing, headwalls, cross-sections (drain and road).
Services (Integrated plan)	Minimum 1:1,000	Water, sewer, power, telecommunications, gas – alignment, depths, location of manholes, property connection markers and inspection pits.
Street Lighting	Minimum 1:1,000	Cable and or connector locations pole height and type, lamp power and type, position of poles, cabinets and a Lux Contour Plan.
Landscaping	Minimum 1:1,000	Existing vegetation to be retained, areas to be landscaped and rehabilitated or enhanced. Plant species, plant densities position pot sizes and numbers, growth height. Reticulation details.

Storm Water Drainage		
Drawings	Scales	Detail (Minimum Requirement)
Longitudinal Sections	Minimum 1:1,000 Horizontally Minimum 1:100 Vertically	Pipe size, grade and length; natural and finished surface level, invert and cover levels of manholes and pits; chainage, stations and offsets of manholes, gullies and pits; sump areas, offsets, outfalls, fencing and ramps, service crossings.
Layout Plan	1:1,000 Horizontally	Same as layout plan for roads, plus pipe work, manhole, gully, pit and sump detail for longitudinal sections, service crossings.

Notes : The storm water drainage plan should, if practical, be shown on the same plan as the road longitudinal plan and profile.

Additional drawings when required by the Director, Engineering and Works Services shall be provided.

2.5 Road Safety Audit

General

Road safety auditing is an important tool to address safety concerns within the road network being designed for construction and/or reconstructed and/or upgraded. The City will require a road safety audit to be conducted as part of the design process where:

(a) The likelihood of road crashes can be reduced.
(b) A reduction in the severity of crashes is possible.
(c) Avoidance of costly remedial works where there is a potential for road crashes can be achieved.
(d) The proposed design cannot meet Austroad Guidelines.
(e) Where the design road network joins an existing road/s with high accident data.

"A road safety audit is a formal examination of an existing or future road or traffic project that interacts with road users in which independent qualified examiners look at the projects, crash potential and safety performance." (AustRoads 1994)

The road safety audit objective is to identify potential safety risks for road users and ensure that measures are taken to eliminate and reduce risks in the design and construction of any particular project. The road safety audit will remove preventable crashes by producing elements within the design and by mitigating any remaining risks by the inclusion of crash reducing elements. The audit itself will enable designers to produce the solution to safety problems.

Stages for Road Safety Auditing

(a) Feasibility.
(b) Preliminary design.
(c) Detailed designs and pre-opening of the road project.

A road safety audit may be carried out as part of reviewing an existing road or a road upgrading scheme, sub divisional road or major property development, or road planning for development of schools or major shopping centres. Accident statistics and patterns will need to be obtained and examined prior to submission of the design to the City.

Road Safety Audit Outcomes

The Manager, Infrastructure Development is to receive the road safety audit and is to react to and co-ordinate responses to the recommendations. The audit will produce a corrective action report with the responses to be documented in terms of whether the road safety audit findings have been accepted, rejected or modified and returned to the road safety audit team leader. All actions must be retained on the City records. A copy of the audit should be made available by registration form to MRWA, the form being available on their website.

The City undertakes to have two staff trained as road safety auditor team members and supports the objective that one staff member be a senior road safety auditor.

Road Safety Certification

Road Safety Auditors are listed on the Main Roads web site. To maintain accreditation road safety auditors need to carry out two audits in two years or complete a refresher course.

Road Safety Audit Team

A road safety audit team should consist of:

(a) An independent team leader (independent of the project – from a consultant or partner in local government, and be qualified as a senior auditor).

(b) A team member from Main Roads WA.

(c) A team member from the City.

Road Safety Audit Practice

The City's practice on road safety audits has the objective of promoting the development and implementation of a safe road environment through the adoption of road safety auditing principles and practice. To achieve this objective the City requires the following application of road safety audit principles to apply:

1. To road safety projects in excess of $100,000 and involving traffic management;

2. To intersections or sections of road that have numerous crashes;

3. To development involving over 100 potential new lots;

4. To developments with a floor space of <4,000m^2 or with multiple accesses off major roads or major traffic generators;

5. To new schools developments with greater than 500 students; and

Note: A road safety audit is additional to a traffic impact study.

The procedure shall be in accordance with AustRoads Road Safety Audit Manual & Checklist and MRWA and IPWEA (WA Division) complementary checklists and procedures.

The City may require the application of a road safety audit to an area where traffic conflict with pedestrians and/or cyclists may occur.

Road safety audits shall be carried out only by trained personnel.

The cost of road safety audits shall be borne by the developer or subdivider in the case of developments and by the City as part of the cost of project in its own works.

In the case of a development or subdivision, a design will not be approved until a road safety audit as required under this practice, has been carried out and its recommendations considered in the final design with documentation to be submitted to the City with design.

3 Urban Areas

3.1 Road Hierarchy Planning

A road hierarchy for subdivision creating new roads shall be developed based on the road classifications in Liveable Neighbourhoods Element 2 - Movement Network as outlined in accordance with Table 2.0 - Urban Area Road Hierarchy Dimensions.

These guidelines address broad acre subdivision in new areas. Modifications can be given for adapting them for infill subdivision in existing suburbs where supporting documentation such as Transport Assessment Guidelines, Traffic Impact Study or Road Safety Audits have been conducted.

TABLE 2.0 - Urban Area Road Hierarchy Dimensions

Road Classification	*Reserve Width*	*Truncation*	*Pavement Width (Seal)*	*Verge Width (to back of kerb)*	*Median Width*
Highway	MRWA to set	MRWA to set	MRWA to set	MRWA to set	MRWA to set
Arterial Road (Controlled Access)	Min. 30m	Min. 14m-	Dual 8m or 12m	Min. 5m	Min. 6m
Distributor Road (Local and District)	18 - 30m	10 - 14m	7.4 - 9m 1.2m footpath and/or 2.0m DUP on 1 or both sides	Min. 5m	-
Collector Road	14 - 20m	8.5 - 10m	6 - 7.4m 1.2m footpath or 2.0m DUP 1 side	Min. 4.5m	-
Access way	12 - 16m	8.5m	5m	3 - 4.5m	-
Access Place	10 - 12m Cul-de-sac Min. 28m	4.0 - 8.5m	4.5m Cul-de-sac Min. 10m radius	Min. 3m	-
Private Battle-Axe Single or Multiple Properties	4 - 6m	-	3 - 4m	Min. 0.5 - 1m	-

The road reserve is required to accommodate a variety of pedestrian and vehicular activities as well as public utilities and drainage. It should of a width to be safe for the various people who use it, contribute to the amenity of the area and be able to reasonably carry out its designed transport function. The transport function shall include the consideration of recycling and waste bin empting. Liveable Neighbourhoods document produced by the Western Australian Planning Commission includes community design, movement network, lot layout, public parkland, urban storm water management, utilities, activity centres and employment and schools.

The road reserve and paved road widths are determined by undertaking a Transport Assessment of the development and determining the appropriate street type from the Liveable Neighbourhoods document. The generally accepted traffic generation for Busselton and Dunsborough may be taken as 8 single vehicles trips per day per standard family dwelling (due to the high holiday home ownership), where peak assessments are required (school holiday periods) a value of 10 single trips per standard dwelling is to be used. Other transport generation rates can be taken from the Transport Assessment Guidelines documentation. A structure plan showing the total local area (including adjoining areas) and a subdivision layout is required to effectively evaluate a proposal.

Cul-de-sac Land Reserve Dimensions - The cul-de-sac head is a service area to adjoining properties. It must facilitate services, vehicle turning and manoeuvring by service vehicles within the road reserve. Connecting access ways or lanes are preferred, however, for a cul-de-sac, the City's requirements are:

- For a circular cul-de-sac head, a 28 metre 'diameter' reserve being 10 m radius and 4.0m pinch points where it can be shown that all services and access can be accommodated without impacting on safety.

- For a hammerhead (Tee) cul-de-sac head, as per Liveable Neighbourhood documents must be able to accommodate a rubbish truck (tandem axle) making a three point turn.

3.2 General Urban Road Design Criteria

Roads shall be designed to give the best possible grade to suit the natural ground conditions.

The general maximum longitudinal grade shall be 10% (1 in 10) for Neighbourhood Connector and Integrator Arterials. Access Streets may have grades up to maximum of 15% and up to 20% where it can be shown that access can be provided within limiting safety, concrete trucks will not spill and future maintenance will not be onerous.

Access streets and Neighbourhood Connector roads may have a 1 way crossfall, if design and construction advantages occur, and drainage appropriately designed where natural crossfall occurs. Generally, pavements shall have a 2 way crossfall. Pavements cross fall should not exceed 3% unless specifically designed for super elevation. One way crossfall shall be 2% unless design is for super elevation. These conditions do not apply on horizontal curves where the requirements of super-elevation or 1 way crossfall to match design speed and radius may apply.

Verges shall be designed to have sufficient width for the provision of drainage, trunk and reticulation services and to properly service the adjoining properties. Verges shall be generally graded at a slope of 2% upwards to the property boundary from the top of the design kerb. Verges on roads with a pavement width of 7.2 metres or less, must have a verge grading of 2% upwards from the top of kerb for at least the first 3 metres then graded up to 10% to or within the property boundary. Verge width shall be as shown on Table 2.0 - Urban Area Road Hierarchy. Verge gradings must take into account side sloped swale drains, where applicable.

Minimum longitudinal gradient for urban roads is to be 0. 6% with raised kerbing, flush kerb roads may have 0.0% longitudinal graded.

The minimum specified verge width shall be achieved irrespective of road curvature. The maximum slope across a median for a kerbed dual carriageway road shall be 10% (1 in 10) unless the median has a swale drain.

Street lighting shall be designed and plans approved by the City and Western Power and constructed in all urban roads, at all intersections, at all traffic management devices, ends of all PAW's and to property entries of all major developments. Street lighting is required in all urban areas in accordance with the lighting categories in AS/NZS 1158.1.3 - road lighting standards:

- Category V lighting - Visual requirement of motorists - eg traffic routes.
- Category P (1-12) - Visual requirements of pedestrians - eg paths.

Street light poles shall be standard Western Power type unless specific approval of the City is given. The City will require Light Emitting Diode (LED) lights to be installed. Design shall include full infrastructure requirement to install the approved lighting and removal of any existing infrastructure.

ROAD HIERACHY	LIGHTING CATEGORY (REFER TO AS 1158)
Primary distributor roads	V3
Integrator roads • City distributor integrator A • City distributor integrator B	 V3 V5
Neighbourhood connector roads	P3
Access roads	P4
Laneways	P4-P5
Public areas	
Pedestrian thoroughfares, shared paths, underpasses	Refer to specific situations on AS 1158.3
• Public carparks	P11-P12

Commercial areas are to be designed to Road Lighting Category V1.

Major car parks and Shopping Centres are to be designed to Road Lighting Category p 11 and 12.

3.3 Specific Road Design Criteria

Roads shall be designed to the criteria detailed in Tables 3.1 - 3.3 in accordance with the width of road.

TABLE .3.1 - Design Criteria - Urban Roads Pavement

Desirable Speed	30 kph	40 kph	50 kph	60 kph
Horizontal Curves Radius	To suit road layout		100 to 300 m	500 m
Cul-de-sac head	10 m	10 m	Not Applicable	Not Applicable
Intersection Radii	10 m	10 m	15 m	15 m
Crossfall	2%	2-3%	3%	3%
Sight Distance Design Speed	60 kph	60 kph	60 kph	70 kph

TABLE .3.2 – (To avoid braking or deviation by moving vehicle) Sight Distance Required by Stationary Vehicles

	More important road has two running lanes		More important road has four running lanes	
Sight height for driver of the stationary vehicle	1.2 - 1.2m	1.8 - 1.2m	1.2 - 1.2 m	1.8 - 1.2m
Design speed of more important road (km/h)	metres	metres	metres	metres
40	80	110	90	125
50	100	140	115	155
60	120	170	140	185
70	140	200	160	215
80	160	220	185	245

SIGHT DISTANCE - ALL ROADS

- CURVES to provide stopping sight distance to 0.2 m object at design speed.
- CRESTS to provide stopping sight distance to 0.2 m object at design speed.

TABLE .3.3 - Nominal Pavement Specifications (minimum)

Pavement Depths	Base	Seal
Battle-Axe, Access Place or Way	200mm gravel / rock base or 250mm limestone	30mm AC (gravel) or 30mm AC on (Limestone) with an emulsion tack coat – urban 7/10mm primer seal and 10mm final seal – public/rural roads 10mm simple seal for battleaxe legs.
Collector Road	250mm gravel/rock base, or 200mm limestone and minimum 75mm gravel or rock base	30mm AC (gravel base) or 40mm AC on Limestone 250mm base – urban primer seal and final seal coat 7/10 and 10mm – rural
Distributor Road	300mm gravel/rock base, or	30mm AC gravel 300mm base –

	250mm Limestone and minimum 80mm gravel	urban primer seal and final seal coat 10mm and 14mm – rural
Arterial Road	350mm gravel/ rock base, or 300mm limestone and 100mm gravel/rock base	10/11mm stone chip primer seal and final coat seal replaced by 30mm AC at intersections

- Interlocking block or brick paving to be used only with the approval of the Director, Engineering and Works Services and only on battleaxe, access places and ways or collector roads.

- Laterite based, coloured pavement asphalt may be used for access places and ways, footpaths, shared paths and parking areas. A prime coat must always be used.

- Laterite aggregate may be used on minor roads with approval of the Director, Engineering and Works Services who will require professional design and that best quality materials are used.

- Pavement specifications may vary when tests and design calculations are carried out and presented for approval. Special conditions will require specific design.

REFERENCE/LEGEND

- Guide Policy for Geometric Design of Major Urban Roads – AUSTROADS.
- AC = Asphaltic Concrete.
- Interim Guide for Design of Intersections at Grade – AUSTROADS.
- Roundabouts: A guide to Application and Design – AUSTROADS.
- Roundabouts on Bus Routes - MTT (Perth) 1982.
- Guide to Traffic Engineering Practice – AUSTROADS.
- Guidelines for the Design of Bicycle Facilities – BIKEWEST.
- Signs Standard – Australian Standards.

Cul-de-sacs for access ways shall have a minimum head radius of 10 metres for a round head design and 20 metre entry/exit radius with 1 in 10 tapers. Alternative configurations are allowed but must address 12 metre radius truck turns.

Battleaxe entry legs shall be kerbed and drained in accordance with access place requirements described within this specification. A minimum 0.5 metre wide verge outside kerbing shall be provided on each side of the battleaxe entry pavement for clearance of vehicles to fences and to contain services. The battleaxe road shall have a vertical alignment horizontal alignment and pavement thickness to meet an access way road specification. Variation of pavement type and thickness shall be to the approval of the Director, Engineering and Works Services. The battleaxe entry crossfall shall not exceed 3% either 2 way or 1 way. Following construction to the City approval and subdivision clearance, the City has no further role with maintaining or managing battleaxes. Designers should arrange for the installation of service ducts, for the full length of battleaxes, prior to pavement construction.

3.4 Earthworks and Re-contouring

Design criteria for re-contouring and earthworks for Urban areas are as follows:

Many areas of the City of Busselton are subject to high water tables, poor permeable soils and flat surfaces leading to drainage problems. The standard of fill is to meet the following criteria:

- No greater than 5% by weight of soil fractions passing the 75 micron sieve.
- All fill is to be clean sand with less than 1% clay content.

The maximum grade across earth worked and re-contoured blocks and developed areas shall be generally 1 in 10 boundary to boundary. The minimum grade of lots should be 1% graded toward the road boundary. The minimum lot fill level shall be 100 mm above the road centre line or at least 100 mm above the 1 in 100 year return flood path flow or level as detailed in the Storm Water Management Plan.

Earthworks for public access ways (PAW) and battleaxe entries (BE) shall have a general level cross section depressed from the boundary to boundary level of the lots, to provide flood route drainage. The maximum longitudinal grade of PAWs shall be 1 in 12 unless specific measures can be designed. The maximum grade on a BE shall be 1 in 5.

Re-contouring of land adjacent to State Roads shall match the boundary levels specified by Main Roads WA.

Re-contouring and earthworks on public open space (POS) shall be to a maximum grade of 1 in 6. Under certain circumstances, the Director, Engineering and Works Services may approve grades up to 1 in 5.

The clearing of the area of re-contouring and earthworks including roads, lots, POS, PAWs and BE's, etc. shall be strictly designed and planned to the City's requirements. Landscape plans are to be approved prior to commencement of works. Topsoil shall be removed, stockpiled and respread on batters, embankments, POS and other earth worked areas to encourage vegetation regrowth. Clearing must be restricted generally to those areas which require earth working and as approved by the City. Design and plans should address retention of vegetation imported by accurate survey. Stabilisation of verges is required by mulching and/or seeding and fertilising with an approved mix. The City may require a native plant seed mix where re-vegetation is required.

Drainage basins shall have stabilised maximum side slopes of 1 vertically to 6 horizontally where unfenced and 1 vertically to 1.5 horizontally where approved safety fencing is provided. Where fencing is constructed, maintenance access to and around the basin shall be allowed. Sub-soil drainage and storm water drainage connections, if required, shall be designed and provided.

Earthworks shall address site classification details by testing (showing recordings for each lot) and certification of each and every lot by a qualified and practicing Civil Engineer, who is a member of the Institute of Engineers Australia. Every effort should be made to achieve a site classification of 'A'. Where a site classification other than 'A' (ie: 'S', 'M' or 'P') is determined, a Section 70a notification is to appear on the title. This is to provide advice to purchasers of the land that additional site costs will be incurred at time of building where the classification is other than "A".

Engineered retaining walls are required where greater than 150 mm depth of fill abuts existing lot/development. Where retaining walls are greater than 500 mm in height, a building licence is required. Where retaining walls exceed 1m in height, design submissions are to be certified by a structural engineer.

3.5 Storm Water Design

The City's urban and industrial areas are generally low lying with high ground water tables. Storm water design is generally based on hydraulic grade line principles to avoid large diameter pipes and shallow soakage, and to protect the environment, retention areas need to be provided wherever possible. Subdivisions and developments need to be planned at an early stage to ensure adequate areas are set aside for drainage basins. An overall strategy is strongly recommended and may be required by the City.

3.6 General Storm Water Design Criteria

Developers of land for urban or industrial purposes are required to provide a drainage system designed to collect and absorb a once in 1 year storm or transmit a once in 5 year storm to the disposal points. Major event of 1 in 100 year storm flood flow shall be accommodated to flow to disposal points, via approved flood paths. Depth of flood water for 1 in 100 year design shall not be greater than 150mm on road centre line or in PAWs at any point.

Drainage designs are to comply with the Department of Water manual "Storm water Management Manual for Western Australia". The guiding principle documents for the City are aligned with the Department for Planning and Infrastructure document titled "Better Urban Water Management" and the Department of Water draft document titled "A Draft Water Quality Improvement Plan for the Vasse Wonnerup Wetlands and Geographe Bay".

Element 5 of 'Liveable Neighbourhoods' contains guidance on integrating stormwater into public parkland

This element gives consideration to water and demonstrates how the consideration of water resources can be integrated into the land use planning system to ensure best practice urban water management outcomes are achieved on the ground, and are consistent with 'State Planning Policy 2.9 Water Resources'.

The levels of detail and process timelines required are consistent with those of the land use planning system.

It is recognised, that in order to achieve water sensitive urban design, implementation of the recommended approach must be supported by a broader, complementary program that addresses key issues, assumptions, tools, monitoring, assessment and learning.

This approach is only one facet of the capacity building that will be required to achieve total water cycle management in Western Australia. It is also noted that the information requirements identified in this document do not constrain the Department of Water or the Department of the Environment and Conservation from requesting additional information where it is considered necessary to address a specific environmental issue.

'Better Urban Water Management' provides a framework and hierarchy of planning and water management documents to be prepared as a development proposal progresses from Strategic Planning, to Metropolitan Regional Scheme and Town Planning Scheme Zoning, to Structure Planning and then to sub-division and lot development. This is outlined in the Figure 4.2.

This guideline is principally aimed at the detail required at the subdivision and development phases; however it forms part of the overall process. The designs developed utilising this guideline must be consistent with and implement the strategies, objectives and concept designs approved in the preceding District and Local Water Management Strategies.

Co-efficient of run-off may be nominally taken (in the absence of detailed calculations) as 80% from of the total road reserve with an appropriate contribution from adjacent areas if the soil has high clay content.

A co-efficient of run-off of 90% shall be used for commercial, industrial and group dwelling sites. Surplus storm water drainage from commercial and industrial properties is to be directed to the available City drainage system. The City requires on-site retention equivalent to 15 minutes time of concentration on commercial and industrial and group dwelling areas.

For storm water drainage the minimum time of concentration to the first gully pit is to be 6 minutes for an underground drainage design, for commercial, industrial and grouped dwelling properties that comply with retention and detention requirements of the City at the net rate of 1 m^3 per 100 m^2 the time of concentration may be 15 minutes.

Where underground drainage and raised kerbing is provided, side entry gullies shall be placed at low points, on the upstream side of intersections (if the flow warrants it) and at intermediate positions to limit the width of flow in the gutter to 1.5 metres or 2 metres where there is one way crossfall. For access ways and access roads this can be extended to 2.5 metres. Grated gully tops may be used where pedestrian or vehicle access makes a side entry gully unsuitable. Gutter design shall contain storm water design flow within the pavement and kerb face.

The underground pipe system shall be designed to have the capacity to handle the design rainfall interval with the design top water level in gullies 150 mm below the surface and in access chambers 300 mm below the surface. Energy losses in access chambers and gullies shall be allowed for per Section 12.3 of "Australian Rainfall and Run-off" and all pipe work is to be laid at de-silting grades. No adverse grade may be used and inverts shall be free draining.

Storm water runoff should be retained onsite using vegetated swales or shallow depressions which have capacity to contain the runoff from at least a 1 hour 1 year Average Recurrence Interval (ARI) rainfall event.

Where WSUD is not used on POS areas the kerbing profile adjacent to the POS should be barrier to prevent intrusion by vehicles. It is preferred to place barrier kerbing adjacent to POS rather than install bollard fencing which causes major maintenance problems in the future.

The City supports gullies with 300 mm silt traps with soakage bases, swales along POS, arterial roads without frontage and central median drainage. Where the base of the gully is within 100mm of the Average Annual Maximum Ground Level (AAMGL) no silt trap will be required.

Direct drainage or discharge of storm water shall not be permitted into any wetland. Storm water runoff from at least 1 hour 1 year average recurrence interval (ARI) rainfall event shall be retained and treated within the development area. Overflow

from larger rainfall events may be permitted subject to the pre development hydrologic regime of the wetland not being altered.

Stormwater basins are to be sized as per Better Urban Water Management manual produced by the Department of Planning and Infrastructure.

A separation of 300mm is required between the invert level of drainage basins and the controlled groundwater level (CGL) or maximum groundwater level.

Detailed calculations shall be submitted to the Director, Engineering and Works Services. Alternative storm water disposal design will be considered when supported by calculations and site tests.

Generally, storm water drainage pipes shall be laid in straight lines between the 3.2 and 4.2 metre alignments from the road reserve boundary. Pipes shall not be run directly under kerbs lines. All junctions shall be at gully or manhole positions.

Nutrient stripping, [gross pollutant traps (GPTs) if required] and settlement basins designed in accordance with the Department of Water Guidelines, will be required prior to discharge to water courses, estuaries, conservation areas or the ocean. Past practice of direct discharge is no longer acceptable for environmental reasons and at source or in line retention, treatment and disposal is the favoured methodology. GPTs are to be suitably located to enable access for maintenance purposes.

Basin swale, open drain or artificial wetland design must address the pollutant removal and nutrient retention and infiltration capacity of the natural and/or the importable soil by soil testing. Silt retention settlement is taken to occur as part of basin size and location must be planned and allowed for in subdivision/development layout planning and provide for maintenance access, landscaping/re-vegetation with suitable nutrient stripping plant species.

For open unfenced basins not greater than 1 in 6 batter slopes, all basins are to incorporate inflow, outflow and overflow structures. Top water level design shall be advised and used to design the minimum fill and finished floor levels for adjoining and nearby lots.

Swale drains and soil water dispersal techniques are acceptable in suitable conditions and where they meet set criteria. Test on water infiltration capacity of the soils may be required.

Construction shall only be in suitably porous sand areas. Sand percolation rates to be satisfactorily demonstrated. Where ground water table is higher than 300mm from surface at any time, swales are not acceptable.

Swale drains may not be used for transferring storm water to outlets or for water storage purposes. They are intended to drain only the immediately adjoining equivalent impervious area where the soil and ground water levels are deemed to be suitable. Similarly the soil water dispersal techniques where roads adjoin public open space and undeveloped verge areas capable of soakage.

Swale drains in built up areas should be 150mm deeper than the top of adjoining flush kerb or road seal edge with side slopes of not greater than 1 in 6. Road cross fall should be crowned in the area of swale drainage and be at not greater that 2%.

The swale drain batters shall be stabilised against erosion by wind and water. Crossovers, driveways and verge landscaping should follow the profile of the swale.

Where swale drains are subject to storm water flow, or storm water is retained for longer than 10 hours after any storm event an underground pipe system shall be provided. Particular regard is to be given to intersection where mountable kerb is required on sweeps to control vehicle paths. This will cause a concentration of storm water and an excess flow to the swale, requiring an underground system to support the soakage characterisation of the soil.

Drainage connections from private property will be required to be via manholes or gullies before or discharge into the City drainage lines or open drains. Property connections may only be made with the specific approval of the City and will attract a connection fee covering administration, inspection and supervision. Where drainage from private property involves carpark, natural ground or paved surface drainage a silt trap will be required within the property.

Sub-soil drainage will be required to protect roads, access ways and property from high ground water levels. Ground water shall be controlled to a level that does not exceed 150 mm from top of lowest part of the subgrade.

Ground water shall be controlled to levels not higher than 1200 mm from finished floor level on urban and industrial lots unless with supporting documentation, on a scientific basis, that the land can be acceptably drained to the satisfaction of the City and the Department of Environment.

Subsoil drainage shall be designed to address soil saturation and isolated springs, and take into account:

- The direction of soil water flow;
- Back flooding from storm water systems (may be combined with storm water);
- Silting and clogging avoidance (filter material);
- Soil porosity and flow rate;
- Maintenance using high pressure water or cleaning rods. Smooth bore pipes shall be used; and
- Impact on pavement design – allow for saturated subgrade.

Headwalls shall be designed to dissipate flow energy and width from pipe/culvert to the stream outlet and for the erosion potential of the storm water while retaining the embankments slope inlets and/or at the outlets.

Design is to be based using stone brick or block in urban and rural residential and tourist areas whereas precast or cast insitu types maybe used in agricultural areas or on major water courses. Wing walls shall be angled at 45^{O} away from the direction of flow and designed to fully retain the adjoining soil.

Spillage aprons are required but shall be concrete insitu or precast material and energy dissipation will be required to be incorporated if the velocity of flow is greater than 2 metres per second.

Reflux (non-return) valves shall be an approved type and be provided where backflow of water may occur at outlets - such at ocean outlets. Ease of operation, removal and maintenance are basic criteria to be addressed in selection of the type of valve.

All works shall be required to show how the land can be drained and connected to the district drainage (comprehensive scheme).

Main Drainage contributions apply to Dunsborough catchments, Busselton Central Business District and its immediate environs and Geographe.

3.7 Catchment Size

All developers and Subdividers with land in a common catchment area have a joint responsibility to ensure that the whole fully developed catchment area (including arterial roads) will be served by an effective drainage system. When only a portion of a catchment is being developed at a particular time the drainage strategy for the whole area must be determined. Subdividers are responsible for arranging their own cost sharing arrangements including for a catchment survey. The Subdivider shall provide, the necessary drain and compensating basin system capacity to carry and store storm water from upstream and within the development area.

Where storm water drains are to be connected to existing drains under the City's control, or where otherwise required by the City, the Consulting Engineer shall submit a drainage catchment plan at the same scale as the layout plan.

The drainage catchment plan shall indicate catchment boundaries, contours, area of each catchment and design run-off. As a general rule the drainage discharge from the development shall be no greater than the natural or the flow prior to development.

The consulting engineer shall include in design, run-off from catchments upstream of the proposed development.

3.8 General Storm Water Design Details

Gullies, manholes, silt traps, basins, subsoil and storm water pipe installation, headwalls and fencing are to be in accordance with approved standard detail drawings.

Gullies shall be universal side entry type, except at crossovers/driveways road widenings where grated tops may be used. This requirement is based on the relevant efficiencies and capacity under all conditions of the two types of gully.

3.9 Easements

Drainage easements through private property are required, where it is necessary to dispose of or transport storm water including subsoil drainage through a lot or lots.

A standard condition of subdivision or development for easement/s may be applied.

For storm water pipes the width of drainage easements is to be based on the depth of the storm water pipe and the angle of repose (45º).

4 Industrial Areas

4.1 Road Hierarchy Planning

A road hierarchy shall be developed as outlined previously and in accordance with Table 4 - Industrial Area Road Hierarchy.

TABLE .4.0 - Industrial Area Road Hierarchy (two way roads)

Road Classification	Reserve Width	Pavement Width	Verge Width
Highway	MRWA	MRWA	MRWA
Distributor Roads	20 - 25 m	10 m	5 - 7.5 m
Collector Roads	20 m	9 m	5 m
Local Roads, Ways	20 m	7.4 m	5 m

Variations shall be approved by the Director, Engineering and Works Services.

Provision shall at all times be made for services including the requirement of storm water pipes and/or swale or open drains to drain the road and properties, to be constructed in the road verge.

4.2 General Road Design Criteria

General road design criteria shall be in accordance with Section 3.2 of this specification - General Criteria for Urban Roads, except for the following variations:

- Cul-de-sac and Battleaxe shall not be used due to the turning circles, over-width/over-length requirements of commercial/ industrial vehicles;
- Maximum longitudinal grade should be 6% (1 in 16.7) on Distributor roads 8% on Collector roads and 10% on Local roads.

Verge width shall be a minimum of 5 metres.

Storm water shall be disposed of in accordance with Section 3.5 of this specification.

All industrial intersections and junction corner radii shall be semi mountable kerbed to a 15 metre radius except for connections to Arterial Roads where the layout shall be to the specification of MRWA.

4.3 Specific Road Design Criteria

Roads shall be designed to the criteria detailed in Table 5.0 in accordance with the width of road. Truncations shall not be less than 10 metres.

TABLE .5.0 - Design Criteria - Industrial Roads

CRITERIA	ROADS WIDTH		
Seal Width	**7.4 m**	**9 m**	**10 m**
Design Speeds	60 km/h	60 km/h	70 km/h
Horizontal Curves			
Radius (minimum)	50 m	100 m	200 m
Crossfall (kerbed)	3%	3%	3%
Crossfall (flush kerbed)	2%	2%	2%
Edges	All industrial area roads shall be kerbed.		
Nominal Pavement Depths			
Sub-base, Base, Seal	250mm gravel or rock base and 30mm AC with prime, or 200mm limestone plus 100mm gravel or rock base, and 30mm AC, or 300mm limestone with 40mm AC.		

4.4 Earthworks and Re-contouring

Design criteria for re-contouring and earthworks for Industrial Areas are as follows:

Industrial areas shall be re-contoured and earth worked to provide suitable access and grades for sewerage disposal, storm water drainage pipes, storm water run-off from lots, large structures and storage areas requiring level pads and to meet the grade requirements for large, over-length and over-width commercial vehicles.

The maximum grade across blocks shall be 1 in 15. The lots shall grade to the road centre line at not less than 1% and be filled to not less than 100mm above the road centre line. The minimum fill level required should also address 100 year flood levels.

The vegetation in the area requiring re-contouring and earthworks shall not be cleared of trees, shrubs and vegetation until a survey identifying it is completed and a clearing plan is approved by the City.

Topsoil shall be removed, stockpiled and respread on batters, embankments, POS and other earth worked areas to encourage vegetation regrowth. Clearing, should be restricted generally to those areas requiring earth working. Retention of vegetation is strongly encouraged.

No spill or cut intrusion into adjoining land is permitted unless with the express approval of the landowner including reserve land. Retaining walls shall be designed and a plan submitted to enable the developer to retain cut or fill within the development land.

5 Rural & Special Rural Areas

5.1 Road Hierarchy Planning

A road hierarchy shall be developed as outlined in Section 3.1 on page 13 and in accordance with Table 6.0 - Rural and Special Rural Area Road Hierarchy.

TABLE 6.0 - Rural and Special Rural Road Hierarchy

Road Classification	Reserve Width	Pavement Width	Formation Width
Highway	refer MRWA	refer MRWA	refer MRWA
Distributor Roads 1,000 - 6,000 vpd	25 - 40 m	7.4 m seal + 1.5 m paved shoulders	10 - 12 m
Collector Roads 200 - 1,000 vpd	20 - 25 m	6.0 - 7.4 m + 1.2 m shoulders	8 - 11 m
Local Roads and Cul-de-sacs <200 vpd	16 - 20 m	5.0 - 6.0 m + 0.5 - 1.2m shoulders	7 - 9.5 m
Battle-Axe	5 - 10 m	with passing lanes 3 - 4 m + 0.5 m shoulders	4 - 6 m

Variations to these standards shall be approved by the Director, Engineering and Works Services.

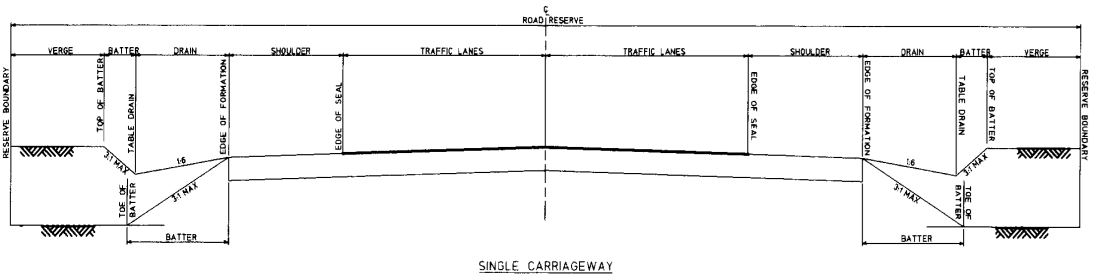
Provision shall be made in the road reserve for overhead and underground services.

Battle-axes to be sealed when Lot sizes $\leq$ 20 hectare and they adjoin a sealed road.

5.2 General Road Design Criteria

Roads shall be designed to give the best possible grade to suit the natural surface conditions. The general cross section shall be in accordance with Figure 1. Variations may be allowed to address circumstances at specific locations.

FIGURE 1: Typical Cross Sections For Rural & Special Rural Roads



The general maximum longitudinal grade shall be 10% (1 in 10) for major roads, 15% for through local roads and up to an absolute maximum of 20% (1 in 5) for access places. Special provision shall be made for surface life and maintenance and for road drainage of slopes greater than 12%.

All roads with a longitudinal gradient greater than 10% shall be asphalted.

All changes of longitudinal grade of more than 1% shall be joined by a designed vertical curve.

Raised kerbing pavements shall have a 2 way (crowned) crossfall of 3%, however, for horizontal curves, 1 way crossfall or super-elevation shall be applied. Flushed kerbed pavement crossfall shall be 2%, crowned and 2 way.

All rural intersection and junction corner radii shall be semi mountable kerbed to a 15 metre radius except for connections to Arterial Roads where the layout shall be to the specification of MRWA. Special rural road radii shall be 12m radii and urban 10m radii at road junction corners.

Table drains shall be provided for all roads, where the verge levels are higher than the road shoulder. Where the verge is lower by not less than 100mm for a distance of not less than 4 metres from the edge of the shoulder, table drains are not required. This is the preferred design where soils are suitable, for rural and special rural roads to overcome the need for drainage provision. Rock pitching of table or open drains may be required where grades of table or open drains exceed 2% and shall be provided for grades of 5% or greater. Kerbing may be used where drainage or clearing advantages can be demonstrated.

Roadside batter slopes shall be stabilised planted and protected from erosion by wind and water. Details shall be included on plans for approval.

The City will require roads to be sealed where it is believed peak traffic generation exceeds 150 vpd, including for wineries, restaurant, industrial or commercial development.

Where access to a rural subdivision is from a distributor type road lighting of the intersection is to be provided at the developers cost.

Where roundabouts and traffic medians have been constructed street lighting will be required.

5.3 Clearing Width

The City promotes and encourages the retention of trees and understorey vegetation on road verges wherever practicable. **The City approval must be obtained prior to any clearing in road reserves and reserve areas**. Approval may also be required from the Department of Environment and Conservation (DEC).

The width required for clearing to accommodate the earthworks for the carriageway is influenced by many factors. Some of the factors to be considered are:

- Areas where special roadside vegetation exists (declared rare and significant flora, or flora which is a significant habitat – DEC must be consulted);
- Design speed sight distance;
- Drainage requirements;
- Road classification and traffic type;
- Terrain and soil type;
- The locality; and
- Vegetation type.

A wide road reserve or adjoining buffer strip may be required for the express purpose of protecting and conserving natural vegetation.

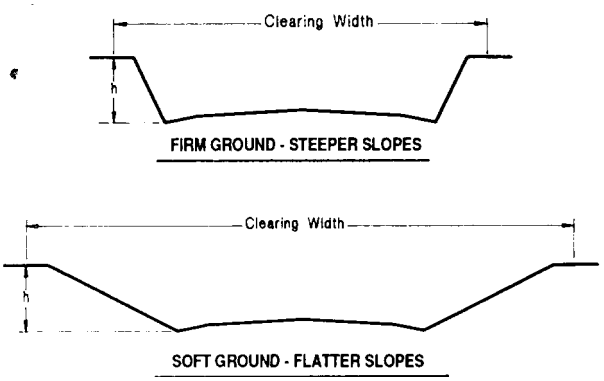
The width of clearing required to carry out the earthworks for the road must be based on engineering needs and not the width of the road reserve.

The width on either side of the carriageway used to accommodate the table drain and batters requires careful site specific consideration to ensure that there is minimal disturbance to roadside vegetation.

Tables 3.1 - 3.3 provide a guideline for suggested clearing width for the categories of roads defined in Table 2.0.

5.4 Design for Minimum Clearing

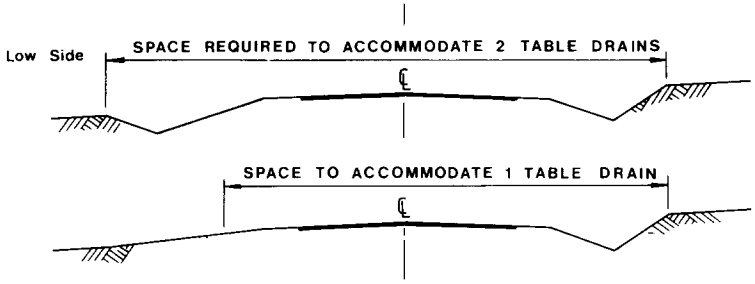
The batter slopes for cuttings, embankments and table drains may be varied, depending on soil type and slope stability, to reduce the space occupied by earthworks.



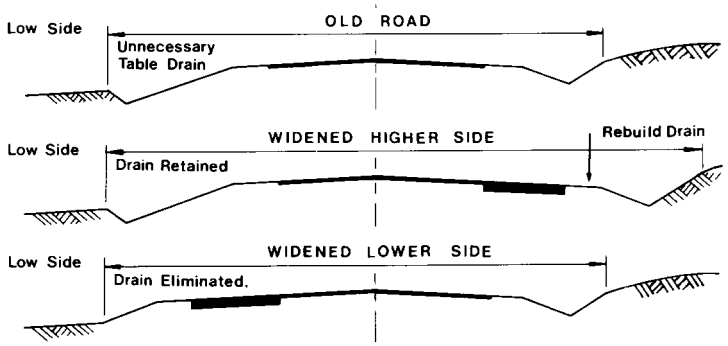
Common trenching, underground power, variations to standard alignments and single side servicing, are factors to be pursued by the Consulting Engineer. Plans are to be presented for approval and the site pegged for inspection prior to commencement.

At its meeting of 13 December 1995, the Council resolved "It be a requirement of the City's approval of engineering designs for subdivisions that common trenching of services be carried out unless in appropriate in those particular circumstances on the basis of the economic, environmental and community benefits that can be achieved".

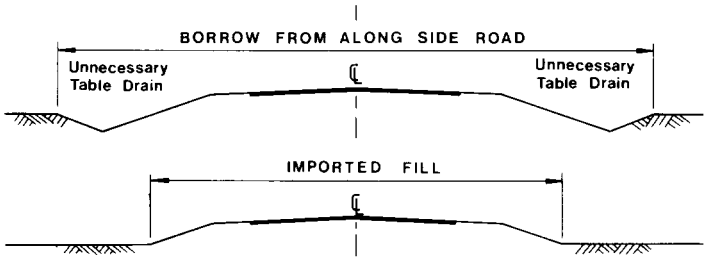
To save space, table drain width and depth may be reduced where drainage needs permit. Installation of kerbing (generally mountable) can be used to assist these aims. Construction of a table drain on the lower side of the road should be avoided, by raising road levels wherever practicable.



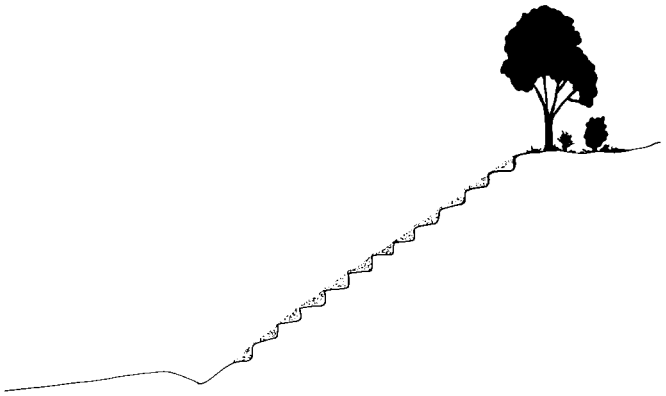
Widening of a carriageway should be on the low side of the road, where appropriate, to reduce the space required for earthworks.



Import fill from off site for the embankment, to avoid side borrow from alongside the road.

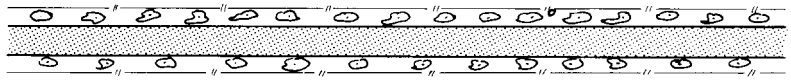


On wide batter slopes use step slope techniques to retain replaced topsoil to assist vegetation regeneration and provide slope stability.

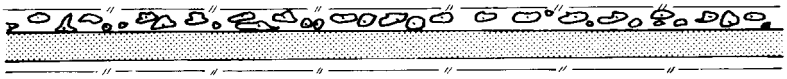


5.5 Roadside Width

Offset the carriageway to 1 side of the road reserve to enable a wider strip of vegetation to be retained rather than have 2 narrow strips.

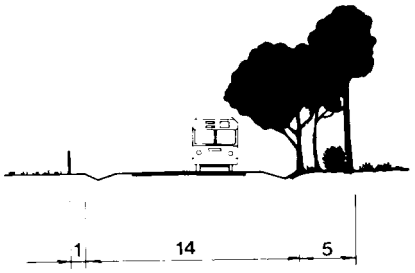


AVOID TWO NARROW ROADSIDES



ONE WIDE ROADSIDE IS PREFERRED

Widen the carriageway to the side where the vegetation is in the poorest condition. Retain the other roadside undisturbed. Where design and site conditions permit, the carriageway alignment may shift from 1 side of the road reserve to the other to maximise the retention of well conserved vegetation.



Widen to one side

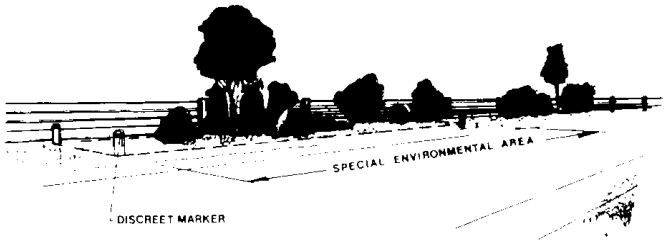
Widen road reserves for their conservation value at every opportunity.

Widen road one side
Widen reserve other side

5.6 Clearing - Protected Flora

Roads identified as having special environmental values should be subjected to specific planning and management considerations to ensure conservation of their value.

Sites containing declared rare and significant flora should be marked as Special Environmental Areas. Consultation with the Department of Environment and Conservation Officers is a statutory requirement under the Environmental Protection (Clearing of Native Vegetation) Regulations 2004 when declared rare and significant flora will be affected.



5.7 Specific Road Design Criteria

Rural and Special Rural Roads generally have higher traffic speeds than Urban Roads, therefore the requirements on design speed selection and matching geometric elements to design speeds are critical, especially for the higher speed values. All Special Rural roads shall be sealed and connect to a sealed road.

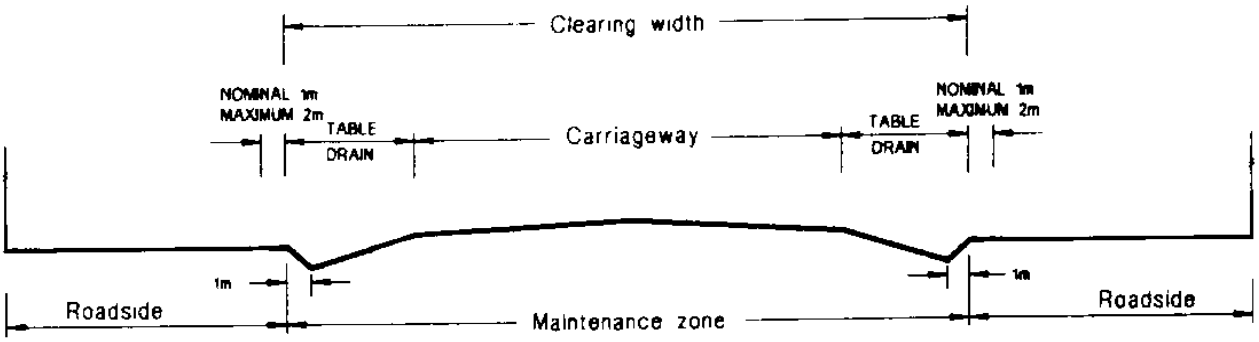
The roads shall be designed to the criteria detailed in Table 7.0 in accordance with the width of road.

TABLE .7.0 - Design Criteria Rural and Special Rural Roads

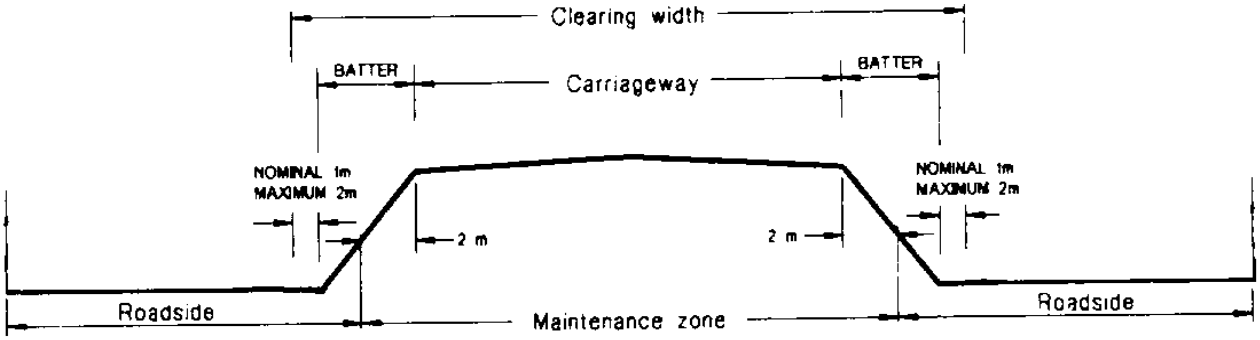
Criteria	Access	Collector	Distributor
Sealed Pavement width	4.5 m – 5 m	6 m – 7 m	7.4 m – 9 m
Pavement width	4.5 m - 6 m	7 m - 8 m	8 m - 10 m
Design Speeds	60 km/h	70 km/h	80 km/h
HORIZONTAL CRITERIA			
Radius Curves	50 m	100 m	200 m
Crossfall	2 - 3%	2 - 3%	2 - 3%
Radius Intersection	15 m	15 m	15 m
Cul-de-sac	10 m minimum	12 m	NA
Vertical Curves	Where change of grade is greater than 1%		
Pavement Depth	As per Table 3.3 - Urban Roads		
Surface Type	AC optional for all roads 25 mm minimum (gravel pave 30 mm)		
Traffic Lanes Access/collector Distributor	2 coat seal in 2 applications (12 to 24 months apart) 7mm followed by 10mm diorite or basalt aggregate 14mm followed by 10mm		
CROSS SECTION -			
Traffic Lanes	2.5 m – 2.75m	3 m – 3.5m	3.7 m
Shoulder	1.0m - 1.2 m	1.2 m - 1.5 m	1.2 - 1.5 m

REFERENCES

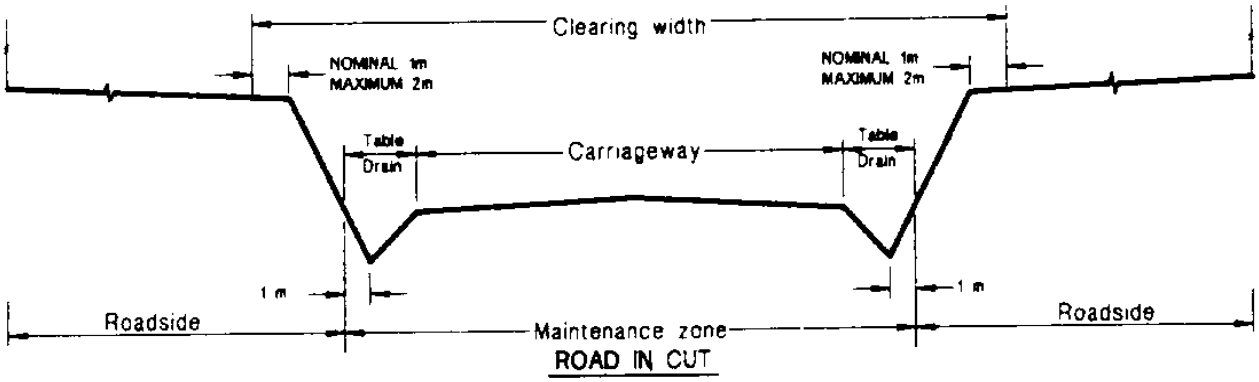
- Interim Guide to the Geometric Design of Rural Roads – AUSTROADS.
- Institute for Public Works Engineers Australia - IPWEA.
- Technical Specification for Supply and Laying of Hot Asphalt Road Surfacing.



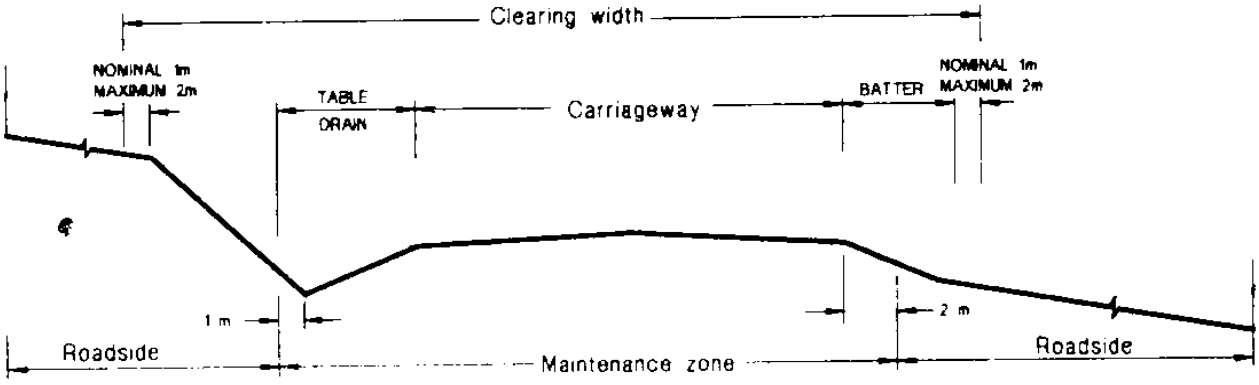
ROAD WITH TABLE DRAIN



ROAD IN FILL



ROAD IN CUT



ROAD IN SIDELING

Cul-de-sac heads shall have a minimum radius of 10 metres to the edge of seal, plus a 1.5 metre wide shoulder. The cul-de-sac head reserve shall be 28 metres minimum radius or 34 metres long if a “hammer head” is used.

Battleaxe roads for lots shall be constructed to a maximum 40 km/h design speed. The surface shall be sealed, including the crossover in Special Rural areas with at least a 10mm granite stone on a base of 200mm gravel or rock base; both base and sub-base 4 - 6 metres wide. Drains and fill batters shall be not closer than 0.5 metres to the edge of shoulder.

Where battleaxe roads are longer than 200 metres (straight) or 150 metres curved, passing pockets shall be provided as 25 metres x6 metres wide (total), one for each 200m or 150m length. Where battleaxe roads adjoin a sealed road in rural areas, and the lot/s are ≤ 20 ha, the battleaxe crossover area shall be sealed.

5.8 Earthworks and Re-contouring

Design criteria for re-contouring and earthworks for Rural and Special Rural and Industrial Areas are as follows:

The maximum batter on roads and properties shall be 1 in 3, in either cut or fill, extending from the table drain in cut or the edge of formation in fill, and stabilised, unless otherwise supported by approved retaining walls or batter protection.

Table drains, run off drains and drainage disposal areas shall be provided to the grades specified in Section 5.9 on page 36.

Re-contouring and earthworks on lots are not generally required.

5.9 Stormwater Drainage Design Criteria

Landowners subdividing rural land are required to make provision for future storm water drainage needs. This is to be in the form of drainage reserves or easements for storm water disposal suitable for providing drainage for the road system to natural water courses. A co-efficient of run-off suitable to the soil, terrain, extent of seal and impervious area in the final developed state of the subdivision together with any design runoff from adjoining land and water courses, shall be used to determine the size of culverts, open and piped drains and basins required. The standard design storm shall be a 5 year return interval storm. Discharge points from drains and culverts shall be to natural water courses.

Easements in favour of the City shall be provided in private property where no feasible alternative exists. Easements are not required for private property.

Flood paths (floodplain and floodway) shall be designed for a 100 return interval storm including overtopping for roads at culvert low points on roads and for location and levels of buildings. Compensating Basins shall be designed on a 1 in 10 year return interval storm. 1:100 year return interval storm top water levels shall be used to advise on finished floor levels for habitable buildings.

The Subdivider shall be responsible for drainage of the road as constructed at the time of subdivision release and shall engage qualified practising consultants to design and supervise the construction of any necessary culverts, pipe works, storage or soakage areas needed to control and dispose of storm water from the road reserve.

Drainage structures shall be such as to control and direct storm water via approved means and alignments to outlets, without undue erosion or siltation, and shall always make provision for extreme (1:100 year return interval) storms, by design and construction of secure over flow and spill way structures.

Easements where required and approved by the City shall not be less than 5 metres in width.

Maintaining natural flow lines, flow volumes and velocities where storm water discharge occurs is the objective to be practiced and taken into account when designing and positioning culverts and other drainage.

Discharge to natural flow lines and depressions, water courses and wetlands shall be of no lesser quality (nutrient and silt content) and at no greater volume or velocity than that which existed prior to development. Control is to be achieved by designed nutrient and silt settlement and compensating basins.

Nutrient stripping basin and structures shall be designed in accordance with the Department of Water manual “Storm water Management Manual for Western Australia”.

At source or in live nutrient stripping is more effective than end of pipe solutions. Design of nutrient basins (may be contained with compensating basins) commences at planning of the overall subdivision guide plan. Planners will be required to demonstrate that storm water drainage levels, storage and treatment has been addressed and that adequate area, including for fencing, landscaping, planting of nutrient stripping species, maintenance access, batter slopes and apparition from private property, have been taken into account.

Soil type and groundwater factors shall be accounted for in design.

6 Shared Paths & Footpaths

6.1 General

Shared paths and footpaths shall be provided in accordance with Liveable Neighbourhoods. Shared paths shall be designed and constructed in accordance with Austroads Section 14 – Cyclists.

The Consulting Engineer will be responsible for co-ordinating the alignment of the shared path and footpath with other features, and in particular, with underground services.

- Footpath width - 1.5 metres minimum;
- Dualuse Path - 2 metres wide (minimum); and
- Cycleways - 2.5 to 3.0 metres wide.

The preferred alignment for paths in road reserves is at the back of the kerb and/or with the edge not closer than 0.3 metres to the property boundary. The closest edge of a path to the kerb, where not constructed on the kerb line shall generally be 1.0 m, to avoid narrow strips of verge that are difficult to maintain.

Prior to commencing construction, the Consulting Engineer shall ensure that all relevant service authorities have been notified of the proposed footpath, and have given their written consent. The City will hold the Consulting Engineer responsible for obtaining these consents.

In general, concrete construction is used where the area may be frequented by traffic and where interrupted by crossovers. Asphalt may be used where the path is not frequently subject to cross traffic, such as through reserves and along roads with limited property access.

Technical details for the construction of paths is shown in Section 3.