PINE RIVERS SHIRE COUNCIL

DESIGN MANUAL

CIVIL INFRASTRUCTURE DESIGN

DESIGN STANDARDS

Part 1 Design Standards for Roadworks

Part 2 Design Standards for Stormwater Drainage Works

Part 3 Design Standards for Water Supply Works

Part 4 Design Standards for Sewerage Works

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DESIGN STANDARDS

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PART 2
DESIGN STANDARDS FOR STORMWATER DRAINAGE WORKS

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PART 2 - DESIGN STANDARDS FOR STORMWATER DRAINAGE WORKS

SECTION 5
SUMMARY DOCUMENT

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5.1 INTRODUCTION

This summary document contains figures and tables from the Pine Rivers Shire Council Design Standards for Stormwater Drainage Works. Its purpose is to provide the designer with a quick reference for drainage design. For further clarification, the designer should always refer to the supporting text in through the Design Standards.

This summary document also contains figure and tables required for addition to Volume 2 of the Queensland Urban Drainage Manual (QUDM). These include rainfall intensity tables, gully capture charts, road capacity charts etc.

Pine Rivers Shire Council periodically reviews the stormwater drainage design standards and accordingly this summary document. Comments and constructive criticisms are invited. They should be made in writing to The Director, Assets and Infrastructure Services Division, Pine Rivers Shire Council.

Finally, designers should note that alternative / innovative designs are welcomed, particularly those which can match the specified drainage performance criteria. These alternate designs however, will be assessed in terms of their environmental sensitivity, and their maintenance implications for Pine Rivers Shire Council. Alternative design concepts should be presented as early as possible in the design process to allow adequate time for review by Council prior to detailed design being finalised.

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5.2 DESIGN DOCUMENTS

Broadly, the hierarchy of technical documents to be used for drainage purposes is as follows: -

Stormwater Management Issue	Reference
Policy, Planning, Legal and Technical Requirements	Pine Rivers Shire Planning Scheme
Minor and Major drainage design methodologies	Queensland Urban Drainage Manual (QUDM)
Culvert and Bridge Hydraulics	Austroads Waterway Design Guidelines
Scour Protection and drop Structures (Chute blocks not permitted)	Queensland department of Transport – Urban Road Design Manual Volume 2
Sediment and Erosion Controls, Best Management Practices (BMPs)	Institute of Engineers Australia (Qld.) Soil Erosion and Sediment Control – Engineering Guidelines for Queensland
Waterway Quality Standards	ANZECC Guidelines
Runoff routing methods, rainfall analysis, flood frequency analysis etc.	Australian Rainfall and Runoff, 1987 Volumes 1 and 2
Permanent Water Quality	NCDC Guidelines

5.3 DEFINITIONS

5.3.1 Road Definitions

QUDM	Pine Rivers Shire Council Road Classification
Major	Arterial, Sub-Arterial, Trunk Collector, Collector Road (Industrial)
Minor	Bus Collector Collector Access street Access Place Collector Road (Rural) Access Road (Rural)

5.3.2 Land Use Definitions

QUDM	Pine Rivers Shire Council Town Planning Classification
Urban	1. Residential A 2. Residential B 3. Special Residential (Urban) 6. Central Business 7. Commercial 8. Local Business 9. Neighbourhood Facilities 10. Home Industry 11. Service Industry 12. General Industry 15. Future Urban
Rural	3. Special Residential (Non-Urban) 4. Park Residential 5. Rural Residential 13. Extractive Industry 14. Rural 16. Future Rural Living 17. Park and Open Space 18. Sports and Recreation

For the ‘Special Facilities’, Special Purposes’, and ‘Special Development’ zones, the QUDM classifications shall be determined by the Pine Rivers Shire Council for each particular site.

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5.4 GENERAL REQUIREMENTS

- All drainage whether internal or external to the site, or both as the case may be, relevant or reasonably required in respect of the proposed development shall be provided at the developer's cost.
- The developer shall pay a catchment headworks or Priority infrastructure charges to the Pine Rivers Shire Council to cater for trunk drainage works resulting form the additional downstream volume runoff and increased pollution loads generated by the development. The charge is based on the area developed. These charges also vary from catchment to catchment.
- Runoff rates and pollution loads shall not be worse on downstream properties. Further, calculated pollutant concentration from the development shall meet ANZECC standards.
- All dry weather runoff and first flush flows catering for the first 15 mm of rainfall from the development shall be treated prior to discharge in to the Pine Rivers Shires' receiving waters.
- Easements are required for all drainage paths. Roof drainage easements are only applicable to residential property.

The table opposite summarises the minimum drainage requirements for various land use types for minor storm events.

Pine Rivers Shire Council Minor Drainage Requirements

Town Planning Zone Reference Number	1, 2, 3A, 6, 7, 8, 9, 10, 11, 12, 15	3b, 4, 5	13, 14, 16	17, 18
Minimum Requirements	Pipe Drainage to all Locations	Pipe drainage Road generally in reserves only	Pipe drainage generally not necessary	<50 metres provide pipe drainage in Urban zones
	Catchpits in all Roads	Catchpits in all Roads	Table drains along roads	> 50 metres enhance existing watercourse overland flow path or drainage feature
	Field inlets	RCP / RCBC at cross drainage locations	RCP / RCBC at cross drainage locations	Use landscaped crossings (e.g. footbridges, stepping stones etc.
	Overland flow clear of allotments in Urban zones	Entrance culverts to allotments where no kerb and channel is provided	Entrance culverts to allotments	

Note: - See 5.3.2 for Town Planning Classifications

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5.5 QUDM MODIFICATIONS

5.5.1 Miscellaneous

5.5.1.1 Time of Concentration

For Urban, Business, Commercial and Industrial areas QUDM standard inlet times are to be used. The Kinematic wave and Bransby-Williams equations are not to be used.

For Rural areas, use methods specified by QUDM.

5.5.1.2 Minimum Pipe and Material Standards

The minimum standards for acceptable materials are: -

Stormwater Pipes	Roof and Allotment Drainage
SRCP Class 2 FRCP Class 2	SRCP Class 2 FRCP Class 2 u / M / O PVC Class SN 4 RRJ u / M / O PVC Dual Wall RRJ

The family of PVC pipes indicated above are not to be used in road reservations and public open space. All flush joint stormwater drainage pipes shall be fitted with sand bands or equivalent approved by Pine Rivers Shire Council.

5.5.1.3 Pipeline Location

Pipelines are not to be longitudinally laid under kerb and channel. Pipe connections from catchpit to catchpit is generally not permitted except at sags.

5.5.1.4 Grated Inlets and Outlets

Grates or trash racks may be required on stormwater system inlets where considered appropriate by a Pine Rivers Shire Council engineer. Specific designs shall take into account possible debris loading from the upstream catchment and the impact of potential system failure should the inlet become blocked.

Proposals incorporating pipe outlets greater than 450 mm diameter (or equivalent box culvert) may be required to provide outlet grates where safety and / or security may be an issue.

5.5.1.5 Drowned Outlets

Drowned outlets shall not be used without the approval of a Pine Rivers Shire Council engineer.

5.5.1.6 d_g V_{ave} Product

The d_g V_{ave} product shall be limited to 0.6m^2/s except where there is an obvious danger of pedestrians being swept away and drawned. In such circumstances d_g V_{ave} should be limited to 0.4m^2/s.

5.5.1.7 Road Drainage Practical Capacity

The practical roadway flow capacity to be used for design major storm shall be taken as 80% of the theoretical value unless otherwise approved by a Pine Rivers Shire Council engineer. This reduction to theoretical value is required to provide for some loss of capacity due to debris in the channel, perked vehicles and kerb and channel and pavement irregularities.

5.5.2 Design ARI's

Table of Design Average Recurrence Intervals

(i) Major System Design ARI (years)		100 (See Notes 1 & 2)
Minor System Design ARI (years)		
Zone		**Years**
Central Business, Commercial, Local Business, Neighbourhood Facilities		10
Service industry, General Industry, Home Industry		5
Residential B		5
Residential A, Special Residential (Urban), Future Urban		5
Special Residential (Non-Urban), Park Residential, Rural, Rural Residential, Future Rural Living		5
Park and Open Space, Sports and Recreation		< 50m – adopt 5 > 50m – enhance open watercourse (See Note 3)
Major Road	Kerb and Channel Flow	50 (See Notes 4 & 6)
	Cross Drainage (Culverts)	50 (See Notes 5 & 6)
Minor Road	Kerb and Channel Flow	Refer to relevant development category
	Cross Drainage (Culverts)	10 (See Notes 5 & 6

See Notes on opposite page.

Notes

1. Where the major system design flow is conveyed to an existing downstream pipe or channel drainage system and sufficient on-site detention to mitigate flows is unachievable, an appropriate major design ARI shall be determined by Pine Rivers Shire Council's engineer (generally not less than 50 years ARI).

2. Where augmentation of an existing undersized drainage system is required and topographic or other features limit the ability to convey the Major Storm flow, a Pine Rivers Shire Council engineer may review the Design Major Storm ARI.

3. Enhancement of the existing overland flow path, drainage feature or watercourse will require revegetation and, where necessary, the waterway area increased to cater for the additional runoff. To cater for this additional runoff a second high level channel should be constructed. This channel should be grassed and be set apart from the original watercourse. The levee separating the channels should be designed to be overtopped at the 2 to 5 year ARI level.

4. The design ARI for the minor drainage system in a major road shall be that indicated for the major road, not that for the development category of the adjacent area.

5. The Pine Rivers Shire Council requires that RCBCs be used for road crossings where a Pine Rivers Shire engineer considers that the stream debris load will be significant. Culverts under all roads should be designed to accept the full flow of the minor system ARI. In addition the designer must ensure that the 100 year ARI backwater does not reduce the required minimum freeboard for properties upstream. If upstream properties do not have the required freeboard, it may be necessary to install culverts of capacity greater than required for the minor system ARI to ensure that no increase in flooding of upstream properties occurs. In addition, the downstream face of the causeway embankment may need protection where overtopping is likely to occur. Design allowance for debris load and appropriate blockage factors shall be approved by a Pine Rivers Shire Council engineer. In urban areas the road crossing over the watercourse shall be depressed to ensure that any flows passing over the road shall be contained to a width similar to the natural flow width.

6. In situations where zones of differing ARIs abut the same road and are likely to share the drainage system, the design ARIs must be satisfied in all possibly affected zones. For existing zones or designs which cannot practicably fulfil the above requirements, Pine Rivers Shire Council may review the design ARIs.

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5.5.3 C Values vs. Land Use

The runoff coefficients (C values) given in this Table replace QUDM Tables 5.04.1, 5.04.2 and 5.04.3.

Land Use	C1	C2	C5	C10	C20	C50	C100
Central Business	0.72	0.77	0.86	0.90	0.95	1.00	1.00
Commercial, Local Business, Neighbourhood Facilities, Service Industry, General Industry, Home Industry, and Residential B	0.70	0.75	0.84	0.88	0.92	1.00	1.00
Significant Paved Areas e.g. Roads and Carparks	0.70	0.75	0.84	0.88	0.92	1.00	1.00
Urban Residential A / Special Residential (Urban) (Including Roads)							
Average Lot ≥600m^2	0.63	0.67	0.75	0.79	0.83	0.91	0.95
≥400m^2 < 600m^2	0.65	0.69	0.77	0.81	0.85	0.93	0.97
Urban Residential A / Special Residential (Urban) (Excluding Roads)							
Average Lot ≥600m^2	0.62	0.66	0.74	0.78	0.82	0.90	0.94
≥400m^2 < 600m^2	0.64	0.68	0.76	0.80	0.84	0.92	0.96
Special Residential (Non-Urban), Park Residential, Rural Residential, Future Rural Living	0.59	0.63	0.70	0.74	0.78	0.85	0.89
Park and Open Space, Sports and Recreation, Rural	0.56	0.60	0.67	0.70	0.74	0.81	0.84

For the ‘Special Facilities’, ‘Special Purposes’, ‘Extractive Industry’ and ‘Special Development’ zones, the QUDM classifications shall be determined by the Pine Rivers Shire Council for each particular site.

5.5.4 Flooded Widths for Minor Storm Design

The following Table replaces QUDM Table 5.09.1 and will apply using the major / minor road classifications as set out in Section 3.1 of this document.

Roadway Flow Width and Depth Limitations (Longitudinal Drainage)

Roadway Flow Width & Depth Limitation	Major Roads	Minor Roads
1. For Minor Storm		
a) Normal Situation	Parking lane width (usually 2.5m) or breakdown lane width. Where no K&C – the minor storm should be contained in the table drain.	(i) For K&C – full pavement width with zero depth at crown; Where no K&C – contained within table drain (ii) Where one way crossfall, to high side of road pavement but not above top of kerb on lower side
b) Where parking bay may be replaced by a through acceleration, deceleration, or turn lane	1.0 metre	Not Applicable
c) Where road falls toward median	1.0 metre	Not Applicable
d) Pedestrian Crossing or Bus Stops	0.45 metre	0.45 metre
2. For Major Storm		
a) Where flood levels of adjacent buildings are above road level	(i) Total flow contained within road reserve (ii) Freeboard > 250 mm to floor level of adjacent buildings, and with maximum flow depth of 200 mm	(i) Total flow contained within road reserve (ii) Freeboard ≥ 250 mm to floor level of adjacent buildings, and with maximum flow depth of 300 mm
b) Where floor levels of adjacent are below or less than 300 mm above	Match downstream pipe / culvert capacity	
(i) Where 100 mm fall on footpath toward kerb	50 mm above top of kerb	50 mm above top of kerb
(ii) Where < 100 mm on footpath toward kerb	Top of Kerb	Top of Kerb
c) Other	Determined by PRSC engineer	Determined by PRSC engineer
3. Pedestrian Safety		
Major and Minor Storms		
a) No obvious danger	≤0.6 m^2/s	≤0.6 m^2/s
b) Obvious danger	≤0.4 m^2/s	≤0.4 m^2/s
4. Vehicle Safety	≤0.6 m^2/s	≤0.6 m^2/s

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5.5.5 Roofwater Drainage for Various Land Uses

The requirements for single use basins will apply.

Zones	QUDM Drainage Level
Special Residential (non urban), Park Residential, Rural Residential, Extractive Industry, Rural, Future Rural Living	I or II
Residential A	III
Residential B, Commercial, Local Business, Neighbourhood Facilities, Home Industry, Service industry, and Industrial Zones	III, IV or V *
Central Business	V *

* Easements over Type III and higher drainage are required at no cost to Council.

Minimum easement widths for underground drainage are as follows: -

Pipe Diameter	Easement Width *
Stormwater Pipe ≤ 825 mm diameter	3.0 metres
Stormwater Pipe ≤ 825 mm diameter and Sewer Pipe ≤ 225 mm diameter	4.0 metres
Stormwater Pipe > 825 mm diameter	Easement boundary to be 1.0 metres clear of outside wall of stormwater pipe

* A Pine Rivers Shire Council engineer may require additional easement width to be provided in certain circumstances, in order to facilitate maintenance access to the stormwater system.

5.5.6 Detention Basins

Detention basins are generally required for two reasons: -

a) To match an existing limited downstream minor drainage system capacity and / or,
b) To return runoff rates to pre-development conditions.

All detention basins should be provided with a low flow water quality treatment system to treat the first 15 mm of runoff. The residence time for these flows shall not be less than 24 hours and not greater than 48 hours. Where basins incorporate sporting fields, sufficient area just upstream of the outlet will be required to be reserved for water quality treatment facilities.

5.5.6.1 Single Use Basins (Runoff Rate Reduction)

Design Parameter	Criteria
Depth ARI	1.2 m for 5 year event 1.5 m for 20 year event 2.0 m for 100 year event
ARI is to be investigated for analysis	1, 5, 20, and 100 for critical durations
Structural Stability of Outlet	Check under PMF conditions
Effect on Upstream Properties	100 year event plus minimum freeboard, and check under PMF conditions
Basin Batter Slopes	1V : 4H maximum
Spillway Embankment Slopes	1V : 6H maximum
Minimum spillway Width	3 metres
Pipe Outflows	Match downstream pipe / culvert capacity
Safety Report	Safety report to be provided by competent engineer

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5.5.6.2 Multi Use Detention Basins (Playing Fields, Parks etc.)

The requirements for single use basins will apply.

Design Parameter	Criteria
Minimum Crossfall	1 : 100
Desired Crossfall	1 : 70
Maximum Crossfall Length	70 metres

5.5.6.3 Multi Use Detention Basins (With Single Playing Field)

All of the above criteria apply including the following: -

Design Parameter	Criteria
Drainage Location	Sited along perimeter
Crown Location	Along longest centreline

5.5.7 Development Levels and Freeboard

Development Levels

Zone	Minimum area within Allotment	Minimum Development Levels
General Industry, Service Industry	4000 m^2 (See Note 1)	Q 100 * + Freeboard (See Note 2)
Residential A, Residential B, Special Residential, Future Urban, Neighbourhood Facilities, Local Business, Central Business, Home Industry, Commercial	2000 m^2 (See Note 1)	Q 100 * + Freeboard (See Note 2)
Park Residential, Rural Residential, Rural, Future Rural Living	1500 m^2	Q 100 * + Freeboard (See Note 2)

Notes

1. Where the allotment is less than the minimum area given then the whole of allotment shall be at the minimum development level
2. The Q100 calculation should be based on ultimate development of the catchment, on the planned long–term waterway condition as determined by a Pine Rivers Shire Council engineer.
3. The floor level should be set above the development level in accordance with the requirements of the Building Act, and Pine Rivers Shire Council development requirements.

Minimum Freeboard

The freeboard is added to the calculated Q100 (ult) level to determine the development level. It varies from location to location as per the following table:-

Location	Minimum Freeboard
Existing Natural Watercourse	Greater of: - ▪ 750 mm; or ▪ The highest recorder flood level + 750mm – calculated Q 100 flood level
Engineered Channels	Greater of: - ▪ 500 mm; or ▪ Flood level in un-maintained channel + 250mm – flood level in maintained channel
Urban Road Drainage	Greater of: - ▪ 250 mm; or ▪ 150 mm + difference in level due to blocked catchpits or inlets
Overland Flow Paths	Greater of: - ▪ 250 mm; or ▪ Flood level in un-maintained flow path + 150mm – flood level in maintained flow path
Road Drainage	▪ Flow width and depth limitations in accordance Section 5.5.4

Note:

1. See Section 5.7.1 for values of un-maintained channel roughness coefficients (Mannings 'n' values)
2. The practical roadway flow capacity to be used for the design major storm shall be taken as 80% of the theoretical value unless otherwise approved by a Pine Rivers Shire Council engineer.

Where a site is subject to many sources of flooding, the highest development level as calculated for each flooding mechanism shall be adopted.

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5.6 ENVIRONMENTAL REQUIREMENTS

Designers are advised to refer to Pine Rivers Shire Council's Water Quality Best Management Practices documents for relevant water quality design parameters. The following are broad guidelines.

5.6.1 Water Quality Treatment

- Receiving Water Quality standards shall be in accordance with the ANZECC standards
- Oil/Grit separators are to be provided for carparks or hardstand areas of Commercial or Industrial developments where other catchment based water quality treatment devices are not available.
- Pine Rivers Shire Council standard weir type trash and sediment traps are to be provided on all outlets of stormwater drainage pipes serving catchments greater than 2 hectares.
- GPTs designed for the collection and easy removal of sediment and trash are to be provided on the outlets of stormwater drainage systems serving catchments greater than 5 hectares.
- All detention basins are to include a low flow water quality treatment facility. The minimum residence time is 24 hours and the maximum residence time is 48 hours.
- Water quality control ponds, lakes and / or artificial wetlands are to be provided where a natural drainage feature traverses the development. Generally, these facilities will be applicable to subdivisional developments which are in excess of five (5) hectares or where a Pine Rivers Shire Council engineer determines that the development will have a detrimental effect on the quality of the receiving waters.
- Existing watercourses or drainage features shall be re-vegetated with native species in accordance with an approved landscaping plan complying with Pine Rivers Shire Council's requirements.

5.6.1.1 Gross Pollutant Traps

GPTs shall be installed on all trunk drainage areas greater than 5 hectares. The construction of major GPTs should be avoided where possible because of poor aesthetics. The following design parameters shall apply to enclosed minor GPTs:-

Design

- Degree of urbanisation (U) = 100% for urban areas with up to 15% open space.
- Average annual retention (P) = 70% of grain sizes ≥ 0.04mm for discharge
- This figure may not be appropriate for discharge to water bodies such as lakes and dams
- Minimum trap area = 8 m^2
- Maximum trap area = 24 m^2
- Trap width = 2 metres
- Maximum trap length = 12 metres
- Trap length = multiple (integer) x 2 metres
- Sediment density (ρ_s) = 2.65 t/m^3
- Sediment porosity (λ') = 0.42
- Average frequency of cleaning = twice per year (when GPT is half full)
- Minimum depth of trap below trash rack = 0.5 metre
- Maximum peak average velocity during the 1 year ARI storm event = 0.3 m/s
- Check velocity for trap half full of sediment and trash rack 50% blocked is < 0.3 m/s
- Maximum inlet pipe approach velocity to trap the 1 year ARI storm event = 1 m/s
- Maximum total depth of GPT = 3.5 metres
- Minimum trash rack height = 500 mm
- Maximum trash rack height = 1200 mm
- Check trash rack is not overtopped in the 1 year ARI storm event with the rack 50% blocked
- Checked impact of fully blocked trash rack with trap 50% full of sediment on the minor and major flow designs.

5.6.1.2 Design Criteria for Water Quality Treatment Facilities

The assessment for water quality treatment facilities (such as wetlands and water quality control ponds) should be cross-checked with the following criteria:

Runoff Coefficients and Pollutant Export Rates

Town Plan Zone	AVRC	Loading Rate (kg/ha)		
		TP	TN	SS
Residential A	0.50	1.6	10.3	950
Residential B	0.65	2.0	10.5	1050
Special Residential (urban)	0.50	1.6	10.3	950
Central Business	0.70	2.3	10.7	1150
Commercial	0.65	2.1	10.6	1100
Local Business	0.65	2.1	10.6	1100
Neighbourhood Facilities	0.60	2.0	10.5	1050
Home industry	0.50	1.6	10.3	950
Service Industry	0.65	2.1	10.6	1100
General Industry	0.70	2.3	10.7	1150
Future Urban	0.30	0.7	7.4	290
Special Residential (non-urban)	0.35	1.1	9	570
Park Residential	0.35	1.1	9	570
Rural Residential	0.30	0.9	8	400
Extractive Industry [1]				
Rural	0.30	0.7	7.4	290
Future Rural Living	0.30	0.7	7.4	290
Park and Open Space	0.35	0.8	7.8	380
Sport and Recreation	0.35	0.9	8.5	750
Forest	0.15	0.08	1.0	50

AVRC = Annual Volumetric Runoff Coefficient
TP = Total Phosphorus
TN = Total Nitrogen
SS = Suspended Solids

1 AVRC and Pollutant Export from extractive industry to be approved by Pine Rivers Shire Council

Water Quality Guidelines

The following Table lists Annual Mean Concentrations (AMC) which are considered to be appropriate to the design of stormwater drainage systems which are in keeping with maintaining ANZECC Water Quality standards for receiving water bodies

Annual Mean Concentration (AMC) (mg/l)

TP		TN		SS
Limiting	Non-Limiting	Limiting	Non-Limiting	Design
0.05	0.08	0.5	0.8	50

The criteria are governed by the limiting nutrient. In freshwater systems, streams and lakes, the limiting nutrient is phosphorous and the governing AMC is 0.05 mg/l. The corresponding permissible total nitrogen AMCs is 0.8 mg/l. In the case of an estuarine (nitrogen limited) system the required nitrogen AMC is 0.5 mg/l, and the permissible phosphorous AMC is 0.08 mg/l.

Pollutant Retention

The required pollutant retention criteria for a water quality control device can be calculated from the catchment export rate and the required pollutant concentration. The necessary retention time for the pollution control device is determined from the following table.

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Hydraulic Residence Time Required for Pollutant Retention (days)

Pollutant Retention %)	Sedimentation System			Wetland		
	TP	TN	SS	TP	TN	SS
10	0.9	1.2	0.3	0.3	0.7	0.17
15	1.3	2.2	0.5	0.7	1.3	0.26
20	2.0	3.9	0.6	1.0	2.2	0.34
25	2.9	6.9	0.9	1.7	3.0	0.6
30	4.4	12	1.3	2.1	3.7	0.8
35	6.5	21	1.8	2.8	4.4	1.2
40	10	38	2.5	3.4	5.4	1.5
45	14	67	3.5	4.3	6.9	1.8
50	21	119	4.8	4.9	9	2.3
55	32	210	6.8	5.7	12	2.9
60	48		10	6.9	19	3.3
65	71		13	8.0	37	4.2
70	106		19	10	57	6
75	158		26	12		8
80	235		37	16		11
85			51	25		18
90			72	50		29
95			101			48

Wetland or Pond Volume

Pond Volume = $\frac{HRT}{365}$ * *ARV* (below outlet invert)

Where *ARV* is the mean annual runoff volume and *HRT* is the hydraulic residence time. The *HRT* is calculated as (pond volume / mean annual flow) and can be thought of as the time required for complete interchange of pond volume under average flow conditions.

Combinations of water quality control devices may be needed to meet the water quality guidelines at the receiving waterbody.

Sediment Forebay

A sediment forebay shall be provided at the inlet to wetlands and water quality control ponds to facilitate the removal of coarse sediment. The criteria for sediment forebay volume 5% of pond volume. The forebay should be designed for ease of access and sediment removal. The design maintenance cycle shall be five years.

Weir Level

The downstream weir level should be set to the Q1 level, i.e. spilling occurring for events greater than Q1 magnitude.

Flood Storage Volume

Wetlands and extended detention ponds are required to have sufficient flood storage such that the pond will drain back to normal water level from weir level in 72 hours. The necessary flood storage volume should be determined using a runoff routing model.

Summary

Criteria are: -

Design Parameter	Criteria
Average Annual Rainfall	1240 mm
Annual Volumetric Runoff Coefficient	As for relevant zone
Pollutant Export Rates	As for relevant zone
Design AMC	As for limiting nutrient
Maximum Depth	3 metres
Depth of reed bed zone	0.2 to 0.5 metres
Spillway Crest Level	Q1
Length to Width Ratio	>3:1 and <10:1
Flood storage depth	1 metre
Flood storage release time	72 hours
Sediment forebay size	5% pond volume

5.6.2 Proposed Recreation / Ornamental Lakes

A Lake Water Quality Management Plan is required for proposed lakes within developments, be they natural or created. This report will include an assessment of the long term maintenance of lake water quality. Water treatment facilities such as buffer zones, sedimentation basins, GPTs, trash traps, wetlands, water pollution control ponds etc. shall also be documented. Prior to commencing this report, the developer must submit to Pine Rivers Shire Council for agreement : -

(i) the terms of reference, and
(ii) the company and names of the persons proposed to undertake this report.

5.6.3 Controls During the Construction Stage

A sediment and runoff control management plan is required to be submitted to Pine Rivers Shire Council prior to commencement of any construction for approval by a Pine Rivers Shire Council engineer. Any runoff diversion works must cater for storms up to the 10 year ARI.

Design Criteria for Sedimentation Basins

Permanent and temporary sedimentation basins are required at the downstream end of all proposed developments whose total drainage area is in excess of 2 hectares or where in the opinion of a Pine Rivers Shire Council engineer, there is potential for a substantial sediment generation from the site. The basis of design of sedimentation basins it the Institution of Engineers (QLD) Soil Erosion and Sediment Control - Engineering Guidelines for Queensland as amended.

The following Table highlights the minimum design parameters.

Design Parameter	Criteria
Design Storm	10 year, 6 hour storm
Minimum Basin Volume	200 cubic metres per disturbed hectare
Spillway Design	10 year ARI
Structured Adequacy	100 year ARI

5.6.4 Development Adjacent to Watercourses, Creeks and Rivers

Development Requirement	Criteria
Filling	Only permitted on land above the maximum of : ▪ Q50 (ult) flood contour for Creeks and watercourse ▪ Q100 (ult) flood contour for Rivers ▪ Highest recorded flood level
Park *	Excludes land below the maximum : ▪ Q20 (ult) flood contour ▪ 20 metres from low bank of waterway

* Also refer to Council's planning requirements

In addition, the following guidelines should be applied: -

- Channelling of creeks and watercourses for the purpose of maximising development area is not permitted by Pine Rivers Shire Council

- Any works that will have an effect on a defined watercourse shall also be approved by the Department of Natural Resources (and/or any relevant State Government Department). These works may include stormwater outlets, scour protection, diversions, widenings or enhancements. This approval, including any license and conditions shall be, shall be submitted with the application for approval of engineering drawings and specifications.

- The long term aim of the Pine Rivers Shire Council is to revegetate all of its major creek and river corridors. Accordingly all hydraulic calculations shall assume a dense vegetated buffer each side of the waterway, whether these buffers exist at present. A vegetated buffer of 20 metres width and Mannings 'n' of 0.15 each side of the waterway should be applied.

- Where additional revegetation is proposed beyond the normal 20m wide buffer area (e.g. nature reserves) an appropriate allowance for the additional vegetation shall be made.

- All watercourses as defined under the Water Resources Act will be required to be revegetated. The minimum density of native trees/bushes is 1 per 8 square metres. The plan will require a tree canopy to be established along the length of the watercourse. The revegetation plan is to be approved by a Pine rivers Shire Council engineer prior to proceeding with the development.

- Existing watercourse erosion problems shall be repaired to the satisfaction of Pine Rivers Shire Council's engineer. Placement of gabions, reno mattresses, and/or rip rap will be the normal requirement, followed by re-establishment of appropriate vegetation.

- A bikeway/walkway may be located in the drainage reserve between Q2 (ult) and Q20 (ult) flood levels, but generally not closer than 20 metres to low bank of the waterway. Also refer to Pine Rivers Shire Council's Bikeway and Recreational Trails Plans.

- All outlet treatment devices (GPTs, Trash traps etc.) are to be located above the Q20 (ult) contour or the 20m buffer distance from the low bank or the nearby waterway whichever is greater. Revegetation of receiving creeks, water courses or drainage features will be required to minimise gully erosion. All proposed creek, watercourse or drainage feature vegetation plans should be submitted to Pine Rivers Shire Council for approval.

- The developer will be required to place at least one sign (preferably at a waterway crossing associated with the development) indicating the creek name, its catchment area and source location, the name of the next major waterway downstream, and the distance to this waterway. These signs shall be to the Pine Rivers Shire Council standard.

5.7 MISCELLANEOUS DESIGN REQUIREMENTS

5.7.1 Manning's 'n' Values

The following tables detail Manning's n values for natural, lined and excavated channels. The tables values are largely based on those prepared by the US Army Corp of Engineers (HEC) and documented in their HEC-RAS manual (Version 1, 1995).

Channel capacities should be based on "normal" values, velocity checks should be carried out using minimum values. Freeboard and flood development levels should be based on maximum values.

Natural Streams

Type of Channel and Description	Manning's 'n' Values		
	Minimum	**Normal**	**Maximum**
	Velocity Check	Capacity Design	Flood Level Check
1. Main Channels			
a. Clean, straight, full, no rifts or deep pools	0.025	0.030	0.033
b. Same as above, but more stones and weeds	0.030	0.035	0.040
c. Clean, winding, some pools and shoals	0.033	0.040	0.045
d. Same as above but some weeds and stones	0.035	0.045	0.050
e. Same as above, lower stages, more ineffective slopes and sections	0.040	0.048	0.055
f. Same as "d" but more stones	0.045	0.050	0.060
g. Sluggish reaches, weedy, deep pools	0.050	0.070	0.080
h. Very weedy reaches, deep pools, or floodways with heavy stands of timber and brush	0.070	0.100	0.150
2. Flood Plains			
a. Pasture no brush			
1. Short Grass	0.025	0.030	0.035
2. High grass	0.030	0.035	0.050
b. Cultivated areas			
1. No crop	0.020	0.030	0.040
2. Mature row crops	0.025	0.035	0.045
3. Mature field crops	0.030	0.040	0.050
c. Brush			
1. Scattered brush, heavy weeds	0.035	0.050	0.070
2. Light brush and trees	0.040	0.060	0.080
3. Medium brush	0.045	0.070	0.110
4. Dense brush	0.070	0.100	0.150
d. Trees			
1. Cleared land with tree stumps, no sprouts	0.030	0.040	0.050
2. Same as above, but heavy sprouts	0.050	0.060	0.080
3. Heavy stand of timber, few down trees, little undergrowth, flow below branches	0.080	0.100	0.120
4. Same as above, but with flow into branches	0.100	0.120	0.150
5. Dense trees with good undergrowth	0.120	0.150	0.200

Lined or Built-Up Channels

Type of Channel and Description	Manning's 'n' Values		
	Minimum	**Normal**	**Maximum**
	Velocity Check	Capacity Design	Flood Level Check
1. Concrete			
a. Trowel Finish	0.011	0.013	0.015
b. Float finish	0.013	0.015	0.016
c. Finished, with gravel bottom	0.015	0.017	0.020
d. Unfinished	0.014	0.017	0.020
e. Gunite, good section	0.016	0.019	0.023
f. Gunite, wavy section	0.018	0.022	0.025
g. On good excavated rock	0.017	0.020	0.023
h. On irregular excavated rock	0.022	0.027	0.030
2. Concrete bottom float finished with sides of:			
a. Dressed stone in mortar	0.015	0.017	0.020
b. Random stone in mortar	0.017	0.020	0.024
c. Cement rubble masonry, plastered	0.016	0.020	0.024
d. Cement rubble masonry	0.020	0.025	0.030
e. Dry rubble on riprap	0.020	0.030	0.035
3. Gravel bottom with sides of:			
a. Formed concrete	0.017	0.020	0.025
b. Random stone in mortar	0.020	0.023	0.026
c. Dry rubble or riprap	0.023	0.033	0.036
4. Brick			
a. Glazed	0.011	0.013	0.015
b. In cement mortar	0.012	0.015	0.018
5. Metal			
a. Smooth Steel Surfaces	0.011	0.012	0.014
b. Corrugated Metal	0.021	0.025	0.030
6. Asphalt			
a. Smooth	0.013	0.013	0.015
b. Rough	0.016	0.016	0.020
c. Bitumen seal	0.015	0.015	0.020
7. Vegetal Lining	0.030	0.040	0.050
8. Reno Mattress / Gabion	0.025	0.030	0.035
9. Concrete Grout filled mattresses	0.022	0.025	0.028

PINE RIVERS SHIRE COUNCIL
SUMMARY DOCUMENT
DESIGN STANDARDS FOR STORMWATER DRAINAGE

Excavated or Dredged Channels

Type of Channel and Description	Manning's 'n' Value		
	Minimum	Normal	Maximum
	Velocity Check	Capacity Design	Flood Level Check
1. Earth, straight and uniform			
a. Clean, recently completed	0.016	0.018	0.020
b. Clean, after weathering	0.018	0.022	0.025
c. Gravel, uniform section, clean	0.022	0.025	0.030
d. With short grass, few weeds	0.022	0.027	0.033
2. Earth, winding and sluggish			
a. No vegetation	0.023	0.025	0.030
b. Grass, some weeds	0.025	0.030	0.033
c. Dense weeds or aquatic plants in deep channels	0.030	0.035	0.040
d. Earth bottom and rubble side	0.028	0.030	0.035
e. Stony bottom and weedy banks	0.025	0.035	0.040
f. Cobble bottom and weedy sides	0.030	0.040	0.050
3. Dragline-excavated or dredged			
a. No vegetation	0.25	0.028	0.033
b. Light brush on banks	0.25	0.050	0.060
4. Rock cuts			
a. Smooth and uniform	0.025	0.035	0.040
b. Jagged and irregular	0.035	0.040	0.050
5. Channels not maintained, weeds and brush			
a. Clean bottom, brush on sides	0.040	0.050	0.080
b. Same as above, highest stage of flow	0.045	0.070	0.110
c. Dense weeds, high as flow depth	0.050	0.080	0.120
d. Dense brush, high stage	0.080	0.110	0.150

5.7.2 Overland Flowpath and Swale Drain Design

The Pine Rivers Shire Council Design Standards places emphasis on overland flow path design. These overland flow paths or swales usually consist of a shallow depth of water, which gives rise to a higher value of Manning's 'n' than used for deeper grassed channels. The classification of various vegetal types is provided in the following table:

Average Length of Vegetation	Degree of Retardance	Example
150 to 250 mm	C	Long grass. Most grasses can be kept to this length with periodic slashing.
50 to 150 mm	D	Well maintained grass, eg Townhouse Developments
0 to 50 mm	E	Lawn cut short, burned grass or bare earth.

Charts 1, 2 and 3 provided in this summary document give the Mannings 'n' calculation for the vegetal types C, D, and E respectively. These are sourced from charts presented in the Queensland Department of Main Roads Design Manual, Volume 2.

Overland flow paths should be designed as follows;

Criteria	Vegetal Type
Channel Dimensions	D
Velocity Check	E
Flooding Check	C

The minimum longitudinal grade of overland flow paths shall be 0.4% unless otherwise approved by a Pine Rivers Shire Council engineer.

CALCULATION METHODOLOGY FOR THE DESIGN OF GRASSED OVERLAND FLOW PATHS

1. Determine required flow (Q_{OL}) to be carried by overland flow path e.g. Q 100 – Q5
2. Estimate size of channel – for preliminary sizing assume velocity of 1 m/s
3. Calculate Hydraulic Radius (Area / Wetted Perimeter)
4. Calculate longitudinal slope, i.e. average slope over entire length
5. Calculate Mannings 'n' from Charts 1, 2, and 3 for vegetal types C, D, and E respectively.
6. Check for adequate capacity using Mannings 'n' value for for vegetal type D using Mannings equation (Chart 2).
7. Perform velocity check using Mannings 'n' derived form Chart 3. (Vegetal type E). Velocity should be less than 2 m/s. If greater than 2 m/s increase cross-sectional area, or introduce drops structures along flow path.
8. Perform flooding check using Mannings 'n' derived from Chart 1. (Vegetal type C). Use this value to calculate (V_C). The increase in height can then be approximated by $\frac{(Q_{OL} - V_C * A)}{(V_C * W)}$ where *W* is the width of the overland flow path, and A is the flow area derived form Step 6 (Vegetal type D). The increase in flood levels should not flood adjacent properties.
9. Iterate Steps 6, 7 and 8 until all conditions are satisfied.

5.7.3 Hydraulic Design of Culverts

Culverts shall be designed as per the latest edition of Austroads Waterway Design, "A Guide to the Hydraulic Design of Bridges, Culverts and Floodways" except as amended in the Pine Rivers Shire Council Design Standards.

5.7.4 Scour Protection of Outlets

The discharge of stormwater from outlets in rural residential and park residential allotments shall consider the dissipation of energy and scour protection. The following are minimum requirements.

5.7.4.1 Length of Stub Easements

The length of stub easements will depend on the location of adjacent open channels, watercourse and stormwater inlets. For outlets within 60 metres of an open channel, watercourse or stormwater inlet, stub easements shall extend from the road reservation boundary to the centre of the open channel, water course or stormwater inlet. If the open channel, water course or stormwater inlet is bounded by an existing easement or drainage reserve, then the easement shall extend from the road reservation boundary to the existing easement or drainage reserve boundary. Discharge into a 'defined watercourse' under the meaning of the Water Resources Act will require consent from the Department of Natural Resources and/or other relevant State Government Departments.

For outlets more than 60 metre from an open channel, watercourse or stormwater inlet the minimum length of stub easements shall be 10 metres, or where required by a Pine Rivers Shire Council engineer, shall extend to convey discharge beyond the nominated building area.

5.7.4.2 Width of Stub Easements

The minimum width of stub easements shall be 3.0 metres. However all drainage works must be located within easement boundaries. For the construction of large open channels, consideration should be given for easement access by Pine Rivers Shire Council maintenance vehicles and equipment. The minimum easement width for open channels shall be as follows: -

Channel Type	Total Width of Easement
Concrete Lined	Channel width + 3 metres
Grass Lined	Channel width + 6 metres *
Grassed Swale batter slopes <1:4H	Swale width + 3 metres

* Refer Section 8.13 of QUDM

5.7.4.3 Energy Dissipation

Energy dissipation works should consider the following criteria.

Outlet Characteristics	Recommended Outlets Treatment
outlet Q < 2 m^3/s and/or outlet V < 3 m/s and/or outlet slope < 3% and/or	Culvert Headwall plus Concrete Apron plus 600 mm deep Apron cutoff wall
outlet Q > 2 m^3/s and/or outlet V > 3 m/s and/or outlet slope > 3% and/or	Culvert Headwall plus Concrete Apron plus 1200 mm deep Apron cutoff wall plus an approved energy dissipation device

There are several types of energy dissipation devices ranging form rock lined channels, plunge pools, extended aprons, ramps that induce hydraulic jumps etc. Chute blocks are however not permitted as an energy dissipation device. The design of these structures are detailed in the Queensland Department of Main Roads Urban Road Drainage Design Manual Volume 2. This manual should be first point of reference for the designer.

Design methodologies for outlet channels and scour basins are outlined in the following sections.

5.7.4.4 Outlet Channel

The following are the criteria for energy dissipation in outlet channels: -

- slope between 0.3% and 0.6%
- minimum length of outlet channel 10 metres long
- outlet channel velocity to conform to Table 8.03 of QUDM
- outlet channel to discharge to a quiescent water body or spread out evenly over flat well grassed ground with a slope no steeper than 3%

Detailed hydraulic calculations

Detailed hydraulic calculations are required for outlet channel proposals that do not satisfy the above criteria.

5.7.4.5 Scour Basins

Scour Basins provide a suitable method of dissipating energy at culvert outlets. Basins may be constructed from natural or artificial materials. The minimum dimensions of the scour basin can be calculated from the following formula.

Scour Geometry = $\alpha (Y_e)^{\gamma} \left(\frac{Q}{Y_e^{\,2.5}} \right)^{\beta} (tc)^{\theta}$

where $\alpha, \beta, \theta, \gamma$ are coefficients from the next page
tc is the time of concentration (min)
Q is the design discharge (m^3/s)
$Y_e = \left(\frac{A}{2} \right)^{0.5}$
A is the area of flow in the culvert (m^2)

Scour Basin Design Parameters

Maximum Scour Hole Dimension	Coefficient			
	α	β	θ	γ
Depth				
TW < 0.5 D	1.02	0.375	0.10	1.0
TW > 0.5 D	0.95	0.375	0.10	1.0
Width				
TW < 0.5 D	0.94	0.915	0.15	1.0
TW > 0.5 D	0.67	0.915	0.15	1.0
Length				
TW < 0.5 D	2.55	0.71	0.125	1.0
TW > 0.5 D	2.34	0.71	0.125	1.0

For further details refer to “Drainage Design and Outlet Protection” by A.Chiu and W. Rahmann (June1980) in Queensland Transport Road Design References 2nd Edition December 1991

Methodology

1. Determine the Time of Concentration (t_C), design discharge (Q), waterway area of outlet culvert (A) and velocity (Q/A)
2. Check that the Time of Concentration does not exceed 24 hours.
3. Check that the maximum outlet velocity does not exceed 6 m/s.
4. Calculate, $Y_e = \left(\frac{A}{2}\right)^{0.5}$
5. Determine tailwater height.
6. Read off values for α , γ , β and θ from the above Scour Basin Design Parameter Table
7. Calculate depth, width and length of scour basin using the formula on the previous page
8. Determine type of outlet materials and apply the appropriate dimensional reduction factor

Dimensional reduction factors

The scour equation given above is conservative as it relates to the natural scour of sand in channels. The construction of concrete scour basins are not recommended unless space requirements dictate. For outlet materials other than sand, the following reduction factors apply: -

Material	Factor
Sand	1.0
Silty Clay	0.5
Clay	0.33
Concrete	0.25

The above factors are not based on any detailed research. The designer may choose to adopt more appropriate values. Justification of different values will however be required. Consideration for the localised drainage of scour basins is also required to reduce the possibility of mosquito breeding.

5.7.4.6 Alternative Energy Dissipation Devices

Other types of drainage energy dissipation devices may be accepted provided they are: -

- Environmentally sensitive
- Cost Efficient
- Minimise nuisance to adjacent property owners
- Aesthetically pleasing
- Require low maintenance
- Are not unsafe

5.7.4.7 Piping or Channel Lining

Where required by a Pine Rivers Shire Council engineer, outlets from the drainage system may have to be piped or conveyed to an approved point of discharge via lined channels in order to minimise risk of damage to property.

5.7.5 Commercial and Industrial Developments

5.7.5.1 On Site Detention

Commercial and Industrial development shall install On Site Detention (OSD) unless alternative treatments are approved by a Pine Rivers Shire Council engineer. Site specific design or proprietary systems may be used providing they incorporate high early discharge devices. The minimum discharge orifice diameter is 100mm. A Q10 event is required to be captured and temporarily stored underground. For Q100 events suitably sized overland flow paths with lawful points of discharge shall be designed to allow the full Q100 peak discharge. A check should be made that blockage of inlets does not result in above floor flooding. All OSD systems are to include a water quality treatment system. This system shall capture and treat the first 150 m^3/ha of development runoff.

5.7.5.2 Methodology

1. Determine capacity of downstream connecting minor drainage system , Q_{cap}
2. Determine design capacity of connecting downstream minor drainage system, Q_{des}
3. Calculate reduction ratio, $r = \frac{(Q_{des} - Q_{cap})}{Q_{des}}$, for $r \geq 0$
4. Calculate minor drainage site discharge, Q_{site}
5. Calculate permissible site discharge (PSD), $Q_{perm} = Q_{site}(1 - r)$
6. Determine orifice pipe diameter using Q_{perm}
7. Ensure calculated orifice pipe diameter ≥ 100mm.
8. Calculate underground site storage requirement, $SSR = 800\, r^2 Q_{site}$ m^3/ha.
9. Ensure underground site storage requirement, SSR exceeds 120 m^3/ha.

5.7.5.3 Design Standards

Detailed design standards and requirements for commercial and industrial developments are contained in the relevant Pine Rivers Shire Council standards.

5.7.6 Control of Flows from External Catchments

Methods to control overland flow from external catchments that affect residential allotments need to be addressed. The following are a list of possible solutions.

5.7.6.1 Diversion Drains

Size	Type
Allotments ≤ 2000 m^2	Concrete lined or swale diversion drain for Q100 capacity.
Allotments > 2000 m^2	Natural lined diversion drain for Q100 capacity. Design in accordance with Section 8 of QUDM.

Note: The minimum freeboard for diversion drains shall be 150mm

5.7.6.2 Bunding

Bunding is not recommended unless the specific area bordering the bunding is covered by a suitable easement. Bunding should be graded to avoid ponding of water. Minimum freeboard for bunding shall be 150 mm.

5.7.6.3 Field Inlets and Pipe Systems

Field inlets and pipe systems should be designed to incorporate any future upstream development. Consideration should be given to the blockage of inlets by natural debris and the impact of overland flow on adjacent residential properties. A minimum blockage factor of 50% shall be applied in all cases.

5.7.6.4 Property Fencing

Property fencing may form part of the wetted perimeter of an overland flow path only if it is of a permanent nature and constructed of masonry brick or similar materials to a height of 600 mm above ground in the flow path. The maximum height of the calculated water surface elevation above the ground level shall be no more than 300 mm. Consideration should be given to reducing the permeability of fencing to avoid adjacent property damage.

5.7.7 Swale Drains

Grass lined swale drains are a recommended method of conveying stormwater from urban and rural residential areas. Whether a subsoil drain is required depends on local soil conditions.

5.7.7.1 Soil Types

Soil Type	Agricultural Drain Required
Sandy / Loamy soil	No
Clay / Impermeable soil	Yes

Clean out points are required every 60 metres.

5.7.7.2 Grassed lined Swale drains

The maximum side slope of grass lined swale drains is 1V : 4H. The minimum base width is 2.5 metres

5.7.7.3 Freeboard

Consideration should be given to the effect of bend losses on the freeboard. For further information refer to QUDM, Section 8, Equation 8.06.

5.7.7.4 Slope

The minimum slope for grass lined swale drains is 0.1%. For maximum slopes refer to QUDM Table 8.03.

5.7.8 Design Charts and Tables

5.7.8.1 Catchpit Capacity Charts

Charts 4 to 7 give the capture rates based on tests commissioned by the Brisbane City Council for their Type ‘A’ gully. These tests were undertaken at the University of South Australia by Prof. J. Argue. The calculated capacities given in Charts 5 to 7 assume a 10% blockage factor. They represent minimum capacity standards. Alternative catchpit designs may be accepted subject to Council’s approval of design and associated capacity charts. Preference will be given to systems that incorporate grates that comply with AS 3996.

5.7.8.2 Rainfall Intensity Tables

The rainfall intensity tables provided in this summary document are derived using the ARR 1987 Volume 2. They are applicable for the whole of the Shire. Area reduction factors (ARFs) are not to be applied to these values. The Tables are given in Chart 8.

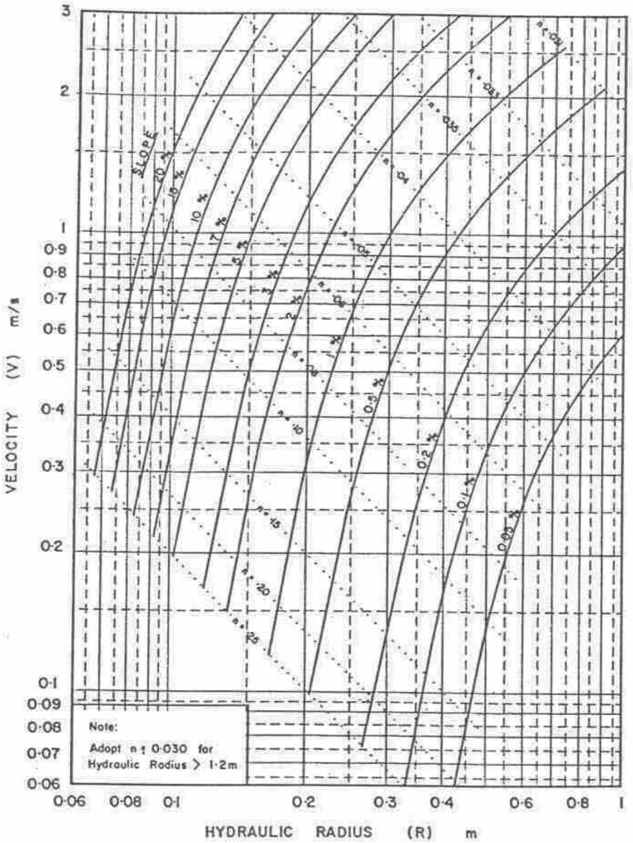
5.7.8.3 Hydraulic Design Calculation Sheet

Charts 9 and 10 detail the standard format for hydraulic gradeline calculations to be submitted to Pine Rivers Shire Council.

5.7.8.4 Road Capacity Charts

Charts 11 to 35 detail the capacity charts for the various types of roads used throughout Pine Rivers Shire. The capacities are based on Izzard's equation as given in Section 5 of the QUDM.

PINE RIVERS SHIRE COUNCIL
SUMMARY DOCUMENT
STORMWATER DRAINAGE DESIGN
(VOLUME I PART II)



Solution of the Manning's formula for vegetal retardance C

CHART 1

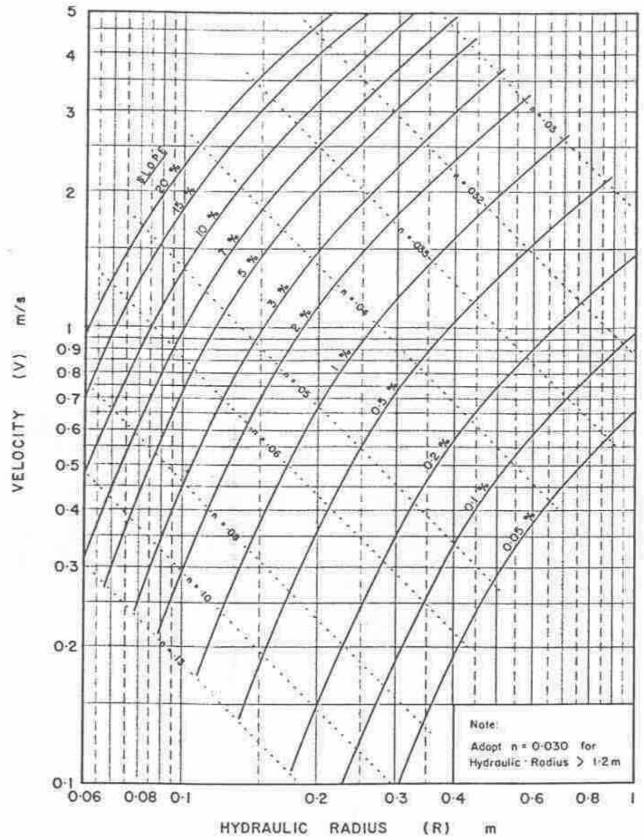


CHART 2

Solution of the Manning's Formula for vegetal retardance D

PINE RIVERS SHIRE COUNCIL
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STORMWATER DRAINAGE DESIGN
(VOLUME I PART II)

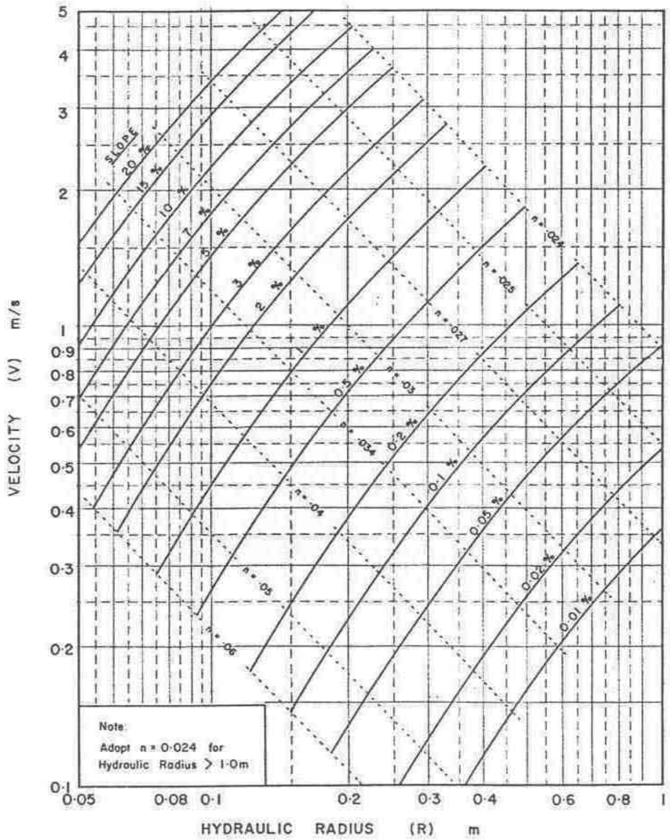
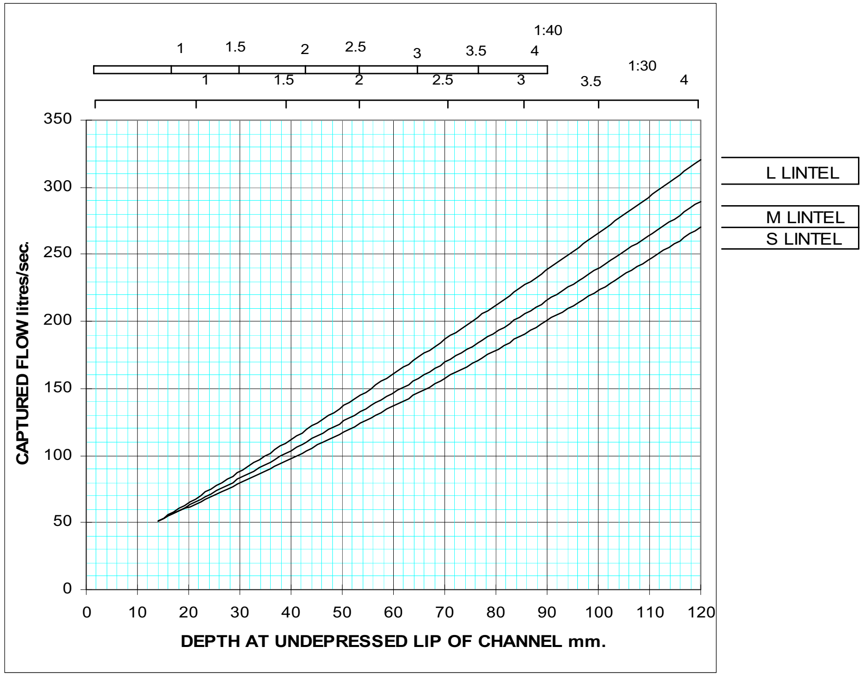


CHART 3

Solution of the Manning's Formula for vegetal retardance E

PINE RIVERS SHIRE COUNCIL - TYPE A CATCHPIT CAPACITY CHARTS

PONDED WIDTH (metres) WITH ROAD CROSSFALL AS BELOW



TRAPPED SAG CAPTURE

(FOR MOUNTABLE OR BARRIER KERB)

* CONTROL WATER LEVEL - 150 mm BELOW CHANNEL INVERT

CAPTURE
KERB OVERTOPPED 90mm.

LINTEL	CAPACITY
S	330 l/sec
M	350 l/sec
L	480 l/sec

NOTE TO USERS OF ON GRADE AND TRAPPED SAG CAPTURE CHARTS

1. THESE CHARTS WERE PRODUCED IN 1994 BY ASSOC. PROF JOHN ARGUE AND HIS STAFF AT URBAN WATER RESOURCES CENTRE, UNIVERSITY OF SOUTH AUSTRALIA, FROM TESTS USING A FULL-SIZE RIG.

2. CURVES SHOWN IN FULL ARE "RELIABLE"; THOSE SHOWN DASHED UP TO Q=250 l/sec. ARE "SATISFACTORY"; THOSE SHOWN DASHED WITHIN THE RANGE 250 l/sec. TO 500 l/sec. ARE "ESTIMATES ONLY", TO BE USED WITH CAUTION. NO EXTRAPOLATION BEYOND THE LIMITS OF THE CHARTS SHOULD BE UNDERTAKEN.

3. THE RESULTS WERE DERIVED WITH 150mm FREEBOARD FROM THE CATCHPIT WATER SURFACE LEVEL TO THE CHANNEL INVERT. WHERE THE WATER SURFACE IS SIGNIFICANTLY BELOW THIS (ie. > 450mm); CAPTURE MAY BE ADJUSTED FOR LONGITUDINAL SLOPES AS FOLLOWS:

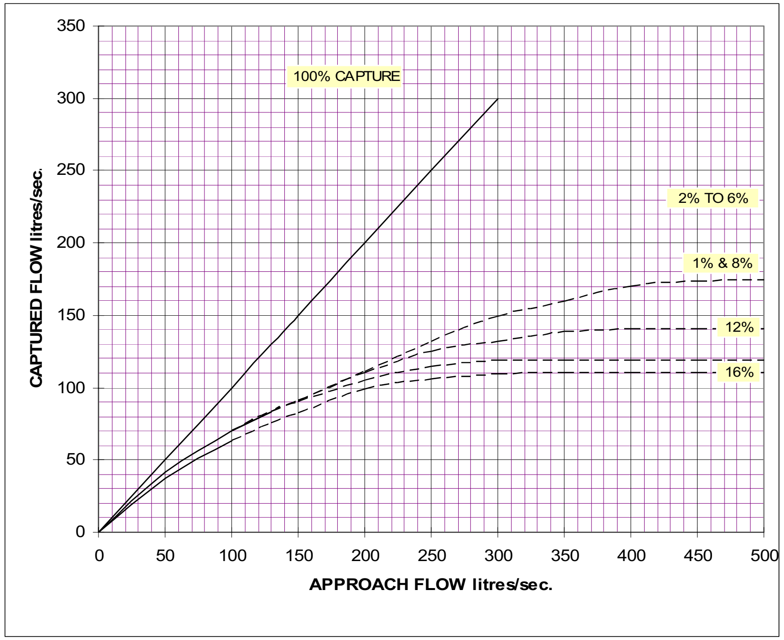
0% TO AND INCLUDING 1%	- NIL
1% TO AND INCLUDING 16%	- INCREASE BY 6%
6% TO AND INCLUDING 16%	- INCREASE BY 10%

4. BARRIER AND MOUNTABLE KERB CONDITIONS WHERE TESTED. MOUNTABLE KERB GAVE MARGINALLY BETTER RESULTS ON GRADE, (0% TO 1% FOR "M" AND 0% TO 3% FOR "L"). THERE WAS NO APPRECIABLE DIFFERENCE FOR SAG CONDITIONS. MOUNTABLE KERB RESULTS HAVE BEEN ADOPTED IN THE CHARTS.

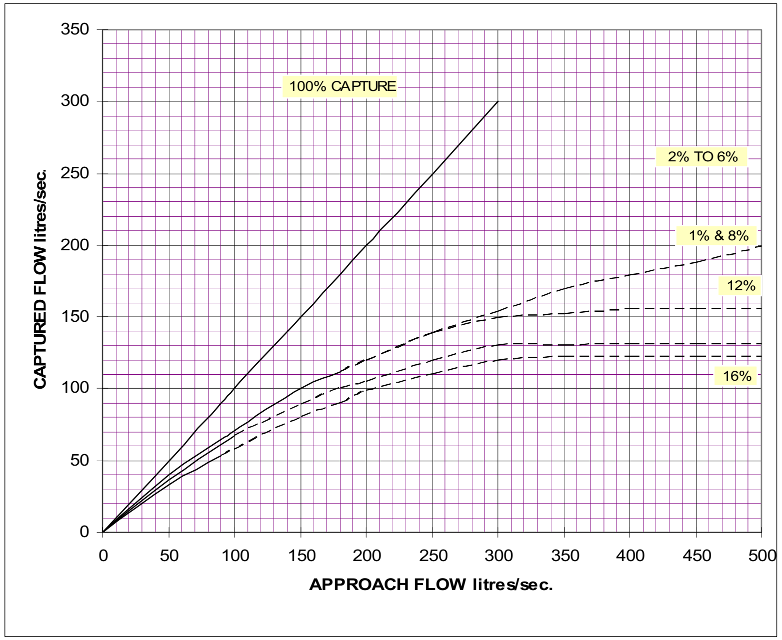
5. BLOCKAGE FACTORS FOR THE PINE RIVERS SHIRE AREA ARE AS FOLLOWS:
ON GRADE - 10% OF CAPTURE
IN SAG - A GRATE MAKES NEGLIGIBLE DIFFERENCE TO UNBLOCKED CAPTURE. THE TRAPPED SAG CHART EXCLUDES GRATE FLOW. IN ACCORDANCE WITH QUDM TABLE 5.10.1(1), NO BLOCKAGE FACTOR NEED BE APPLIED TO THIS CHART.

CHART 4

PINE RIVERS SHIRE COUNCIL - TYPE A CATCHPIT CAPACITY CHARTS



S LINTEL - ROAD CROSSFALL 1:40



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ON GRADE CAPTURE

(FOR MOUNTABLE OR BARRIER KERB)

* CONTROL WATER LEVEL - 150mm BELOW CHANNEL INVERT.

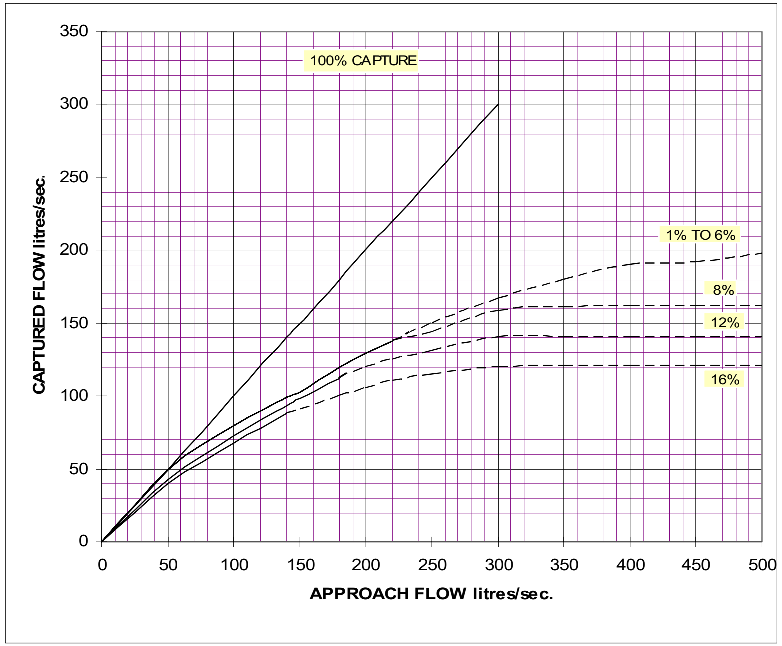
* 10% BLOCKAGE FACTOR APPLIED

LEGEND:

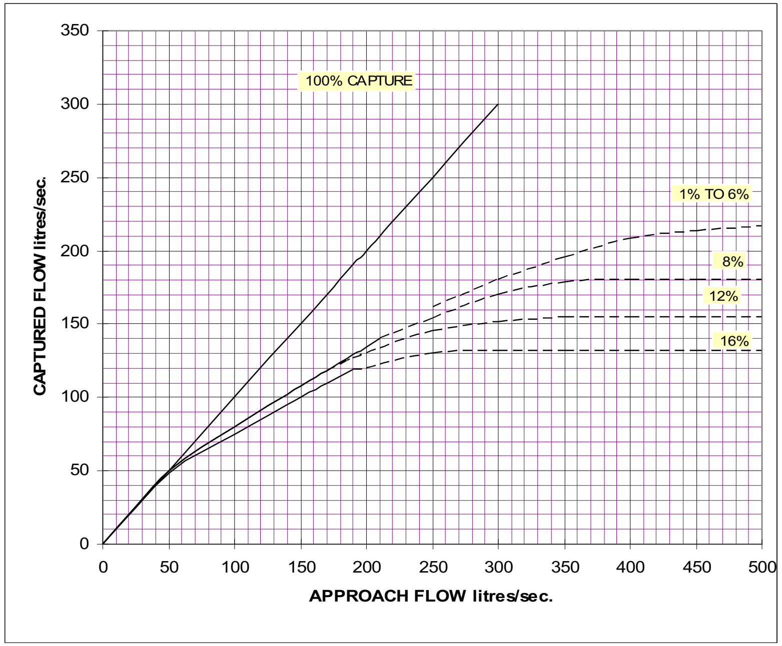
_ %.	KERB AND CHANNEL LONGITUDINAL SLOPE
————	BASED ON ACTUAL DATA UP TO 70% CAPTURE (RELIABLE)
_ _ _ _ _ _	BASED ON ACTUAL DATA BEYOND 70% CAPTURE (LESS RELIABLE, CONSERVATIVE)

CHART 5

PINE RIVERS SHIRE COUNCIL - TYPE A CATCHPIT CAPACITY CHARTS



M LINTEL - ROAD CROSSFALL 1:40



M LINTEL - ROAD CROSSFALL 1:30

ON GRADE CAPTURE

(FOR MOUNTABLE OR BARRIER KERB)

* CONTROL WATER LEVEL - 150mm BELOW CHANNEL INVERT.

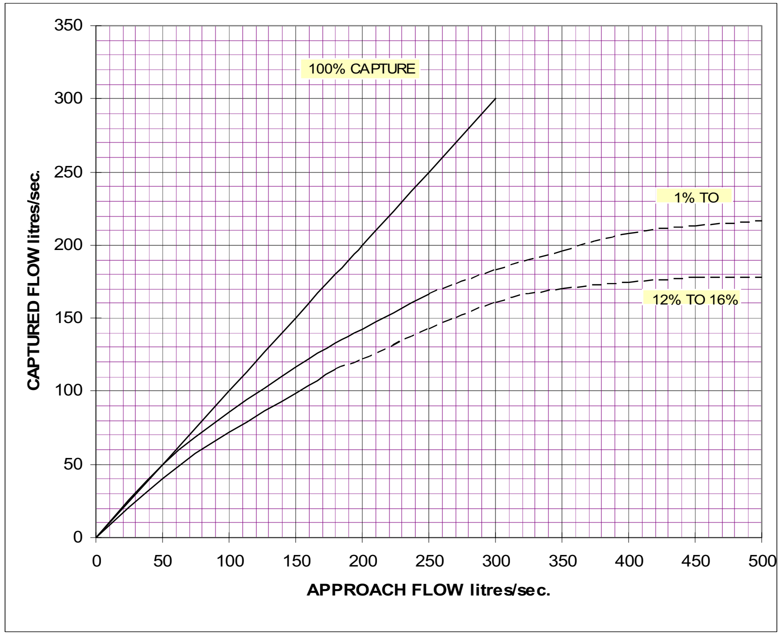
* 10% BLOCKAGE FACTOR APPLIED

LEGEND:

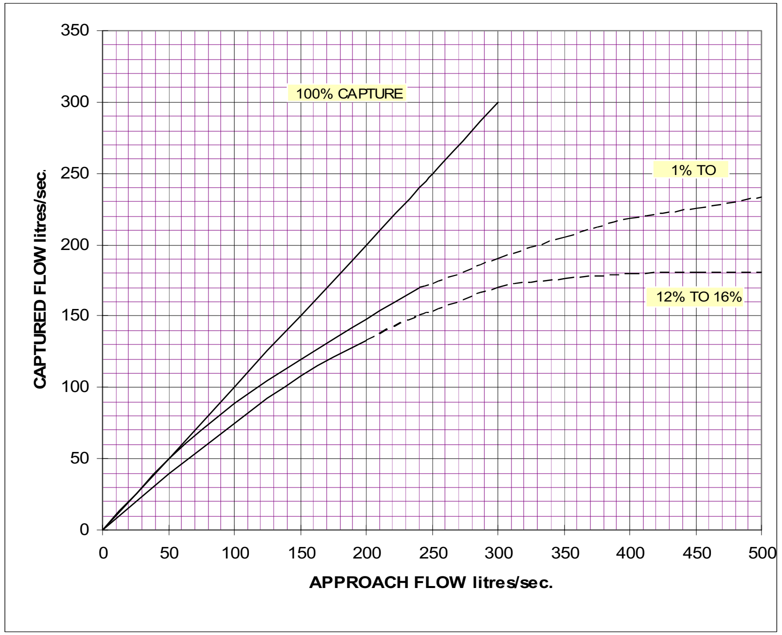
_ %.	KERB AND CHANNEL LONGITUDINAL SLOPE
————	BASED ON ACTUAL DATA UP TO 70% CAPTURE (RELIABLE)
_ _ _ _ _ _	BASED ON ACTUAL DATA BEYOND 70% CAPTURE (LESS RELIABLE, CONSERVATIVE)

CHART 6

PINE RIVERS SHIRE COUNCIL TYPE A CATCHPIT CAPACITY CHARTS



L LINTEL - ROAD CROSSFALL 1:40



L LINTEL - ROAD CROSSFALL 1:30

ON GRADE CAPTURE

(FOR MOUNTABLE OR BARRIER KERB)

* CONTROL WATER LEVEL - 150mm BELOW CHANNEL INVERT.

* 10% BLOCKAGE FACTOR APPLIED

LEGEND:

_ %.	KERB AND CHANNEL LONGITUDINAL SLOPE
________	BASED ON ACTUAL DATA UP TO 70% CAPTURE (RELIABLE)
_ _ _ _ _ _	BASED ON ACTUAL DATA BEYOND 70% CAPTURE (LESS RELIABLE, CONSERVATIVE)

CHART 7

PINE RIVERS SHIRE COUNCIL - RAINFALL INTENSITY CHARTS

DURATION (MINS)	AVERAGE RECURRENCE INTERVAL 1 YEAR mm/hr	2 YEAR mm/hr	5 YEAR mm/hr	10 YEAR mm/hr	20 YEAR mm/hr	50 YEAR mm/hr	100 YEAR mm/hr
5.0	118	150	189	216	245	294	329
5.2	117	149	187	213	243	290	324
5.4	115	147	185	211	240	286	319
5.6	114	146	183	208	238	282	315
5.8	112	144	182	205	235	278	310
6.0	111	143	180	203	233	274	305
6.2	110	141	178	201	231	271	302
6.4	109	140	176	198	228	268	299
6.6	107	138	174	196	226	265	296
6.8	106	136	173	194	223	262	292
7.0	105	135	171	192	221	259	289
7.2	104	133	169	190	219	257	287
7.4	103	132	167	188	217	254	284
7.6	102	131	166	186	215	252	281
7.8	101	129	164	185	212	250	278
8.0	100	128	162	183	210	247	276
8.5	97	125	159	179	206	242	270
9.0	95	122	155	175	201	237	264
9.5	93	120	152	171	197	232	259
10.0	91	117	149	168	193	227	254
10.5	89	115	146	164	189	223	249
11.0	87	112	143	161	186	219	244
11.5	86	110	140	158	183	215	240
12.0	84	108	138	156	179	211	236
12.5	83	106	135	153	176	208	232
13.0	81	105	133	150	173	204	228
13.5	80	103	131	148	171	201	225
14.0	79	101	129	146	168	198	222
14.5	77	100	127	143	166	195	218
15.0	76	98	125	141	163	192	215
15.5	75	97	123	139	161	190	212
16.0	74	95	121	137	159	187	209
16.5	73	94	120	135	157	185	207
17.0	72	93	118	134	154	182	204
17.5	71	91	117	132	152	180	201
18.0	70	90	115	130	150	178	199
18.5	69	89	114	129	149	176	197
19.0	68	88	112	127	147	174	194

DURATION (MINS)	AVERAGE RECURRENCE INTERVAL 1 YEAR mm/hr	2 YEAR mm/hr	5 YEAR mm/hr	10 YEAR mm/hr	20 YEAR mm/hr	50 YEAR mm/hr	100 YEAR mm/hr
19.5	67	87	111	126	145	171	192
20.0	66	86	110	124	143	169	190
20.5	66	85	108	123	142	168	188
21.0	65	84	107	121	141	166	186
21.5	64	83	106	120	139	164	184
22.0	64	82	105	119	138	163	182
22.5	63	81	104	118	136	161	180
23.0	62	80	103	116	135	159	179
23.5	61	79	102	115	133	158	177
24.0	61	78	101	114	132	156	175
24.5	60	77	99	113	130	154	173
25.0	59	77	98	111	129	153	171
26.0	58	75	97	110	127	150	168
27.0	57	74	95	108	125	148	165
28.0	56	72	93	106	122	145	163
29.0	55	71	91	104	120	142	160
30.0	54	70	90	102	118	140	157
31.0	53	69	88	100	116	138	155
32.0	53	68	88	100	115	137	153
33.0	52	68	87	99	115	136	152
34.0	52	67	86	98	114	135	151
35.0	50	64	83	94	109	130	145
36.0	49	63	82	93	108	128	144
37.0	48	62	81	92	106	126	142
38.0	48	62	79	90	105	124	140
39.0	47	61	78	89	103	123	138
40.0	46	60	77	88	102	121	136
45.0	43	56	73	83	96	114	128
50.0	41	53	69	78	91	108	121
55.0	39	50	65	74	86	103	115
60.0	37	48	62	71	82	98	110
90.0	28	37	48	54	63	75	85
120.0	24	31	39	45	52	62	70
150.0	21	27	35	40	46	55	61
180.0	18	23	30	34	40	47	53
210.0	16	21	27	31	36	43	48
240.0	15	19	25	28	33	39	44
360.0	11	15	19	22	25	30	33

Based on coefficients issued by the Bureau of Meteorology - Melbourne 1988 Ref FN2615 For 27°18' S 153°06' E

21-7-94

Calculated in accordance with Chapter 2, Australian Rainfall & Runoff - 1987 Edition

CHART 8

PINE RIVERS SHIRE COUNCIL - HYDRAULIC DESIGN CALCULATION SHEET

LOCATION				TIME			SUB-CATCHMENT RUNOFF						
1	2	3	4	5	6	7	8	9	10	11	12	13	14
						t_c	I	C	A	(CxA)	Σ (CxA)	Q	
DESIGN A.R.I.	STRUCTURE NO.	DRAIN SECTION	SUB-CATCHMENTS CONTRIBUTING	SURFACE CONDITION (LAND USE)	SLOPE OF CATCHMENT	SUB-CATCHMENT TIME OF CONCENTRATION	RAINFALL INTENSITY	COEFFICIENT OF RUNOFF	SUBCATCHMENT AREA	EQUIVALENT AREA	SUM OF CONTRIBUTING EQUIVALENT AREAS	SUB-CATCHMENT DISCHARGE	FLOW PAST PREVIOUS GULLIES
							From Intensity Chart			(9) x (10)	■ (11)	(8) x (12) / 360	■ (24)
years					%	min	mm/hr		ha	ha	ha	m³/sec	m³/sec

INLET DESIGN											DRAIN DESIGN											
15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37
			W_f	d_g	V_g				Q_g		t_c	I	Σ (CxA)	Q_t	Q_m	Q_s	Q_o	L	S		V	T
FLOW IN K & C (INCLUDING BYPASS)	ROAD GRADE AT INLET	K - K WIDTH	FLOW WIDTH	FLOW DEPTH AT INVERT	GUTTER FLOOD VELOCITY	dg x Vg	INLET NUMBER	INLET TYPE	FLOW INTO INLET	BYPASS FLOW	CRITICAL TIME OF CONCENTRATION	RAINFALL INTENSITY	TOTAL CONTRIBUTING EQUIVALENT AREA	MAJOR TOTAL FLOW	MAJOR SURFACE FLOW CAPACITY	MAJOR SURFACE FLOW	FLOW IN PIPE	REACH LENGTH	PIPE GRADE	PIPE / BOX DIMENSIONS	FLOW VELOCITY	TIME OF FLOW IN REACH
(13) + (14)						(20) x (19)		From Std. Drg.	From Charts	(15) - (24)		From Intensity Chart	■ of U/S (12)								(32) / Area of Sect	(33) / (36) x 60
m³/sec	%	m	m	m		m²/sec			m³/sec	m³/sec	min	mm/hr	ha	m³/sec	m³/sec	m³/sec	m³/sec	m	%	mm	m/sec	min

CHART 9

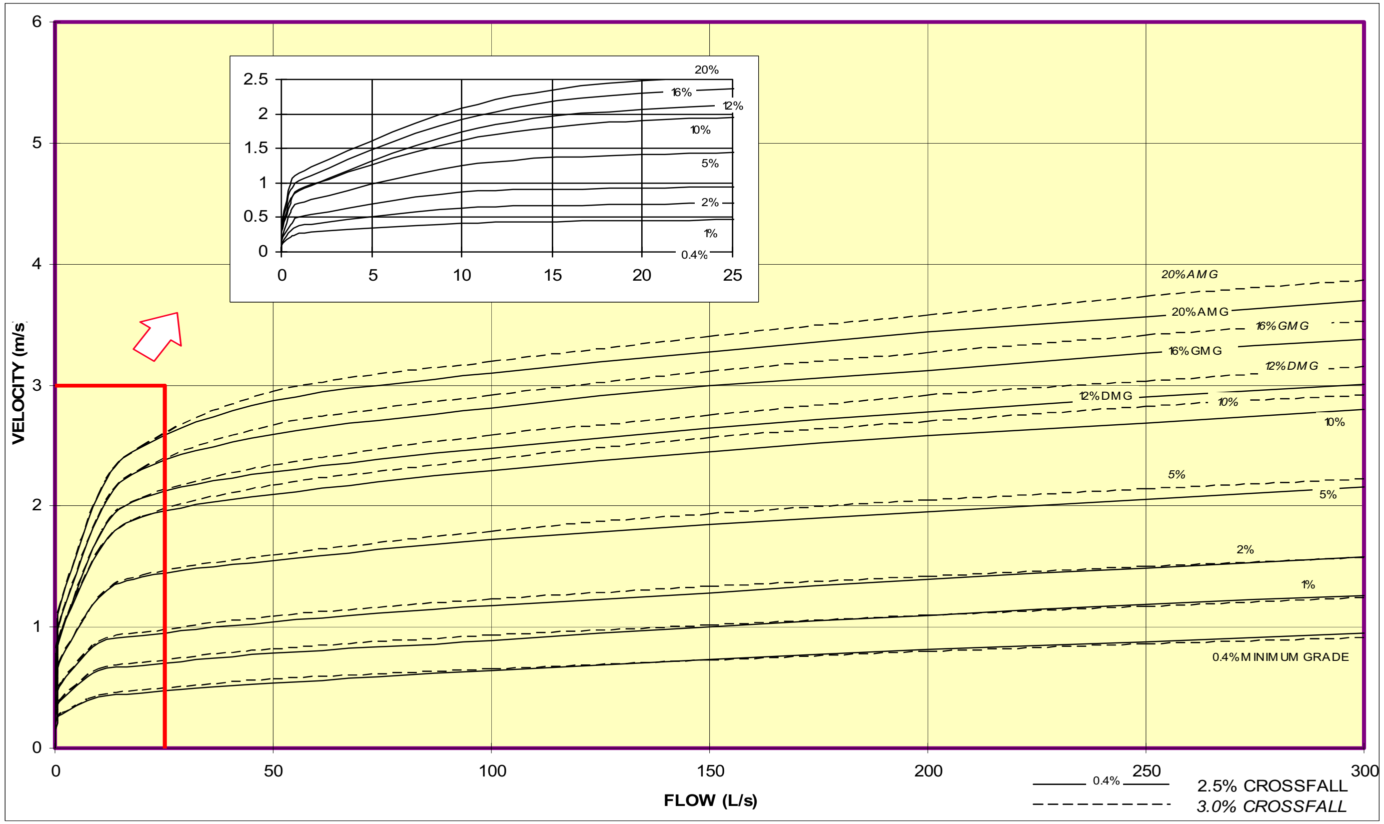
PINE RIVERS SHIRE COUNCIL -HYDRAULIC DESIGN CALCULATION SHEET

HEADLOSSES											PART FULL	
38	39	40	41	42	43	44	45	46	47	48	49	50
	RATIOS	$V^2/2g$	K_u	h_u	K_L	h_L	K_W	h_W	S_f	h_f		V_p
STRUCTURE CHART No.	STRUCTURE RATIOS FOR "K" VALUE CALCULATIONS	VELOCITY HEAD	U/S HEADLOSS COEFFICIENT	U/S PIPE STRUCTURE HEADLOSS	LATERAL HEADLOSS COEFFICIENT	LATERAL PIPE STRUCTURE HEADLOSS	W.S.E. COEFFICIENT	CHANGE IN W.S.E.	FRICTION SLOPE	PIPE FRICTION HEADLOSS	DEPTH	VELOCITY
FROM Q.U.D.M. CHARTS VOLUME 2		$\frac{(36) \times (36)}{2g}$	From Q.U.D.M. Volume 2	(40) x (41)	From Q.U.D.M. Volume 2		From Q.U.D.M. Volume 2		From Sect. 14.5.7 A.R.R. Vol. 1 1987	$\frac{(47) \times (33)}{100}$		
		m		m		m		m	%	m	m	m/sec

DESIGN LEVELS								REMARKS
51	52	53	54	55	56	57	58	59
OBVERT LEVELS	DRAIN SECTION H.G.L.	U/S H.G.L.	LATERAL H.G.L.	W.S.E.	SURFACE OR K & C INVERT LEVEL	FREEBOARD	STRUCTURE NO.	
U/S RL D/S RL	U/S RL D/S RL							
m	m	m	m	m	m	m		

CHART 10

PINE RIVERS SHIRE COUNCIL
THEORETICAL VELOCITY AND CAPACITY CHART FOR 1/2 ROAD

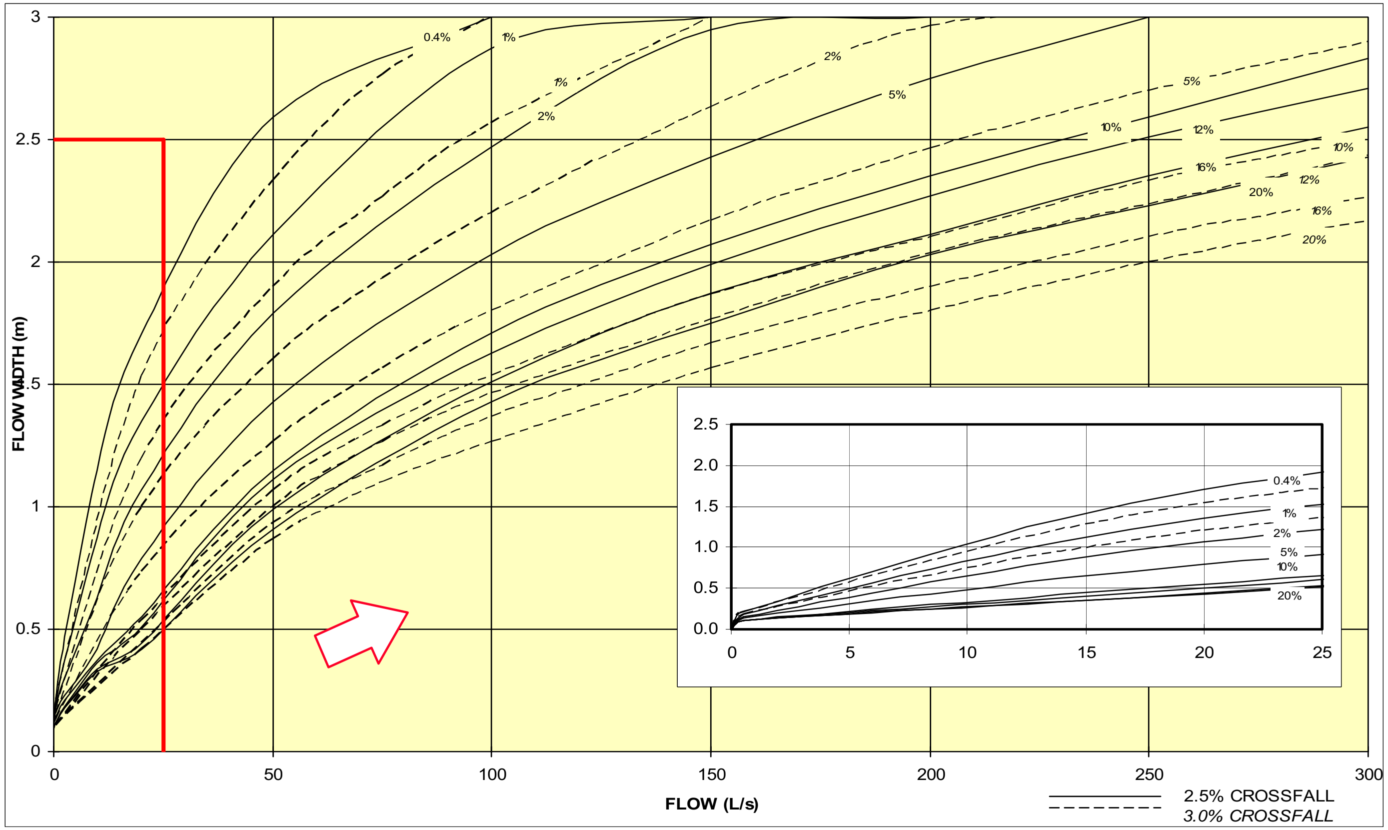


AMG = ABSOLUTE MAXIMUM GRADE
GMG = GENERAL MAXIMUM GRADE
DMG = DESIRABLE MAXIMUM GRADE

FOR ALL ROAD TYPES OF WIDTH GREATER THAN OR EQUAL TO 6.0m.

CHART 11

PINE RIVERS SHIRE COUNCIL
THEORETICAL FLOW WIDTH AND CAPACITY CHART FOR 1/2 ROAD



NOTE: IF 3.0% CROSSFALL CURVE IS NOT GIVEN THE CURVE IS THE SAME AS FOR 2.5% CROSSFALL

ROAD TYPE: URBAN RESIDENTIAL STREET

CLASSIFICATION: ACCESS PLACE

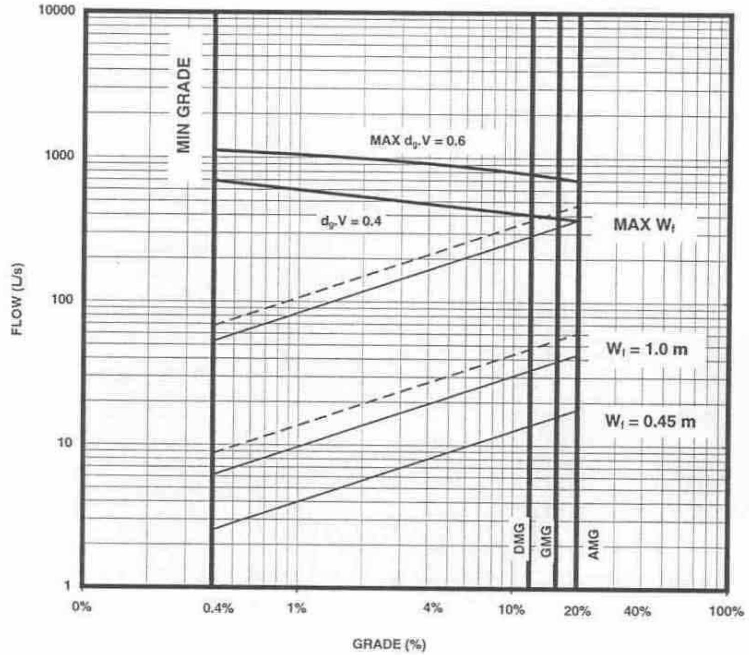
ROAD WIDTH: 6.0 m

STD. DWG: 8-10001, 8-10008

CHART 12

PINE RIVERS SHIRE COUNCIL
DESIGN CAPACITY CHARTS FOR 1/2 ROAD

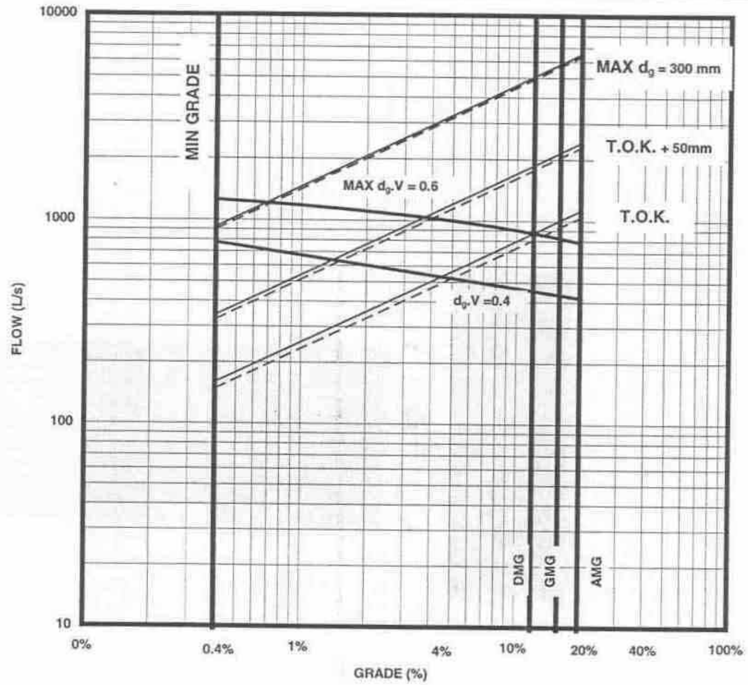
PINE RIVERS



MINOR STORM

—— 2.5% CROSSFALL
– – – 3.0% CROSSFALL

NOTE:- 2.5% CROSSFALL AND 3.0% CROSSFALL ARE ON THE SAME CURVE FOR $W_f = 0.45$ m



MAJOR STORM

—— 2.5 % CROSSFALL
– – – 3.0% CROSSFALL
T.O.K. = TOP OF KERB

NOTE: DESIGN CAPACITY = 80% OF THEORETICAL CAPACITY

AMG = ABSOLUTE MAXIMUM GRADE
GMG = GENERAL MAXIMUM GRADE
DMG = DESIRABLE MAXIMUM GRADE

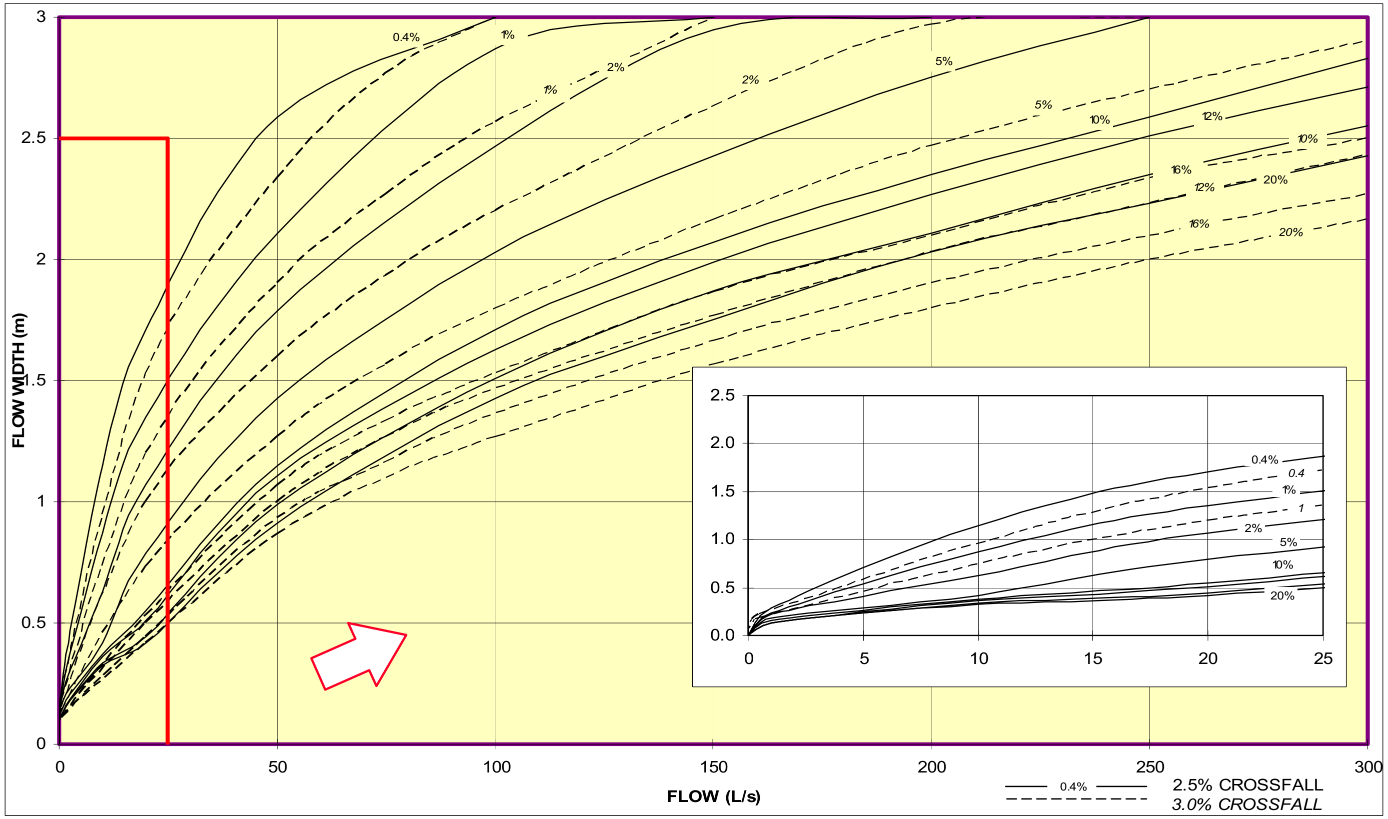
Wf = FLOW WIDTH

ROAD TYPE: URBAN RESIDENTIAL STREET
CLASSIFICATION: ACCESS PLACE
ROAD WIDTH: 6.0 m

STD. DWG: 8-10001, 8-10008

CHART 13

PINE RIVERS SHIRE COUNCIL
THEORETICAL FLOW WIDTH AND CAPACITY CHART FOR 1/2 ROAD



NOTE: IF 3.0% CROSSFALL CURVE IS NOT GIVEN THE CURVE IS THE SAME AS FOR 2.5% CROSSFALL

ROAD TYPE: URBAN RESIDENTIAL STREET

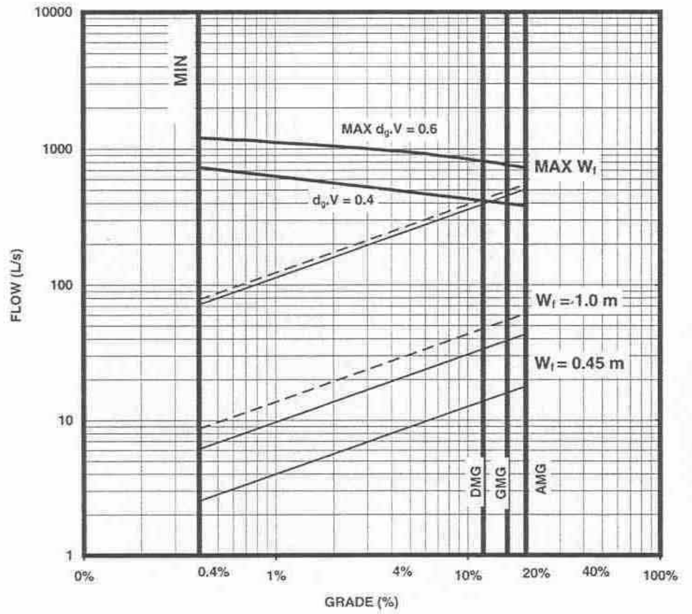
CLASSIFICATION: ACCESS STREET

ROAD WIDTH: 6.0 m

STD. DWG: 8-10001, 8-10008

CHART 14

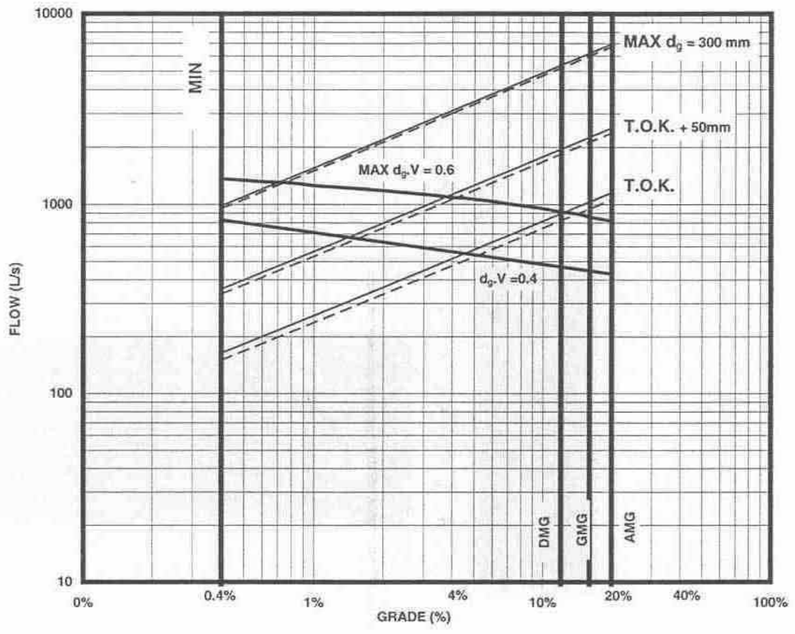
PINE RIVERS SHIRE COUNCIL
DESIGN CAPACITY CHARTS FOR 1/2 ROAD



MINOR STORM

—— 2.5% CROSSFALL
– – – 3.0% CROSSFALL

NOTE:- 2.5% CROSSFALL AND 3.0% CROSSFALL ARE ON THE SAME CURVE FOR W_f = 0.45 m



MAJOR STORM

—— 2.5 % CROSSFALL
– – – 3.0% CROSSFALL
T.O.K. = TOP OF KERB

CHART 6

NOTE: DESIGN CAPACITY = 80% OF THEORETICAL CAPACITY

AMG = ABSOLUTE MAXIMUM GRADE
GMG = GENERAL MAXIMUM GRADE
DMG = DESIRABLE MAXIMUM GRADE

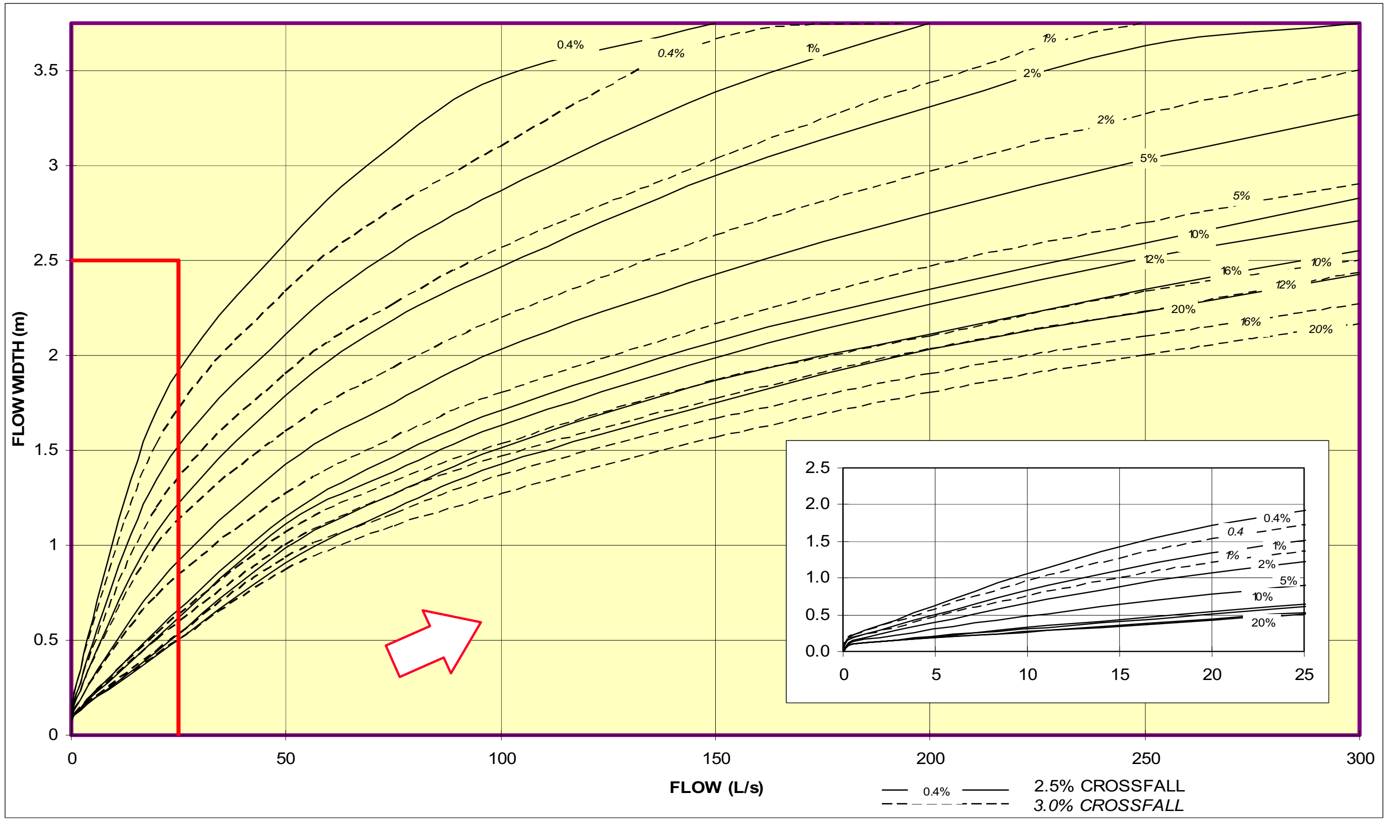
W_f = FLOW WIDTH

ROAD TYPE: URBAN RESIDENTIAL STREET
CLASSIFICATION: ACCESS STREET
ROAD WIDTH: 6.0 m

STD. DWG: 8-10001, 8-10008

CHART 15

PINE RIVERS SHIRE COUNCIL
THEORETICAL FLOW WIDTH AND CAPACITY CHART FOR 1/2 ROAD



NOTE: IF 3.0% CROSSFALL CURVE IS NOT GIVEN THE CURVE IS THE SAME AS FOR 2.5% CROSSFALL

ROAD TYPE: URBAN RESIDENTIAL STREET

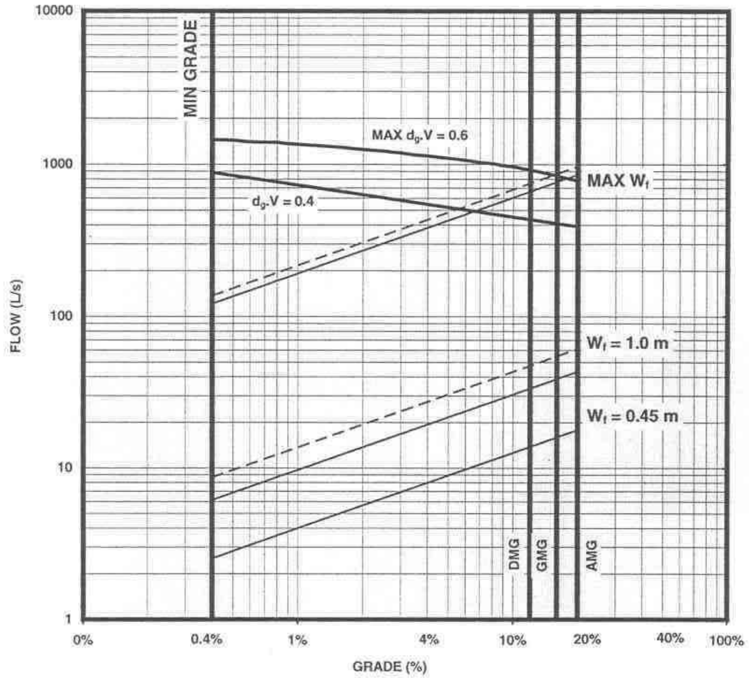
CLASSIFICATION: COLLECTOR

ROAD WIDTH: 7.5m

STD. DWG: 8-10002, 8-10008

CHART 16

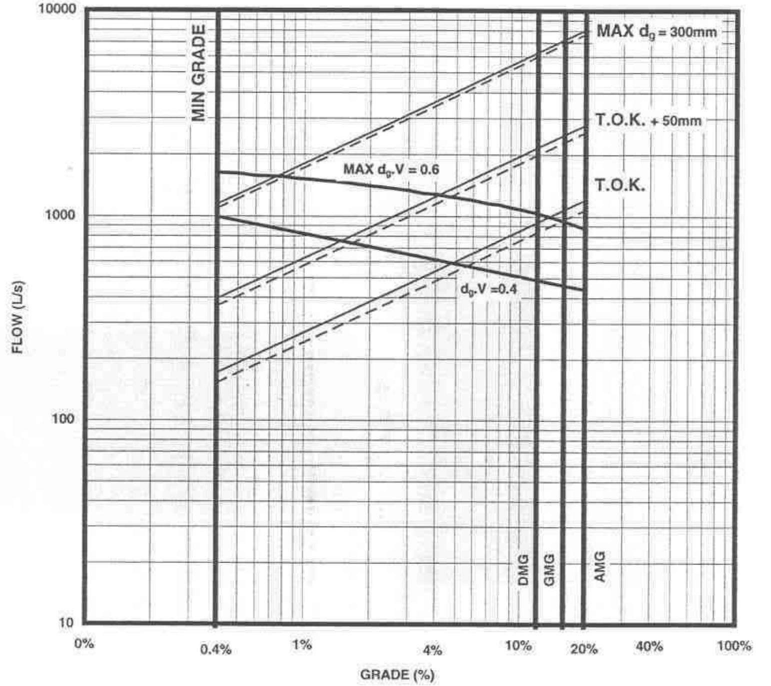
PINE RIVERS SHIRE COUNCIL
DESIGN CAPACITY CHARTS FOR 1/2 ROAD



MINOR STORM

——— 2.5% CROSSFALL
– – – 3.0% CROSSFALL

NOTE:- 2.5% CROSSFALL AND 3.0% CROSSFALL ARE ON THE SAME CURVE FOR $W_f = 0.45$ m



MAJOR STORM

——— 2.5 % CROSSFALL
– – – 3.0% CROSSFALL
T.O.K. = TOP OF KERB

NOTE: DESIGN CAPACITY = 80% OF THEORETICAL CAPACITY

AMG = ABSOLUTE MAXIMUM GRADE
GMG = GENERAL MAXIMUM GRADE
DMG = DESIRABLE MAXIMUM GRADE

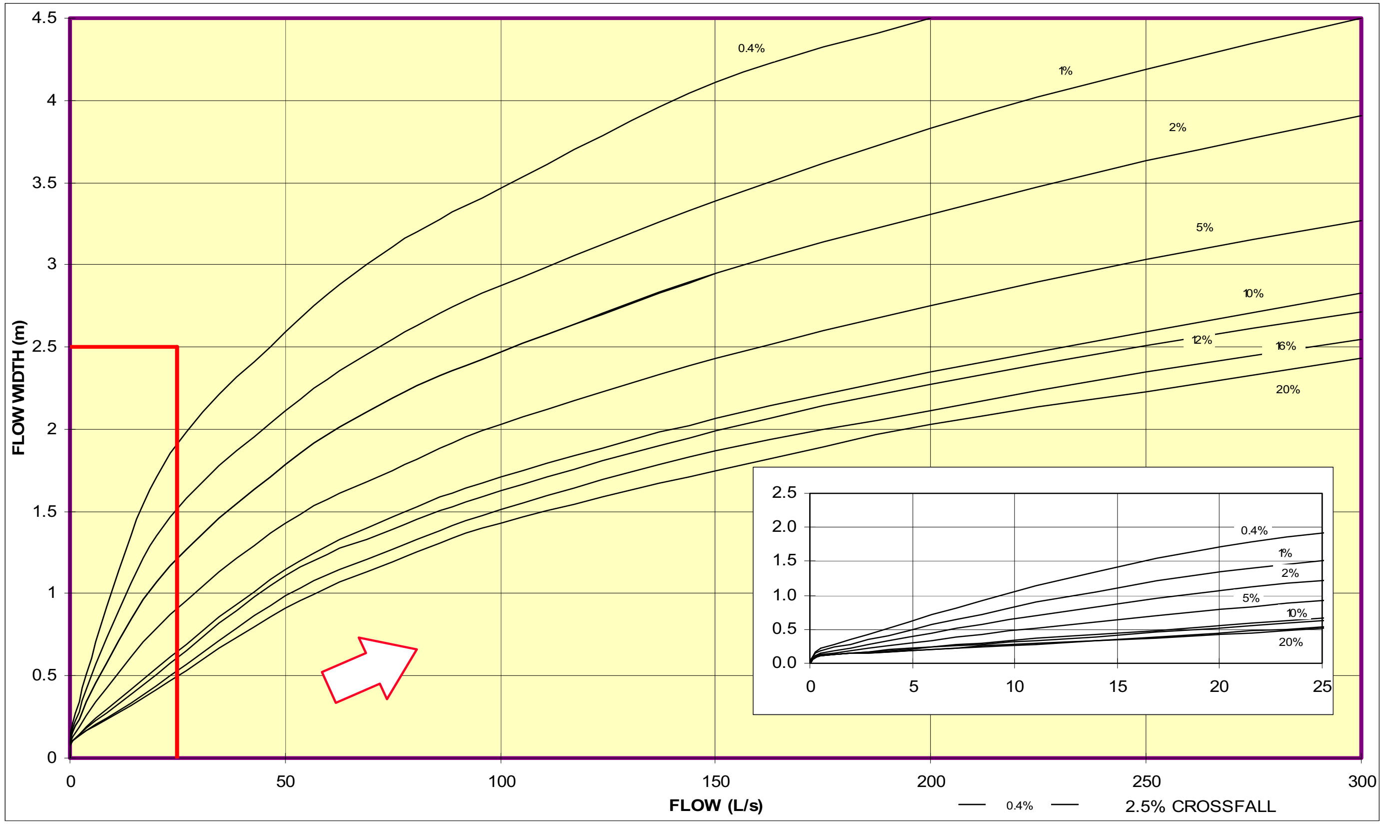
W_f = FLOW WIDTH

ROAD TYPE: URBAN RESIDENTIAL STREET
CLASSIFICATION: COLLECTOR
ROAD WIDTH: 7.5m

STD. DWG: 8-10002, 8-10008

CHART 17

PINE RIVERS SHIRE COUNCIL
THEORETICAL FLOW WIDTH AND CAPACITY CHART FOR 1/2 ROAD



ROAD TYPE: URBAN RESIDENTIAL STREET

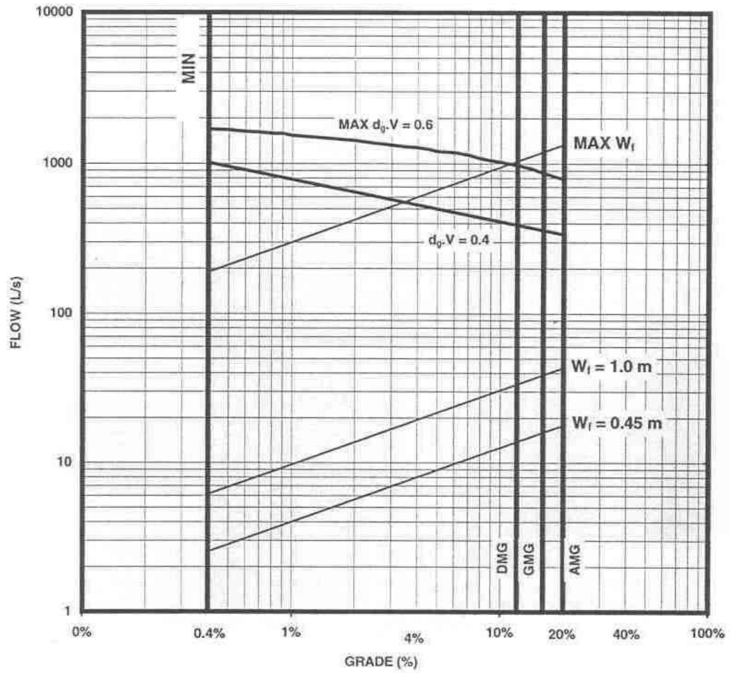
CLASSIFICATION: TRUNK COLLECTOR

ROAD WIDTH: 9.0m

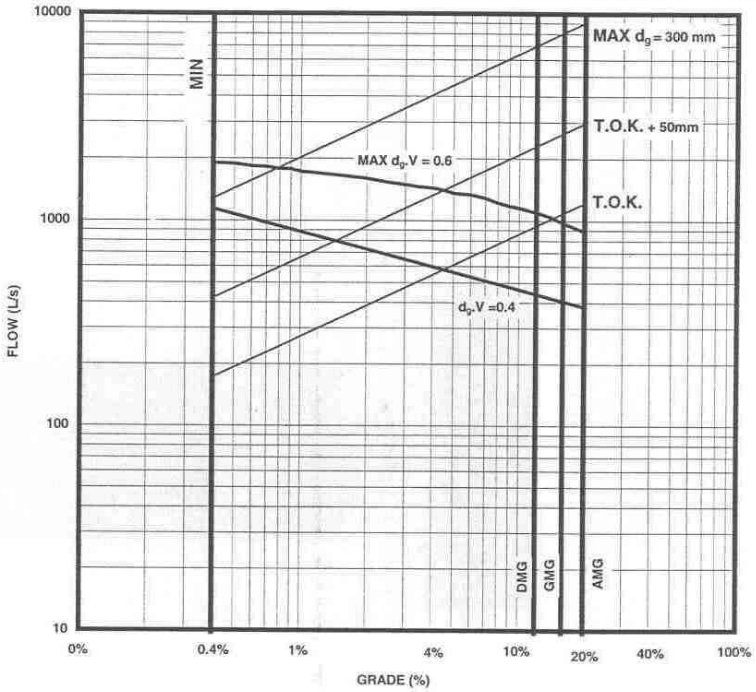
STD. DWG: 8-10005, 8-10010

CHART 18

PINE RIVERS SHIRE COUNCIL
DESIGN CAPACITY CHARTS FOR 1/2 ROAD



MINOR STORM —— 2.5% CROSSFALL



MAJOR STORM —— 2.5 % CROSSFALL
T.O.K. = TOP OF KERB

NOTE: DESIGN CAPACITY = 80% OF THEORETICAL CAPACITY

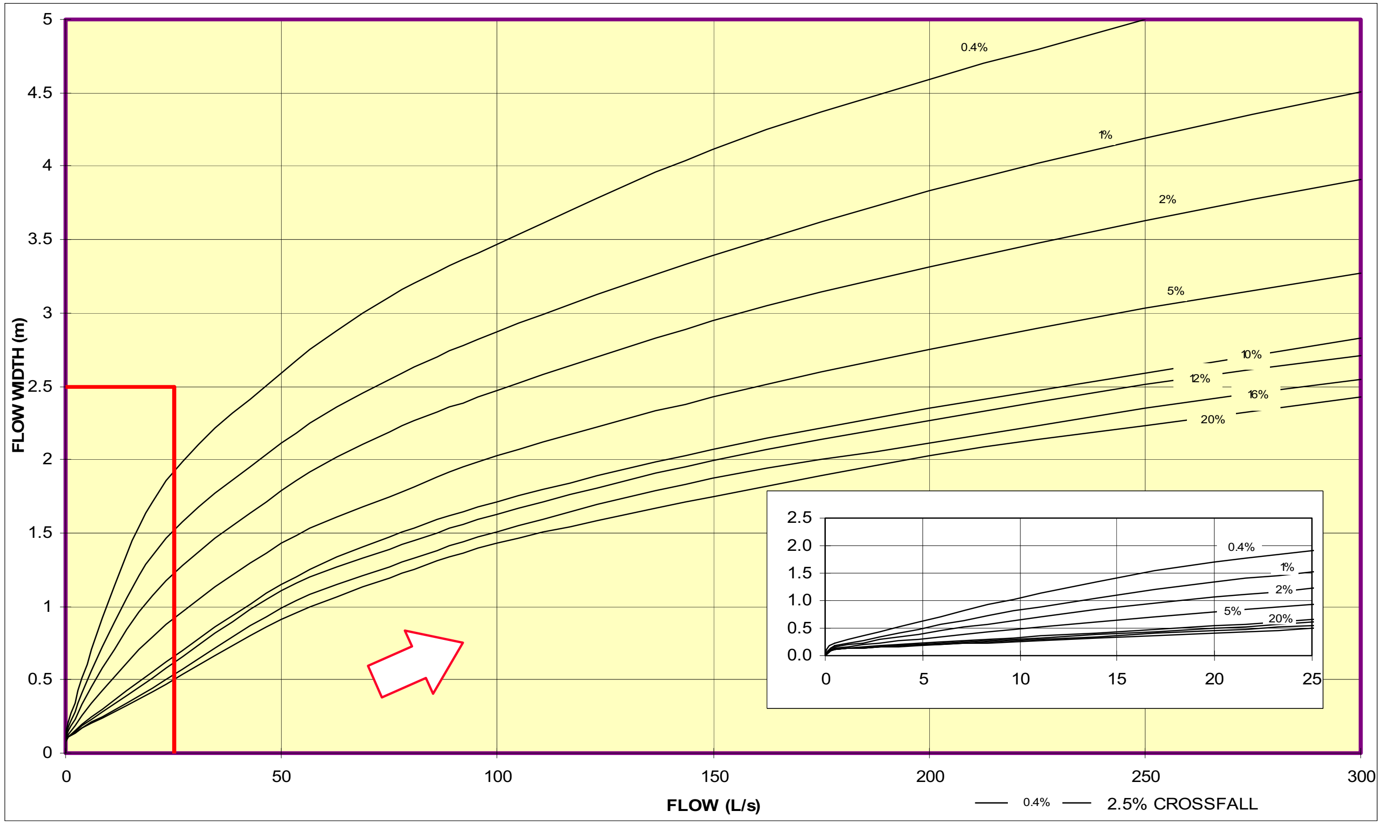
AMG = ABSOLUTE MAXIMUM GRADE
GMG = GENERAL MAXIMUM GRADE
DMG = DESIRABLE MAXIMUM GRADE

W_f = FLOW WIDTH

ROAD TYPE: URBAN RESIDENTIAL STREET
CLASSIFICATION: TRUNK COLLECTOR
ROAD WIDTH: 9.0m

STD. DWG: 8-10005, 8-10010
CHART 19

PINE RIVERS SHIRE COUNCIL
THEORETICAL FLOW WIDTH AND CAPACITY CHART FOR 1/2 ROAD

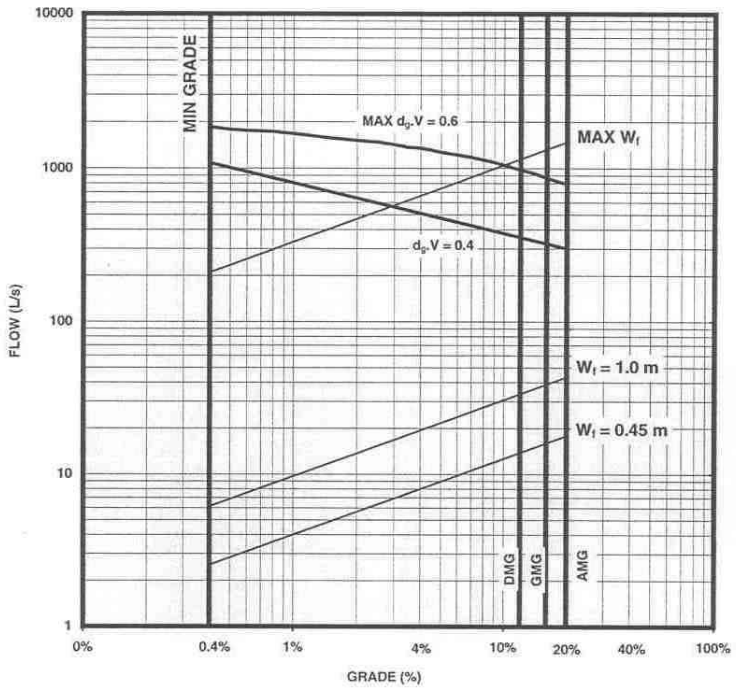


ROAD TYPE: URBAN RESIDENTIAL STREET
CLASSIFICATION: DIVIDED TRUNK COLLECTOR
ROAD WIDTH: 5.0m each side

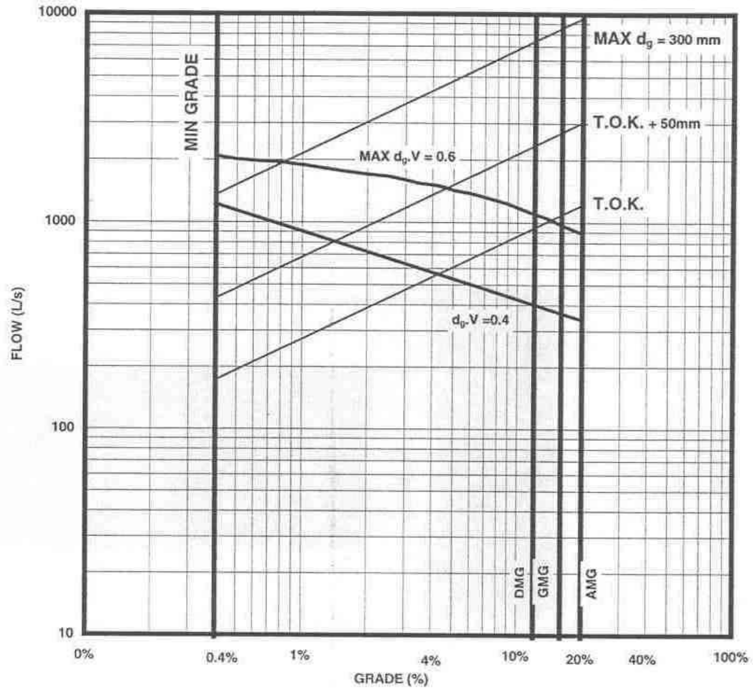
STD. DWG: 8-10005, 8-10010

CHART 20

PINE RIVERS SHIRE COUNCIL
DESIGN CAPACITY CHARTS FOR 1/2 ROAD



MINOR STORM — 2.5% CROSSFALL



MAJOR STORM — 2.5 % CROSSFALL
T.O.K. = TOP OF KERB

NOTE: DESIGN CAPACITY = 80% OF THEORETICAL CAPACITY

AMG = ABSOLUTE MAXIMUM GRADE
GMG = GENERAL MAXIMUM GRADE
DMG = DESIRABLE MAXIMUM GRADE

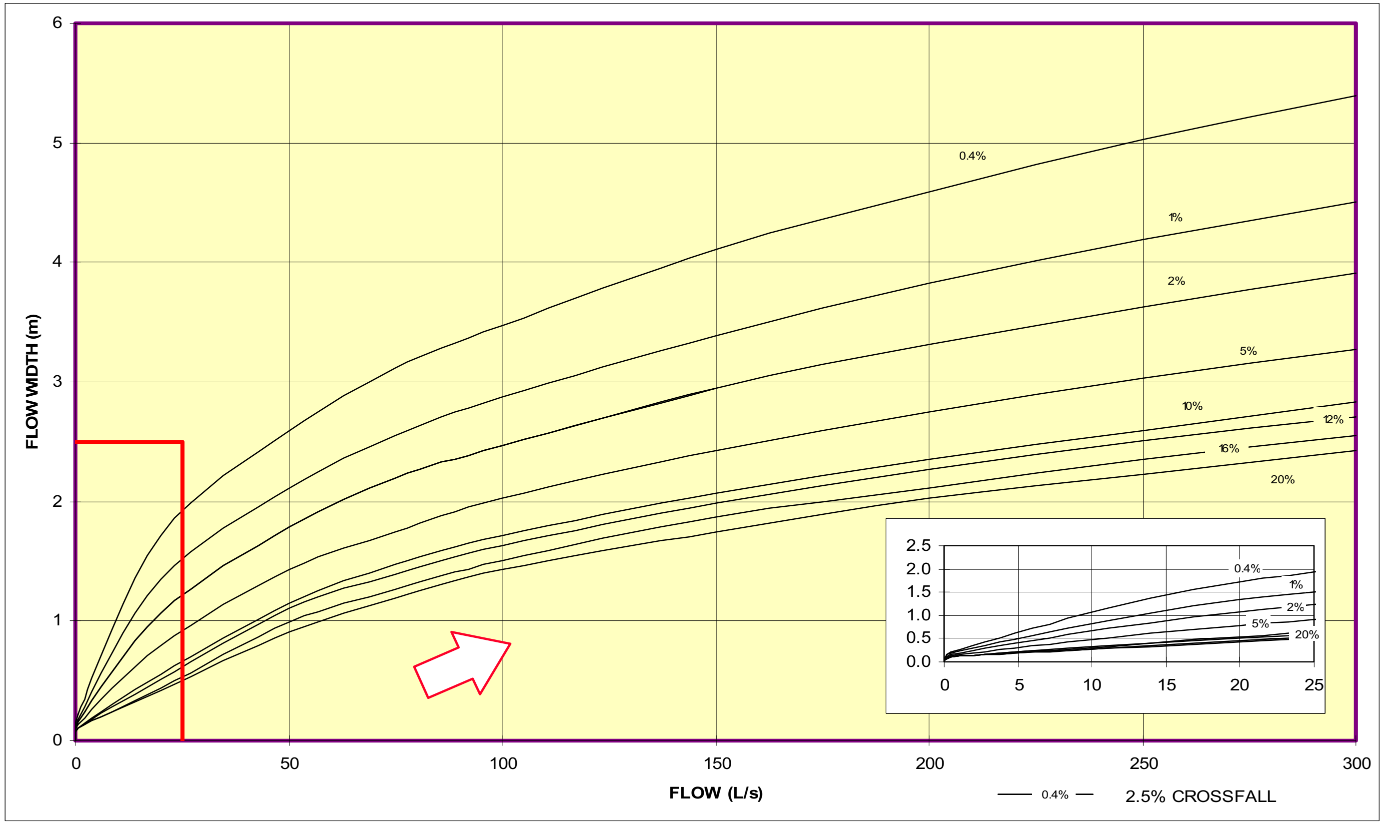
W_f = FLOW WIDTH

ROAD TYPE: URBAN RESIDENTIAL STREET
CLASSIFICATION: DIVIDED TRUNK COLLECTOR
ROAD WIDTH: 5.0m each side

STD. DWG: 8-10005, 8-10010

CHART 21

PINE RIVERS SHIRE COUNCIL
THEORETICAL FLOW WIDTH AND CAPACITY CHART FOR 1/2 ROAD

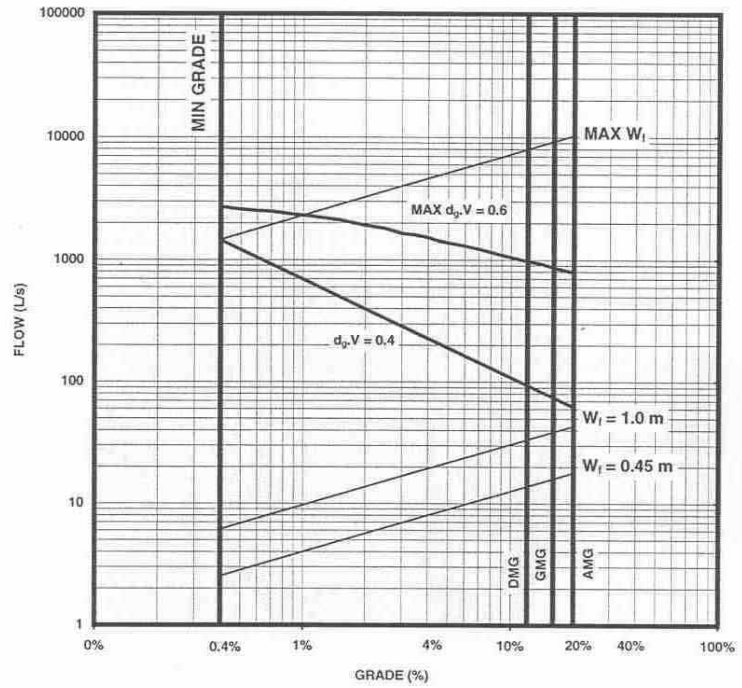


ROAD TYPE: URBAN MAJOR ROAD
CLASSIFICATION: ARTERIAL
ROAD WIDTH: 8.5m each side

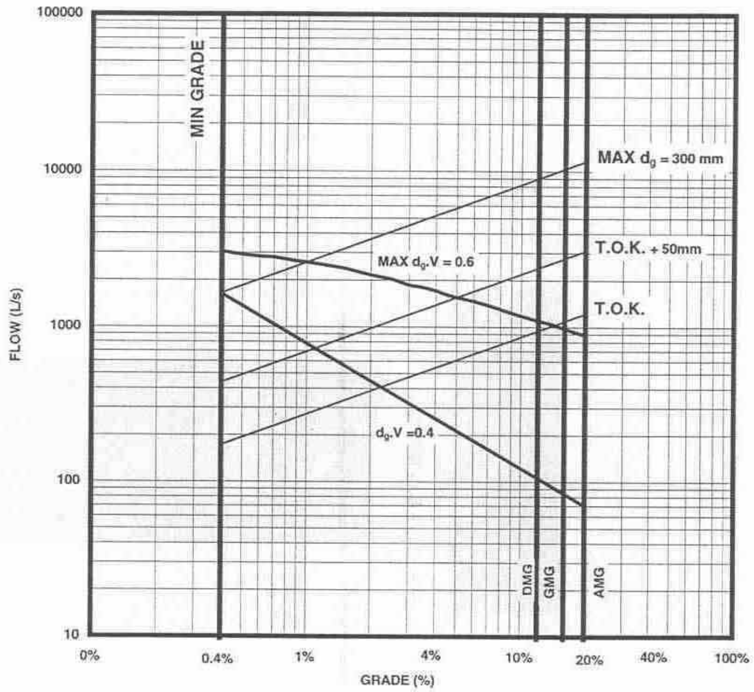
STD. DWG: 8-10007, 8-10009

CHART 22

PINE RIVERS SHIRE COUNCIL
DESIGN CAPACITY CHARTS FOR 1/2 ROAD



MINOR STORM — 2.5% CROSSFALL



MAJOR STORM — 2.5 % CROSSFALL
T.O.K. = TOP OF KERB

CHART 14

NOTE: DESIGN CAPACITY = 80% OF THEORETICAL CAPACITY

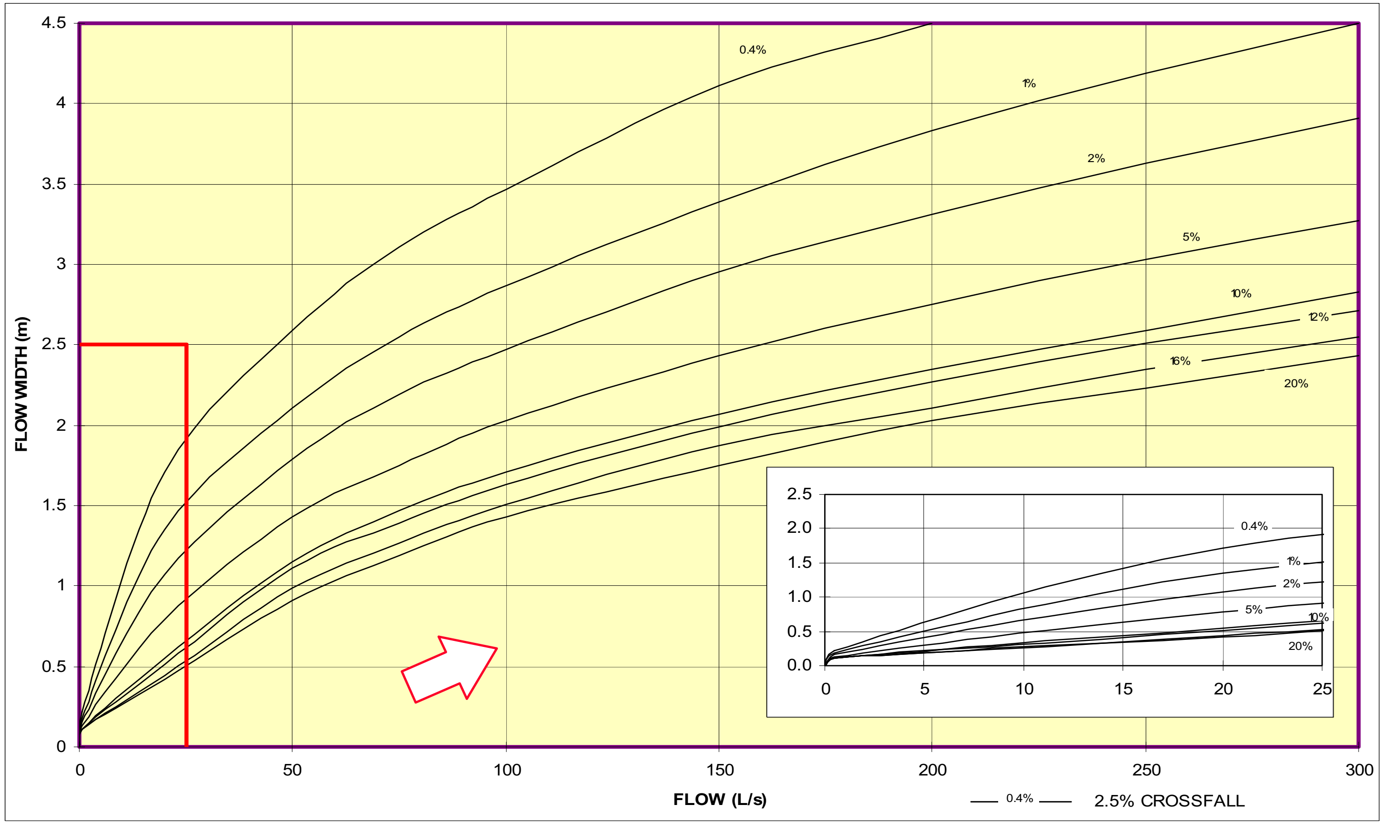
AMG = ABSOLUTE MAXIMUM GRADE
GMG = GENERAL MAXIMUM GRADE
DMG = DESIRABLE MAXIMUM GRADE

W_f = FLOW WIDTH

ROAD TYPE: URBAN MAJOR ROAD
CLASSIFICATION: ARTERIAL
ROAD WIDTH: 8.5m each side

STD. DWG: 8-10007, 8-10009
CHART 23

PINE RIVERS SHIRE COUNCIL
THEORETICAL FLOW WIDTH AND CAPACITY CHART FOR 1/2 ROAD



NOTE: DESIGN CAPACITY = 80% OF THEORETICAL CAPACITY

ROAD TYPE: URBAN MAJOR ROAD

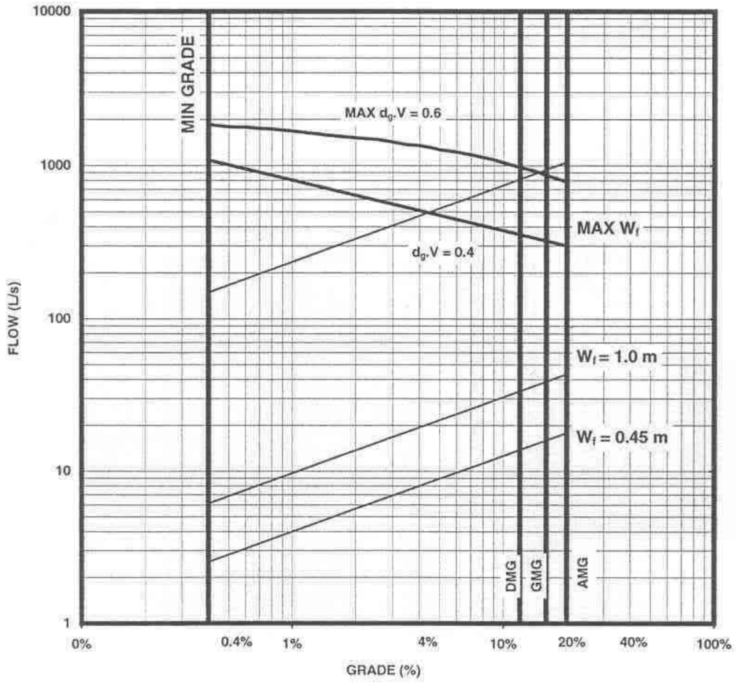
CLASSIFICATION: SUB ARTERIAL

ROAD WIDTH: 9.0m

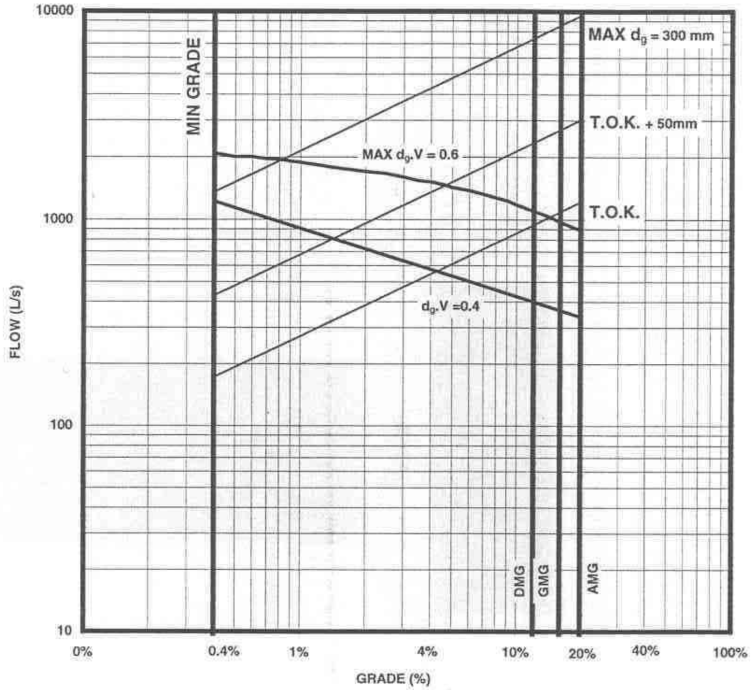
STD. DWG: 8-10006, 8-10009

CHART 24

PINE RIVERS SHIRE COUNCIL
DESIGN CAPACITY CHARTS FOR 1/2 ROAD



MINOR STORM —— 2.5% CROSSFALL



MAJOR STORM —— 2.5 % CROSSFALL
T.O.K. = TOP OF KERB

NOTE: DESIGN CAPACITY = 80% OF THEORETICAL CAPACITY

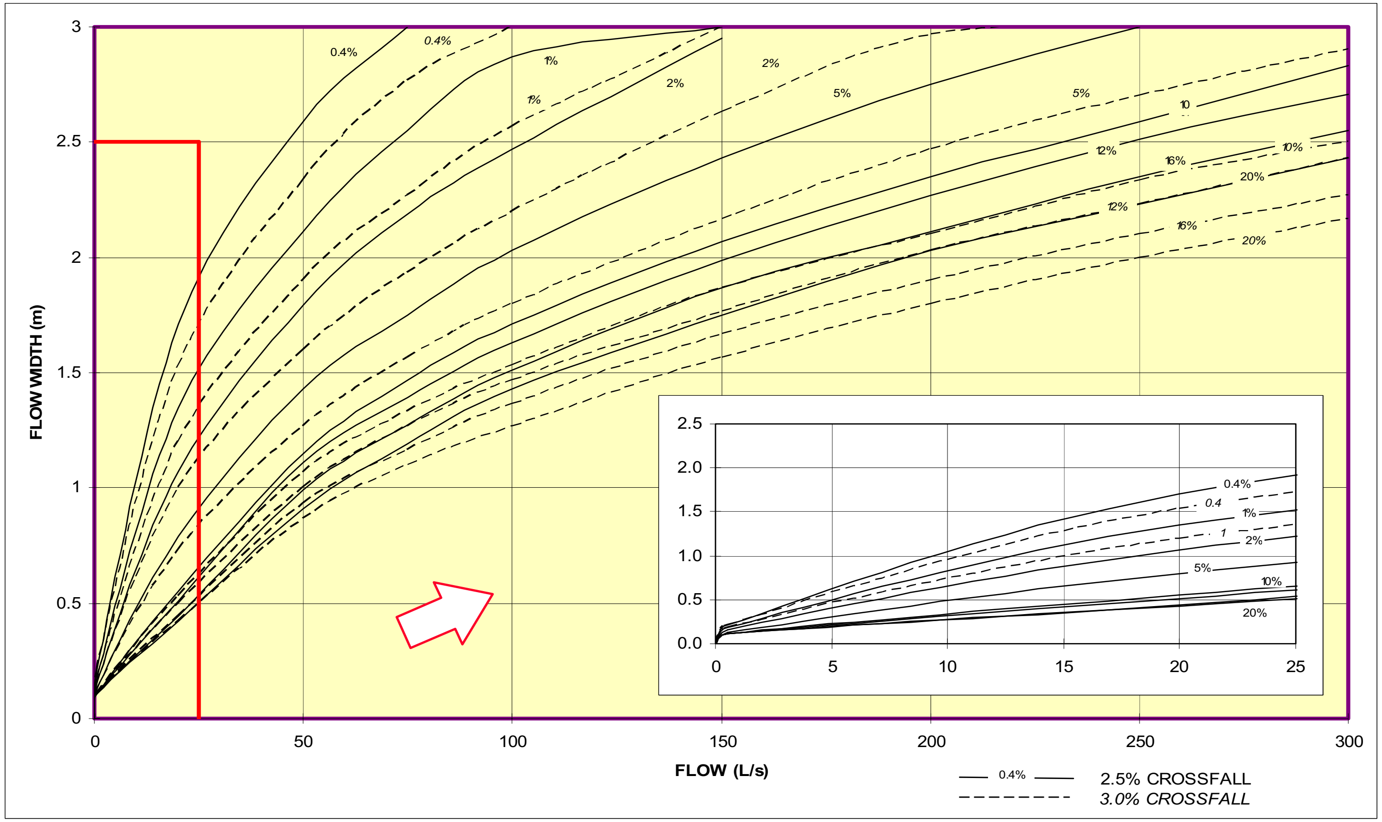
AMG = ABSOLUTE MAXIMUM GRADE
GMG = GENERAL MAXIMUM GRADE
DMG = DESIRABLE MAXIMUM GRADE

W_f = FLOW WIDTH

ROAD TYPE: URBAN MAJOR ROAD
CLASSIFICATION: SUB ARTERIAL
ROAD WIDTH: 9.0m

STD. DWG: 8-10006, 8-10009
CHART 25

PINE RIVERS SHIRE COUNCIL
THEORETICAL FLOW WIDTH AND CAPACITYCHART FOR 1/2 ROAD



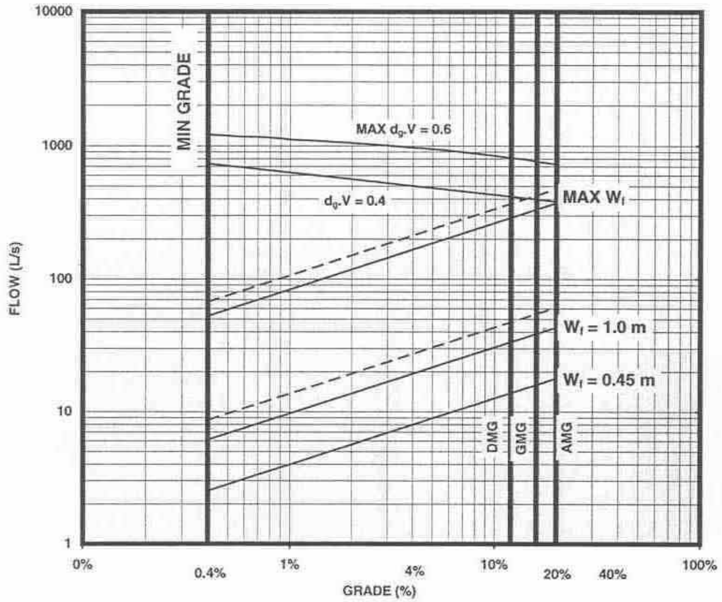
NOTE: IF 3.0% CROSSFALL IS NOT GIVEN THE CURVE IS THE SAME AS FOR THE 2.5% CROSSFALL

ROAD TYPE: NON-URBAN RURAL RESIDENTIAL STREET
CLASSIFICATION: ACCESS PLACE
ROAD WIDTH: 6.0 m

STD. DWG: 8-10017, 8-10020

CHART 26

PINE RIVERS SHIRE COUNCIL
DESIGN CAPACITY CHARTS FOR 1/2 ROAD



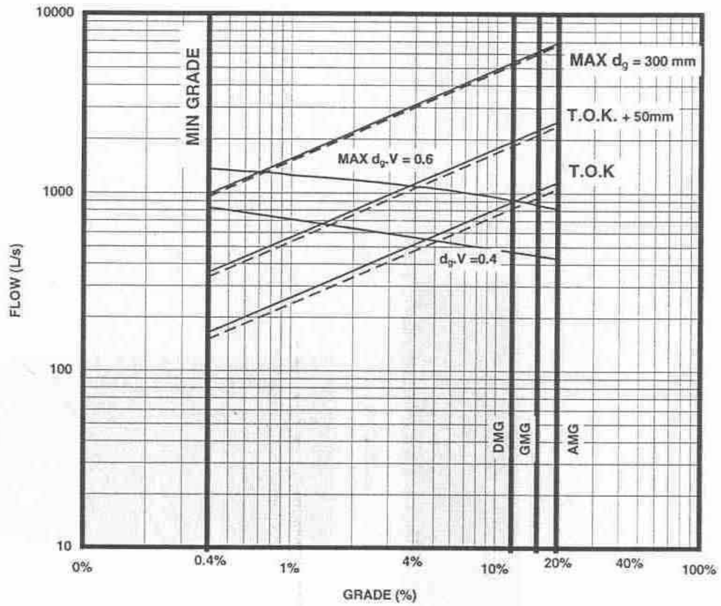


CHART 18

NOTE: DESIGN CAPACITY = 80% OF THEORETICAL CAPACITY

AMG = ABSOLUTE MAXIMUM GRADE
GMG = GENERAL MAXIMUM GRADE
DMG = DESIRABLE MAXIMUM GRADE

W_f = FLOW WIDTH

ROAD TYPE: NON-URBAN RURAL RESIDENTIAL STREET

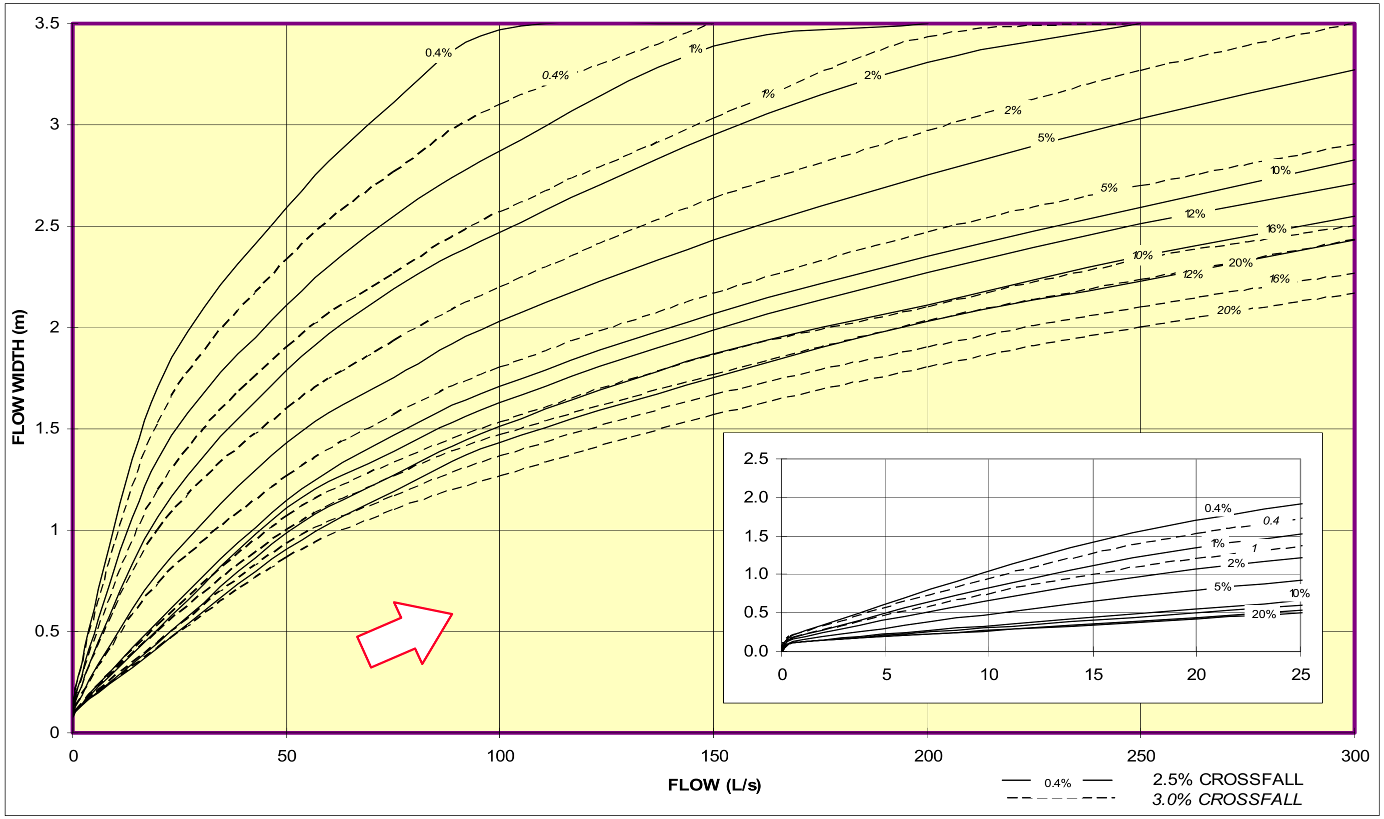
CLASSIFICATION: ACCESS PLACE

ROAD WIDTH: 6.0 m

STD. DWG: 8-10017, 8-10020

CHART 27

PINE RIVERS SHIRE COUNCIL
THEORETICAL FLOW WIDTH AND CAPACITY CHART FOR 1/2 ROAD



NOTE: IF 3.0% CROSSFALL CURVE IS NOT GIVEN THE CURVE IS THE SAME AS FOR 2.5% CROSSFALL

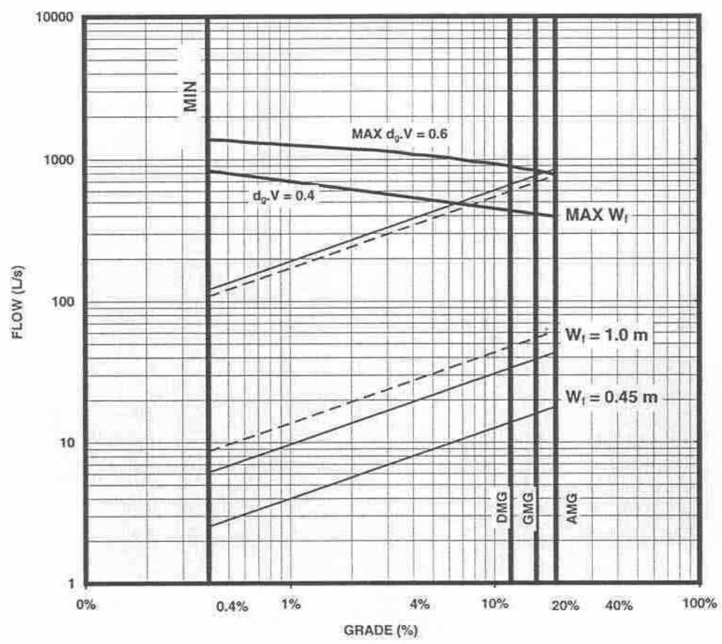
ROAD TYPE: **NON-URBAN RURAL RESIDENTIAL STREET**
CLASSIFICATION: **ACCESS STREET**
ROAD WIDTH: **7.0m**

STD. DWG: 8-10018, 8-10020

CHART 28

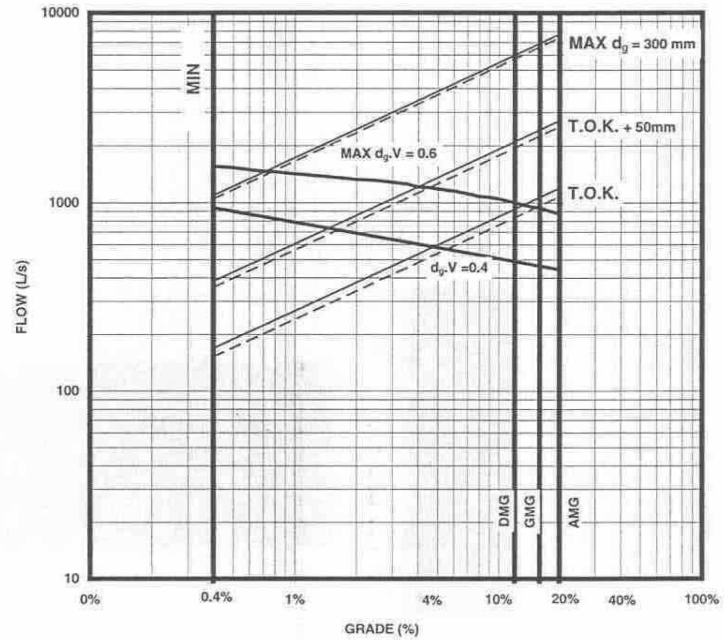
PINE RIVERS SHIRE COUNCIL
DESIGN CAPACITY CHARTS FOR 1/2 ROAD

PINE RIVERS



MINOR STORM —— 2.5% CROSSFALL
– – – *3.0% CROSSFALL*

NOTE:- 2.5% CROSSFALL AND 3.0% CROSSFALL ARE ON THE SAME CURVE FOR W_f = 0.45 m



MAJOR STORM —— 2.5 % CROSSFALL
– – – *3.0% CROSSFALL*
T.O.K. = TOP OF KERB

NOTE: DESIGN CAPACITY = 80% OF THEORETICAL CAPACITY

AMG = ABSOLUTE MAXIMUM GRADE
GMG = GENERAL MAXIMUM GRADE
DMG = DESIRABLE MAXIMUM GRADE

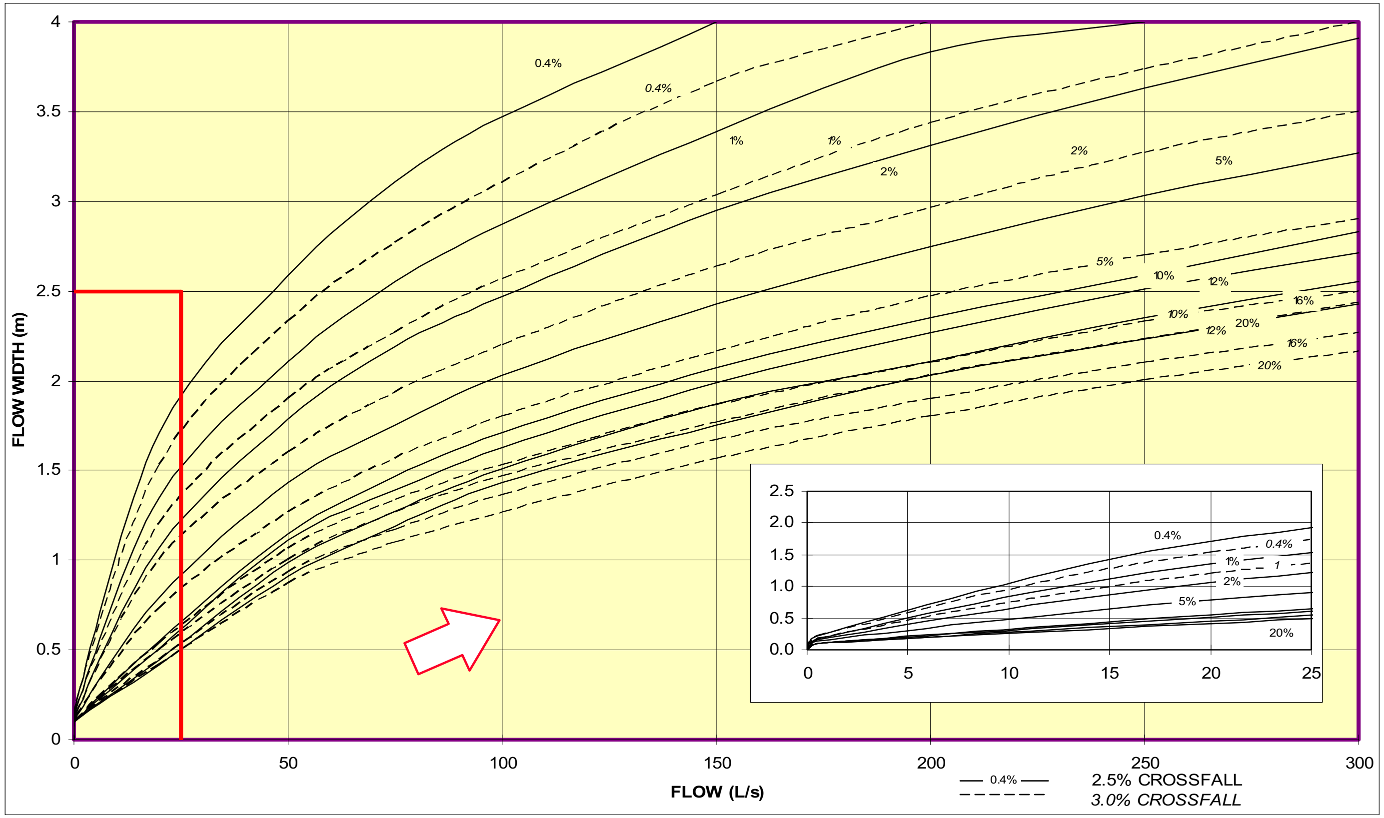
W_f = FLOW WIDTH

ROAD TYPE: NON-URBAN RURAL RESIDENTIAL STREET
CLASSIFICATION: ACCESS STREET
ROAD WIDTH: 7.0m

STD. DWG: 8-10018, 8-10020

CHART 29

PINE RIVERS SHIRE COUNCIL
THEORETICAL FLOW WIDTH AND CAPACITY CHART FOR 1/2 ROAD



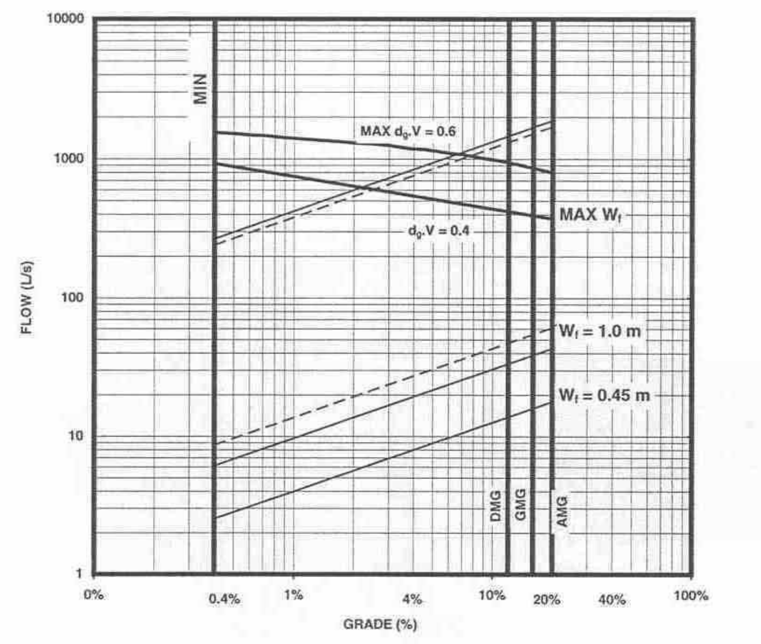
NOTE: IF 3.0% CROSSFALL CURVE IS NOT GIVEN THE CURVE IS THE SAME AS FOR 2.5% CROSSFALL

ROAD TYPE: NON-URBAN RURAL RESIDENTIAL STREET
CLASSIFICATION: COLLECTOR
ROAD WIDTH: 8.0m

STD. DWG: 8-10019, 8-10020

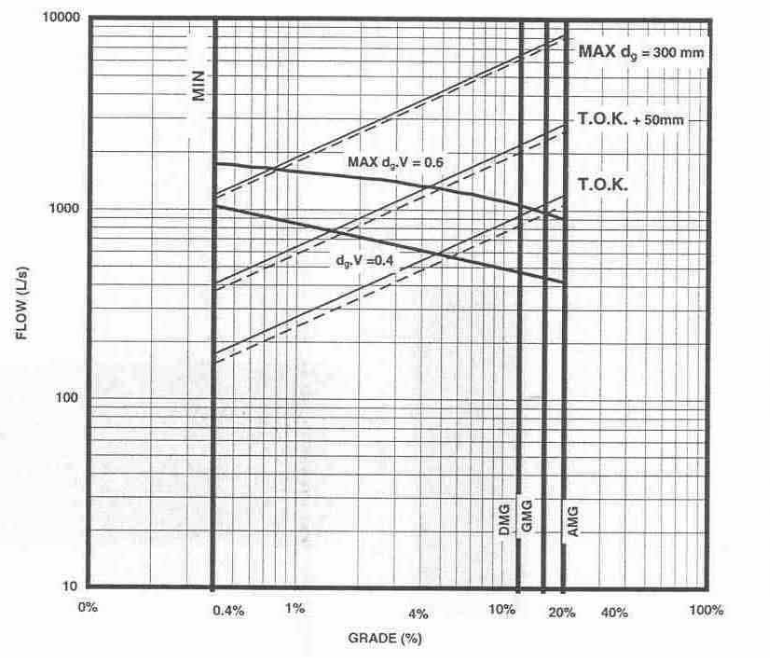
CHART 30

PINE RIVERS SHIRE COUNCIL
DESIGN CAPACITY CHARTS FOR 1/2 ROAD



MINOR STORM ——— 2.5% CROSSFALL
– – – *3.0% CROSSFALL*

NOTE:- 2.5% CROSSFALL AND 3.0% CROSSFALL ARE ON THE SAME CURVE FOR W_f = 0.45 m



MAJOR STORM ——— 2.5 % CROSSFALL
– – – *3.0% CROSSFALL*
T.O.K. = TOP OF KERB

CHART 22

NOTE: DESIGN CAPACITY = 80% OF THEORETICAL CAPACITY

AMG = ABSOLUTE MAXIMUM GRADE
GMG = GENERAL MAXIMUM GRADE
DMG = DESIRABLE MAXIMUM GRADE

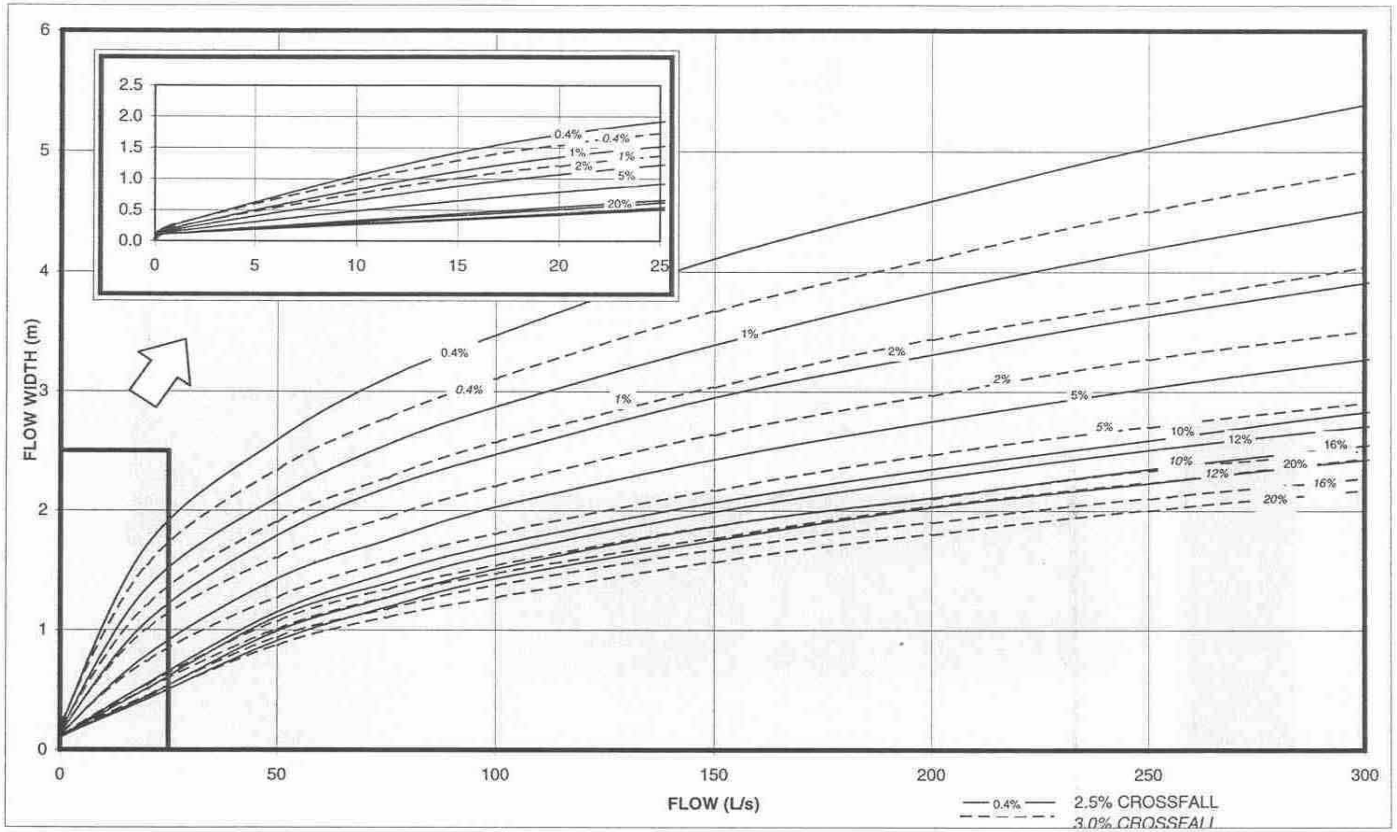
W_f = FLOW WIDTH

ROAD TYPE: NON-URBAN RURAL RESIDENTIAL STREET
CLASSIFICATION: COLLECTOR
ROAD WIDTH: 8.0m

STD. DWG: 8-10019, 8-10020

CHART 31

PINE RIVERS SHIRE COUNCIL
THEORETICAL FLOW WIDTH AND CAPACITY CHART FOR 1/2 ROAD

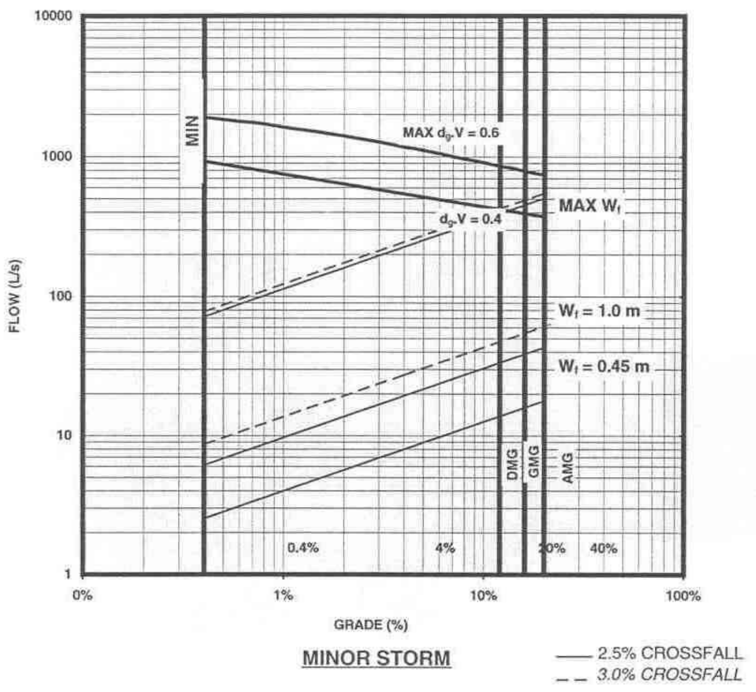


NOTE: IF 3.0% CROSSFALL CURVE IS NOT GIVEN THE CURVE IS THE SAME AS FOR 2.5% CROSSFALL

ROAD TYPE: INDUSTRIAL ROAD
CLASSIFICATION: ACCESS
ROAD WIDTH: 12.0m

STD. DWG: 8-10014
CHART 32

PINE RIVERS SHIRE COUNCIL
DESIGN CAPACITY CHARTS FOR 1/2 ROAD



NOTE:- 2.5% CROSSFALL AND 3.0% CROSSFALL ARE ON THE SAME CURVE FOR W_f = 0.45 m

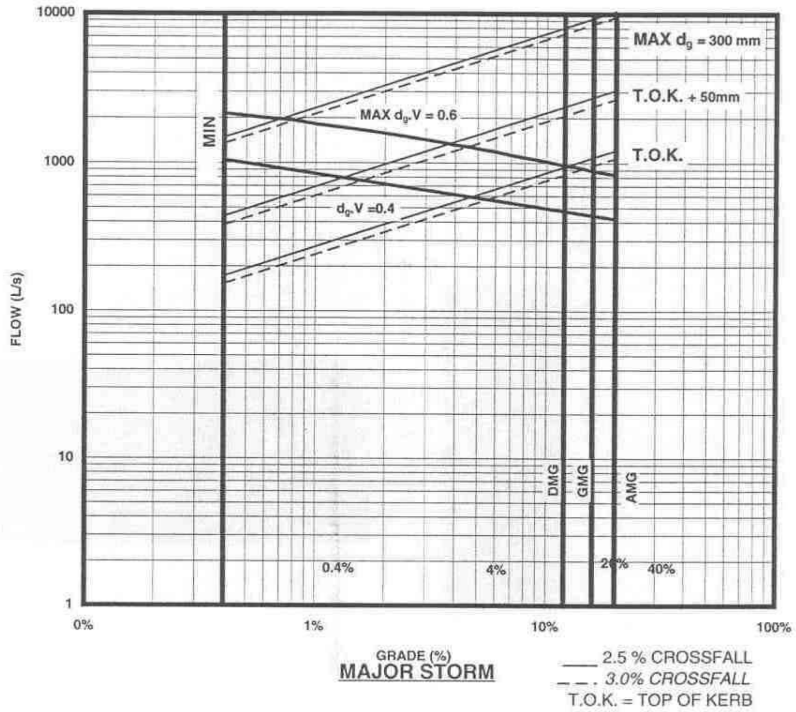


CHART 22

NOTE: DESIGN CAPACITY = 80% OF THEORETICAL CAPACITY

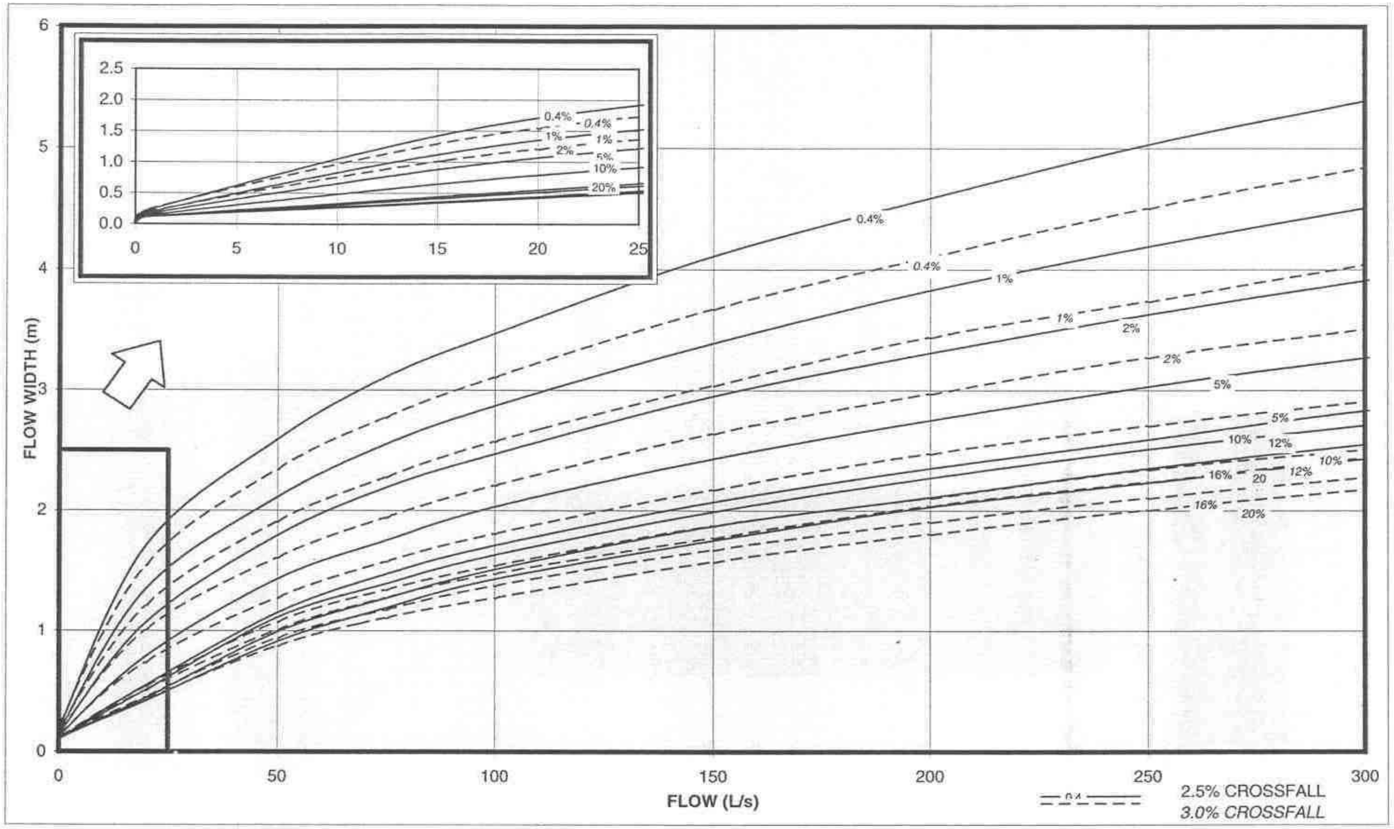
AMG = ABSOLUTE MAXIMUM GRADE
GMG = GENERAL MAXIMUM GRADE
DMG = DESIRABLE MAXIMUM GRADE

W_f = FLOW WIDTH

ROAD TYPE: INDUSTRIAL ROAD
CLASSIFICATION: ACCESS
ROAD WIDTH: 12.0m

STD. DWG: 8-10014
CHART 33

PINE RIVERS SHIRE COUNCIL
THEORETICAL FLOW WIDTH AND CAPACITY CHART FOR 1/2 ROAD



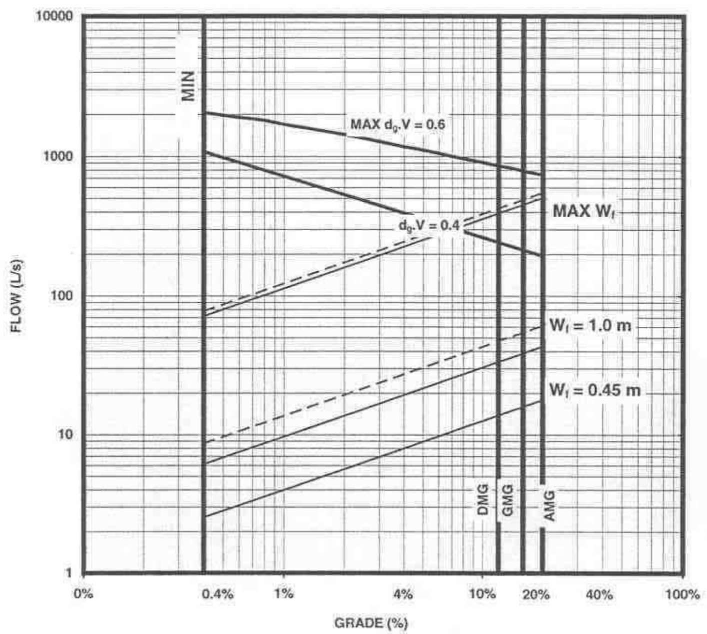
NOTE: IF 3.0% CROSSFALL CURVE IS NOT GIVEN THE CURVE IS THE SAME AS FOR 2.5% CROSSFALL

ROAD TYPE:	**INDUSTRIAL ROAD**
CLASSIFICATION:	**COLLECTOR**
ROAD WIDTH:	**14.0m**

STD. DWG: 8-10015

CHART 34

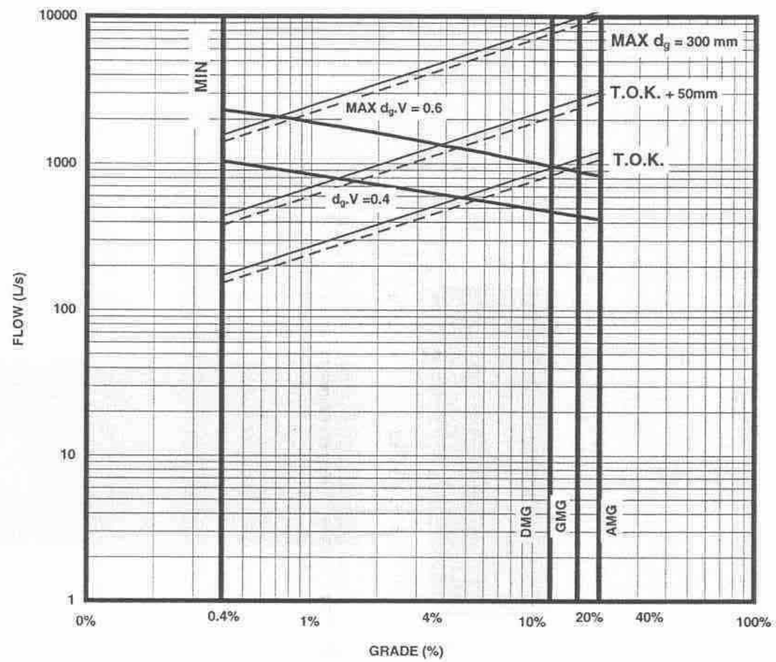
PINE RIVERS SHIRE COUNCIL
DESIGN CAPACITY CHARTS FOR 1/2 ROAD



MINOR STORM

——2.5% CROSSFALL
– – –3.0% CROSSFALL

NOTE:- 2.5% CROSSFALL AND 3.0% CROSSFALL ARE ON THE SAME CURVE FOR W_f = 0.45 m



MAJOR STORM

—— 2.5 % CROSSFALL
– – – 3.0% CROSSFALL
T.O.K. = TOP OF KERB

CHART 22

NOTE: DESIGN CAPACITY = 80% OF THEORETICAL CAPACITY

AMG = ABSOLUTE MAXIMUM GRADE
GMG = GENERAL MAXIMUM GRADE
DMG = DESIRABLE MAXIMUM GRADE

W_f = FLOW WIDTH

ROAD TYPE: INDUSTRIAL ROAD
CLASSIFICATION: COLLECTOR
ROAD WIDTH: 14.0m

STD. DWG: 8-10015
CHART 35