

USE OF AUS-SPEC PUBLICATIONS

1. Greater Taree City Council grants a non-exclusive Licence to the end user for the use of Greater Taree City Council AUS-SPEC Specifications and hereafter referred to as "AUS-SPEC".
2. AUS-SPEC will only be used for works where Greater Taree City Council is a Consent Authority for, or owner or operator or manager of, assets, or consultant to same.
3. No copying or modification of AUS-SPEC documents is permitted unless authorised by Greater Taree City Council in writing.
4. The end user shall be responsible for the correct application of AUS-SPEC. The end user acknowledges that Standards Australia, IPWEA and Greater Taree City Council have no control over and cannot influence the circumstances in which AUS-SPEC may be used by the end user and, accordingly, the end user agrees to indemnify and hold harmless Standards Australia, IPWEA and Greater Taree City Council against all actions, suits, proceedings, claims, demands, costs or losses whatsoever which may be brought, commenced or made against them, either jointly or separately, or which may be suffered by them or any of them in respect of the use of AUS-SPEC.
5. This License is personal and shall not be assigned, and the end user shall not allow any other person to use or have access to AUS-SPEC.
6. This Agreement shall be governed and construed in accordance with the laws of New South Wales.
7. These Licence conditions are deemed to have been accepted by the end user.



DEVELOPMENT DESIGN SPECIFICATION

D5

STORMWATER DRAINAGE DESIGN

Amendment Record for this Specification Part

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

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

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

Amendment Sequence No.	Key Topic addressed in amendment	Clause No.	Amendment Code	Author Initials	Amendment Date
1	IPWEA Mid North Coast Working Party Review.	D05	A,O,M	HC	Jan 2001
1	Concrete bulkheads P D5-16	D526	A	GS	June 2003
1	Handbook of Drainage Criteria Missouri Charts 2-6	Ke Charts	O	GS	June 2003
2	A number of additions and amendments have been made to the document	All	A,O,M	AS	August 2005

--	--	--	--	--	--

CONTENTS

CLAUSE	PAGE
GENERAL	1
D5.01 SCOPE.....	1
D5.02 OBJECTIVES.....	1
D5.03 REFERENCE AND SOURCE DOCUMENTS.....	2
HYDROLOGY	3
D5.04 DESIGN RAINFALL DATA.....	3
D5.05 CATCHMENT AREA	3
D5.06 RATIONAL METHOD	4
D5.07 OTHER HYDROLOGICAL MODELS	5
HYDRAULICS	5
D5.08 HYDRAULIC GRADE LINE.....	5
D5.09 MINOR SYSTEM CRITERIA.....	5
D5.10 PITS.....	6
D5.11 HYDRAULIC LOSSES	8
D5.12 MAJOR SYSTEM CRITERIA	9
D5.13 OPEN CHANNELS.....	10
D5.14 MAJOR STRUCTURES	11
D5.15 RETENTION BASINS.....	11
STORMWATER DETENTION	13
D5.16 ON-SITE STORMWATER DETENTION	13
INTERALLOTMENT DRAINAGE	14
D5.17 INTERALLOTMENT DRAINAGE.....	14
DETAILED DESIGN.....	15
D5.18 PIPES.....	15

D5.19 PIT DESIGN..... 15
D5.20 STORMWATER DISCHARGE..... 16
D5.21 MISCELLANEOUS 16

DOCUMENTATION17

D5.22 PLANS..... 17
D5.23 EASEMENTS AND AGREEMENTS 17
D5.24 SUMMARY SHEETS..... 17
D5.25 COMPUTER PROGRAM FILES AND PROGRAM OUTPUT 1
D5.26 USE OF PUMPS..... 1
D5.27 RESERVED 2
D5.28 RESERVED 2
D5.29 STORMWATER TANKS 2

APPENDICES19

HANDBOOK OF DRAINAGE CRITERIA, INCLUDING, ON-SITE DETENTION GUIDELINES, IFD TABLES, ETC.

DEVELOPMENT DESIGN SPECIFICATION D5 STORMWATER DRAINAGE DESIGN

GENERAL

D5.01 SCOPE

1. The work to be executed under this Specification consists of the design of stormwater drainage systems for urban and rural areas including, but not limited to the following

- Subdivisions
- Buildings, structures and surrounds
- Earthworks, dams, lakes, road works and drainage works
- Trenches, pipelines
- Development site works (access roads, car parks, landscaping, drainage works, pedestrian facilities)
- Extractive industries
- Mining

D5.02 OBJECTIVES

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

- (a) To ensure that inundation of private and public property occurs only on rare occasions and that, in such events, surface flow routes convey stormwater below the prescribed velocity/depth limits.
- (b) To provide convenience and safety for pedestrians and traffic in frequent stormwater flows by controlling those flows within prescribed limits.
- (c) Retain within each catchment as much incident rainfall and runoff as is possible and appropriate for the planned use and the characteristics of the catchment.
- (d) To control and treat the flow of stormwater to achieve acceptable standards prior to discharge to receiving waters.

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

Design Principles

- (a) New Developments are to provide a stormwater drainage system in accordance with the "major/minor" system concept set out in Chapter 14 of Australian Rainfall & Runoff, 1999; that is, the "major" system shall provide safe, well-defined overland flow paths for rare and extreme storm runoff events while the "minor" system shall be capable of carrying and controlling flows from frequent runoff events.

- (b) Redevelopment - Where the proposed development replaces an existing development, the on-site drainage system is to be designed in such a way that the estimated peak flow rate from the site for the design average recurrence interval (ARI) of the receiving minor system is no greater than that which would be expected from the existing development.
- (c) Water Sensitive Urban Design (WSUD) Methods shall be incorporated in all developments with the Australian Runoff Quality manual (ARQ) and Aus-Spec D7.

D5.03 REFERENCE AND SOURCE DOCUMENTS

Current versions of all documents shall be used.

(a) Council Specifications

- C220 - Stormwater Drainage - General
- C221 - Pipe Drainage
- C222 - Precast Box Culverts
- C223 - Drainage Structures
- C224 - Open Drains including Kerb & Gutter
- Council Stormwater Management Plan
- D7 - Erosion & Stormwater Management Design Specification.

(b) Australian Standards

- AS 1254 - Unplasticised PVC (uPVC) pipes and fittings for stormwater or surface water applications.
- AS 2032 - Code of practice for installation of uPVC pipe systems.
- AS 3725 - Loads on buried concrete pipes.
- AS 4058 - Precast concrete pipes.
- AS 4139 - Fibre reinforced concrete pipes and fittings.
- AS 3500 - Part 3 National Plumbing & Drainage Code – Stormwater Drainage
- AS5100 - Bridge Design

(c) State Authorities

- RTA, NSW - Model Analysis to determine Hydraulic Capacities of Kerb Inlets and Gully Pit Gratings, 1979.
- NSW Dept Housing - Dept of Housing Road Manual.
- NSW Govt - Floodplain Development Manual.
- NSW Govt - Dam Safety Act

(d) Other

- Argue, John - Stormwater drainage design in small urban catchments: a handbook for Australian practice. Australian Road Research Board Special Report 34
- Australian National Conference On Large Dams, Leederville WA.
 - ANCOLD 1986, Guidelines on Design Floods for Dams.
- Chow, Ven Te - Open Channel Hydraulics, 1959.
- Concrete Pipe Association of Australia
 - Concrete Pipe Guide, charts for the selection of concrete pipes to suit varying conditions.
- Hare CM. - Magnitude of Hydraulic Losses at Junctions in Piped Drainage Systems. Transactions, Inst. of Eng. Aust., Feb.

1983.

Henderson, FM. Open Channel Flow, 1966.

Inst. of Eng. - Australian Rainfall and Runoff - A guide to flood estimation. Sept 1999.

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

Sangster, WM., Wood, HW., Smerdon, ET., and Bossy, HG.
- Pressure Changes at Storm Drain Junction, Engineering Series, Bulletin No. 41, Eng. Experiment Station, Univ. of Missouri 1958.

Landcom - Managing Urban Stormwater: Soils and Construction, 2004 (The Blue Book)

HYDROLOGY

D5.04 DESIGN RAINFALL DATA

1. Design Intensity-Frequency-Duration (IFD) Rainfall – IFD relationships shall be derived in accordance with Chapter 2, Volume 1 of ARR 1987, for the particular catchment under consideration.

***I-F-D
Relationships***

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

3. Design IFD rainfalls are provided for specific locations in the Handbook of Drainage Criteria.

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

***Average
Recurrence
Intervals***

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

- 100 years for the "major" system in all developments.
- 20 years for trunk drainage "minor" systems
- 10 years for commercial/industrial area "minor" systems
- 5 years for residential area "minor" systems
- 5 years for rural residential area "minor" systems
- 1 year for parks and recreation area "minor" systems.

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

D5.05 CATCHMENT AREA

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

***Catchment
Definition***

catchment.

2. Where no detailed survey of the catchment is available, 1:4000 orthophoto maps, or GIS data approved by Council, is to be used to determine the catchments and to measure areas. Catchment boundaries and characteristics are to be confirmed by field survey.
3. Catchment area land use shall be based on current available zoning information or proposed future zonings, where applicable.

D5.06 RATIONAL METHOD

1. Rational Method calculations to determine peak flows shall be carried out in accordance with Chapter 14, AR&R and the requirements of this Specification.
2. All calculations shall be carried out by a qualified person experienced in hydrologic and hydraulic design.
3. Co-efficients of Run-off shall be calculated as per Section 14.5 of AR&R and full details of co-efficients utilised shall be provided. Full development of the catchment is to be assumed.
4. Details of percentage impervious for specific locations and for individual zonings are given below. These should be used in lieu of more detailed calculations.

Qualified Person

Runoff Co-efficients

Location	%
Forest	0-20
Agricultural	0-20
Woodland	0-25
Open Space & Parks	20-35
Rural & Rural Residential	30
Low Density Urban Residential 2 (a1)	60
Medium Density Residential	75
High Density & Unit Development 2 (a4)	95
Industrial	99
Commercial	100
Other	As calculated

Details shall be provided for use of these percentage impervious areas provided above.

5. Times of Concentration - The time of concentration of a catchment is defined as the time required for storm runoff to flow from the most remote point on the catchment to the outlet of the catchment. Partial area effects are to be checked.
6. Where the flow path is through areas having different flow characteristics or includes property and roadway, then the flow time of each portion of the flow path shall be calculated separately.
7. The maximum time of concentration in an urban area shall be 20 minutes unless sufficient evidence is provided to justify a greater time. The minimum time of concentration used shall be 5 minutes.
8. Flow paths to pits shall be representative of the fully developed catchment considering such things as fencing and the likely locations of buildings and shall be shown for each collection pit on the catchment area plan. Consideration shall be given to likely changes to individual flow paths due to the full development of the catchment.
9. Surface roughness co-efficients "n" shall generally be derived from information in Chapter 14 of AR&R. Values applicable to specific zoning types and overland flow path types are given below:

Times of Concentration

Overland Flow Retardance

Flow across Parks	0.35
Flow across Rural Residential land	0.30
Flow across low density Residential	0.21
Flow across medium density Residential	0.11
Flow across Industrial	0.06
Flow across Commercial	0.04
Flow across Paved Areas	0.01
Flow across Asphalt Roads	0.02
Flow across Gravel Areas	0.02

D5.07 OTHER HYDROLOGICAL MODELS

- Other hydrological models may be used as long as the requirements of AR&R 1999 are met, summaries of calculations are provided and details are given of all program input and output. See D5.24 for sample and handbook of Drainage Criteria.
- Where computer analysis programs are used, copies of the final data files shall be provided on submission of the design to Council and with the final drawings after approval by Council.

**Alternative
Models**

HYDRAULICS

D5.08 HYDRAULIC GRADE LINE

- Hydraulic calculations shall generally be carried out in accordance with Australian Rainfall and Runoff and shall be undertaken by a qualified person experienced in hydrologic and hydraulic design. The calculations shall substantiate the hydraulic grade line adopted for design of the system and shown on the drawings. Summaries of calculations are added to the plan and details of all calculations are given including listings of all programme input and output.
- The "major" system shall provide safe, well-defined overland flow paths for rare and extreme storm runoff events while the "minor" system shall be capable of carrying and controlling flows from frequent runoff events.
- Downstream water surface level requirements are given below:-
 - Known hydraulic grade line level from downstream calculations including pit losses at the starting pit in the design event.
 - Where the downstream starting point is a pit and the hydraulic grade line is unknown, a level of 0.15m below the invert of the pit inlet in the downstream pit is to be adopted.
 - Where the outlet is an open channel and the design storm is the minor event the top of the outlet pipe shall be the downstream control.
 - Where the outlet is an open channel and the design storm is the major event, the downstream control shall be the 1% probability flood level.
 - Where tidal, the greater of high water mark and pipe culvert shall be used.
- The water surface in drainage pits shall be limited to 0.150m, below the gutter invert for inlet pits and 0.150m below the underside of the lid for junction pits.

**Qualified
Person**

Calculations

**Downstream
Control**

**Water Surface
Limits**

D5.09 MINOR SYSTEM CRITERIA

- The acceptable gutter flow width in the 20% ARI event is 2.5 metres maximum, as shown in the table of the Handbook of Drainage Criteria. Gutter flow around kerb returns

**Gutter Flow
Widths**

shall be limited to 20 l/s.

2. Minimum conduit sizes are given below:

Conduit Sizes

- The minimum pipe size shall be 375mm diameter.
- The minimum box culvert size shall be 600mm wide x 300mm high.

3. Minimum and maximum velocity of flow in stormwater pipelines shall be 0.6m/sec and 6m/sec respectively.

Velocity Limits

D5.10 PITS

1. Inlet pits shall be spaced so that the gutter flow width is limited in accordance with this specification and so that the inlet efficiency is not affected by adjacent inlet openings or kerb variations and upstream of carriageway narrowing. Preference shall be given to the location of drainage pits at the upstream side of allotments and driveways. Pits are to be located clear of kerb returns and kerb marks. Pits are to be located to prevent flow across intersections during a minor storm event, during major storm events flow is to comply with "D5.12 Major System Criteria".

Spacing

2. Other pits shall be provided:

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

3. The maximum allowable spacing of pits where flow shall be as follows:

Maximum Spacing

	Pipe Size (mm)	Spacing (m)
Generally	less than 1200	80
	1200 or larger	120
In tidal influence	all	80

4. Kerb inlet opening lengths to side entry pits shall be as follows:

Inlet Capacity

	Preferred Max (mm)	Absolute Max (mm)	Absolute Min (mm)
Generally	3.0	5.0	1.2
Sag-Points	3.0	5.0	2.4

5. Information on pit capacities is available in the following sources:-

- Roads and Traffic Authority's "Model analysis to determine Hydraulic Capacities of Kerb Inlets and Gully Pit Gratings", with due allowance to inlet bypass due to grade, for grade inlet pits, and recognised orifice or weir formulae for sag inlet pits.
- NSW Department of Housing Road Manual – Pit capture charts.
- Pit relationships given in Chapter 14 of AR&R 1987.

- Graph in the Handbook of Drainage Criteria.

6. Pit capture rates shall include the following capture allowances for blockage for the major system:-

Allowance for Inlet Blockage in Major System Analysis

Condition	Inlet Type	Percentage of Theoretical Capture Allowed
Sag	Side entry	80%
Sag	Grated	50%
Sag	Combination	Side inlet capacity only. Grate assumed completely blocked
Sag	"Letterbox"	50%
Continuous Grade	Side entry	80%
Continuous Grade	Grated	50%
Continuous Grade	Combination	90%
Sag or on Grade	Pipe or Headwall Inlet	70% of pipe full capacity

7. Project specific Council approval shall be sought prior to using bends.

D5.11 HYDRAULIC LOSSES

1. The pressure change co-efficient "Ke" shall be determined from Missouri Charts or Hare equations. Common loss co-efficients may be found in AR & R and in the Handbook of Drainage Criteria.

Pit Losses

2. Pipeline systems are to be streamlined where possible to reduce head losses at pits.

3. Reserved

4. Reserved

5. Reserved

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

- (a) All pipe inlets, including roof and subsoil pipes, shall where possible, enter the main pipe system at junction pits. These shall be finished flush with and be grouted into the pit wall.
- (b) Connection to existing pipelines using fabricated slope junctions shall be accepted. Connections are to be to the top of the pipe in accordance with the standard drawing (SD60).

7. Construction of a junction without a structure should be avoided where possible. Permission to do this is required by Council prior to detailed design.

Pipe Junction Losses

8. Transitions to smaller downstream conduits shall not be permitted without approval of Council prior to detailed design.

**Contraction/
Expansion
Losses**

9. Drainage pipe systems shall be designed as an overall system, with due regard to the upstream and downstream system and not as individual pipe lengths. Drainage pipeline systems shall generally be designed as gravity systems flowing full at design discharge, but may be pressurised with the use of appropriate pits and joints. Pipe friction losses and pipe sizes in relation to discharge shall be determined using the Colebrook-White formula with the acceptable roughness co-efficients being 0.6mm for concrete pipes and 0.06mm for FRC pipes. Details of any streamlining claimed in the design calculation must be fully detailed on the construction drawings.

**Pipe Friction
Losses**

D5.12 MAJOR SYSTEM CRITERIA

1. Surcharging of drainage systems which would provide for water depth above the top of kerb will not be permitted except as defined below. Surcharging of drainage system for storm frequencies greater than 5% ARI probability may be permitted across the road centreline where the road pavement is below the natural surface of the adjoining private property. Flow across footpaths will only be permitted in situations specifically approved by Council, where this will not cause flooding of private property.

Surcharging

2. The velocity x depth product of flow across the footpath and within the road reserve shall be such that safety of children and vehicles is considered. The maximum allowable depth of water is 0.2 metres and the maximum velocity x depth product of $0.4\text{m}^2/\text{s}$ is permitted. Where the safety of only vehicles can be affected, a maximum velocity x depth product of $0.6\text{m}^2/\text{s}$ is permitted. In open channels and surcharge flow paths the above velocity x depth product criteria will be followed where possible or the design shall address the requirements for safety in relation to children by providing safe egress points from the channel or other appropriate methods. Designs must be in accordance with the Floodplain Development Manual (figure 6).

**Velocity/ Depth
Criteria**

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

Freeboard

Generally:-

- (a) A minimum freeboard of 0.3m shall be provided between the 100 year flood level and floor levels on structures and entrances to underground car parks. A higher freeboard may be required in certain circumstances such as flood prone areas.
- (b) Where the road is in fill or overtopping of kerbs and flow through properties may occur a 100mm freeboard shall be provided between the ponding level of water in the road and the high point in the footpath. Driveway construction in these instances needs to consider this requirement.

In Surcharge Paths:-

- (c) A minimum freeboard of 0.3 shall be provided between the 100 year flood level and floor levels on structures and entrances to underground car parks.

Freeboard calculations for drainage in new subdivisions shall assume raft slab construction on lots adjoining surcharge paths.

In Open Channels:-

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

4. Flow capacities of roads should be calculated using Technical Note 4 in Chapter 14 of AR&R.

Roadway Capacities

5. Pit capture rates to be determined in accordance with clause D5.19.5.

Roadway Capacities

D5.13 OPEN CHANNELS

1. Generally, open channels will only be permitted where they form part of the trunk drainage system and shall be designed to have smooth transitions with adequate access provisions for maintenance and cleaning. Where Council permits the use of an open channel to convey flows from a development site to the receiving water body, such a channel shall comply with the requirements of this Specification.

Safety

2. Design of open channels shall be generally in accordance with Chapter 14, Volume 1 of AR&R, and shall be designed with safety requirements as set out in Section 14.10.4 of AR&R as a primary criterion. Open channels shall be designed to contain the major system flow less any flow complete blockage of the minor system.

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

Channel

Roughness

Mannings "n" Roughness Co-efficients for open channels shall generally be derived from information in Chapter 14 of AR&R. Mannings "n" values applicable to specific channel types are given below:-

Concrete Pipes or Box Sections	0.011
Concrete (trowel finish)	0.014
Concrete (formed without finishing)	0.016
Sprayed Concrete (gunite)	0.018
Bitumen Seal	0.018
Bricks or pavers	0.015
Pitches or dressed stone on mortar	0.016
Rubble Masonry or Random stone in mortar	0.028
Rock Lining or Rip-Rap	0.028
Corrugated Metal	0.027
Earth (clear)	0.022
Earth (with weeds and gravel)	0.028
Rock Cut	0.038
Short Grass	0.033
Long Grass	0.043

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

5. Maximum side slopes on grassed lined open channels shall be 1 in 6. Channel inverts shall generally have minimum cross slopes of 1 in 20.

Side Slopes

6. Low flow provisions in open channels (man-made or altered channels) will require low flows to be contained within a pipe system or concrete lined channel section at the invert of the main channel. Subsurface drainage shall be provided in grass lined channels to prevent waterlogging of the channel bed. The width of the concrete lined channel section shall be the width of the drain invert or at least sufficiently wide enough to accommodate the full width Council maintenance equipment without risk of damage to the channel invert. **Low Flows**

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

D5.14 MAJOR STRUCTURES

1. All major structures shall be designed for the 100 year ARI storm event without afflux in urban areas unless otherwise approved by Council. Some afflux and upstream inundation may be permitted in certain rural and urban areas provided the increased upstream flooding is minimal and does not inundate private property. **Afflux**

2. A minimum clearance of 0.3m between the 100 year ARI flood level and the underside of any major structure superstructure is required to allow for passage of debris without blockage. **Freeboard**

3. All bridges shall be designed for 1% probability flood intensity without afflux in urban areas. **Bridges**

4. Certified structural design shall be required on bridges and other major culvert structures and may be required on some specialised structures. Structural design shall be carried out in accordance with Aus-Spec D3.

5. All culverts shall be designed to ensure that roads are not overtopped in the 1% ARI flow. **Culverts**

6. Culverts (either pipe or box section) shall be designed using established design techniques in AR&R. Design charts issued by the Concrete Pipe Association of Australia (1983) may be used with due regard to inlet and exit losses, inlet and outlet control and scour protection.

D5.15 RETENTION BASINS

1. For each ARI a range of storm events shall be run to determine the peak flood level and discharge from the retention basin. Storm patterns shall be those given in **Critical Storm Duration**

AR&R Volume II. Sensitivity to storm pattern should be checked by reversing these storm patterns.

2. The critical storm duration with the retention basin is likely to be longer than without the basin. A graph showing the range of peak flood levels in the basin and peak discharges from the basin shall be provided for the storms examined.

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

4. The high level outlet to any retarding basin shall have capacity to contain a minimum of the 100 year ARI flood event. Additional spillway capacity may be required due to the hazard category of the structure. The hazard category should be determined by reference to ANCOLD (1986). **High Level Outlet**

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

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

Low Flow Provision

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

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

Freeboard at Dwellings

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

Safety Issues

- (a) Maximum water depth shall be 1.2 m in the 100 year ARI storm event.
- (b) The basins should have side slopes of 6(H) to 1(V) or less
- (c) If side slopes are steeper than 6(H) to 1(v) the basin/pond shall be enclosed by child proof security fence.
- (d) The maximum velocity through the pond based on a 1 in 1 year storm should not exceed 0.3 metres per second.
- (e) A minimum freeboard of 0.3 metres should be provided between a restricted discharge outlet for the pond and a storm overflow weir. This discharge outlet should be designed so that the weir overtops on average three times per year.
- (f) Inlet and outlet structures should be located at extreme ends of the basin, with short-circuiting of flow further minimised by the use of baffles.
- (g) Depth indicators shall be provided indicating maximum depth in the basin spillway.
- (h) Appropriate hazard signage shall be provided for the basin and spillway.
- (i) Protection of the flow intake shall be provided to prevent blockage and to prevent the risk of people being trapped.
- (j) Basins shall be designed so that no ponding of water occurs on to private property or roads.
- (k) No basin shall be located upstream of an urban area.
- (l) Submission of design plans to the Dam Safety Committee is required where any of these guidelines are not met or Council specifically requires such submission.

10. Minimum basin slope shall be 1%.

11. Access for maintenance vehicles shall be provided by an all weather access track to the satisfaction of Council.

12. Retention basins should be designed, where possible, as water quality improvement facilities so that the sediment and pollutant loads in the run-off from the lot meets Australian Rainfall Quality (ARQ), EPA and Managing Urban Stormwater Soils and Construction ("The Blue Book") guidelines and recommendation and at least is equal to or less than the receiving waters (see D7).

STORMWATER DETENTION

D5.16 ON-SITE STORMWATER DETENTION

1. This section applies to individual dwelling, multi unit developments, commercial and industrial development. **Re-development**
2. General Requirements
 - (a) Installation of On-site detention shall be required within the Council area unless the subject site is situated in a subdivision that has a catchment wide detention system already implemented. Detention requirements shall be verified by Council for locations included in current catchment management plans.
 - (b) All OSD shall be fitted with an overflow, which drains to a legal drainage point and designed to overflow the 1 in 100 year event without inundation of habitable and non habitable floor levels.
 - (c) On site detention shall meet the detention volume, and flow rates as indicated in Table 5.3.

**TABLE D 5.3
ONSITE DETENTION REQUIREMENTS**

Location	Onsite Detention Storage Volume	Permissible Site Discharge
Vacant or previously undeveloped land within an existing subdivision with no or limited catchment based detention facilities	Volume as required to maintain the undeveloped flow rate based on a current percentage imperviousness of 0%	Less than or equal to volumetric flow rate of the undeveloped catchment for all design storms up to a 1:100 year ARI event.
Redevelopment of existing developed land	Volume as required to maintain the existing flow rate as a minimum based on a current percentage imperviousness of the existing	Less than or equal to volumetric flow rate of the existing catchment of all design storms up to a 1:100 year ARI Event

3. (a) Each onsite detention system shall be marked by a plate in a prominent position which states *“This is an onsite detention system. It is an offence to reduce the volume of the tank or basin or interfere with the orifice plate that control the outflow.”*
 - (b) Depth indicators shall be located in a prominent position within the OSD.
4. Refer to the Handbook of Drainage Criteria for detailed design of OSD.

D5.16 OFFSITE STORMWATER DETENTION

1. This section shall apply to all developments other than individual dwellings, multi unit development, commercial and industrial development. Typical included are multiple allotments, subdivision and areas great than 2500m².
2. Detention shall meet the Permissible Site Discharge (PSD) and Site Storage Requirements (SSR) detention volume, and flow rates as indicated in Table D5.4.
3. Stormwater detention facilities shall be combined with retention structures to maintain the water cycle regimes within each catchment area.

**TABLE D 5.4
DETENTION DISCHARGE AND STORAGE**

Location	Onsite Detention Storage Volume	Permissible Site Discharge
Previously Undeveloped Catchment Areas	Equivalent to different in vol. Between pre-development and post development for flows up to ARI of 100 Yr based on a current percentage imperviousness of 0%	Equivalent to pre-development discharge rate for all storm events up to ARI of 100 Yr
Previously Developed Catchment	As determined to maintain the existing discharge rate based on a current percentage imperviousness of the existing	Equivalent to existing discharge rate for all storm events up to ARI of 100 Yr

INTERALLOTMENT DRAINAGE

D5.17 INTERALLOTMENT DRAINAGE

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

Where excessive overland flow is anticipated from upstream property (eg downstream of parks or undrained lots) appropriate drainage and easements shall be provided.

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

3. Pipe Capacity – The interallotment drain shall be designed to accept all runoff from roof drainage systems and ancillary hardstand areas of each allotment for flow rates having a design ARI of 1 in 20 Years. Runoff generated during a 1 in 100 YR ARI event shall be directed to a legal discharge point in accordance with D4.12.3 of this specification. Pipe size shall be confined to a minimum 150mm Ø up to a maximum of 375mm Ø as follows:

- 150 mm diameter minimum for up to and including a maximum of two lots;
- 225 mm diameter minimum greater than two lots.

4. Refer to Section D5.6.4 for details of percentage impervious for specific locations.

Impervious Area

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

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

Pits

7. Pipes - Minimum Grade - The interallotment drainage shall have a minimum longitudinal gradient of 1%.

Grade

8. Interallotment Drainage Pipe Standards – The interallotment drainage shall be constructed from rubber ring jointed pipes of either fibre reinforced concrete drainage pipe,

Pipe Type

reinforced concrete pipe, or UPVC pipe which shall conform respectively to the requirements of AS 4139, AS 4058 and AS 1254. In public road and recreation reserves where vehicle loads may be encountered, pipes of appropriate loading capacity.

9. Interallotment Drainage Pipe – Relationship to Sewer Mains - Where interallotment drainage and sewer mains are laid adjacent to each other they are to be spaced a minimum of 0.5 metres between pipes **Sewer**

10. Runoff generated in greater than a 1 in 20 Yr ARI event shall be taken into account in the design of downstream structures.

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

12. Interallotment drainage shall be designed to accept the fully developed runoff from the upstream catchment for up to a 1:20 year ARI Event.

13. Interallotment drainage systems shall allow for overland flowpaths for storm events in excess of the design storm event so as to not affect downstream properties.

DETAILED DESIGN

D5.18 PIPES

1. Pipes and Material Standards – Reinforced concrete pipes shall conform to AS 4058-1992. Fibre reinforced concrete pipes shall conform to AS 4139-1993. uPVC pipes shall conform to AS 1254-91 (use of uPVC pipes shall be restricted to interallotment drainage).

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

3. Pipe Jointing shall be rubber ring jointed, and in accordance with manufacturer's instruction manuals for the individual pipe material.

4. Pipe Location - Drainage lines in road reserves shall generally be located behind the kerb line and parallel to the kerb. Drainage lines in easements shall be centrally located within easements.

5. Alternatives to pipes shall be considered on merit and are subject to Council approval.

D5.19 PIT DESIGN

1. Pits shall be designed with benching to improve hydraulic efficiency and reduce water ponding. Typical pit designs and other pit design requirements are included in the Handbook of Drainage Criteria and as standard drawings. Safety and safe access are important considerations in pit design. Non standard pits shall be fully detailed in the construction drawings and certified in accordance with Aus-Spec D3 as an engineered structure.

D5.20 STORMWATER DISCHARGE

1. Scour protection at culvert or pipe system outlets shall include energy dissipation measures incorporating gabion mattresses or suitable alternatives. **Scour**

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

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

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

System Type		Easement Width (rounded up to nearest 0.5m)
Drainage	Single pipe	3.0m (minimum)
	Multiple pipes	Overall outside width of pipe group +2m
	Box culverts	Overall width of box + 2m
	Open channels	Width including free board + 2m (generally restricted to drainage reserves)
	Surcharge paths	Width including free board + 2m
	Interallotments Drainage	1.0m (minimum)

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

6. Stormwater runoff quality shall meet the greater of the receiving waters and/or Australian Rainfall Quality guidelines before discharge into natural system.

D5.21 MISCELLANEOUS

1. Subsoil Drainage shall be provided at the bottom of pipe trenches upstream of pits for a minimum length of 3 metres. Construction to be in accordance with design specification D4.

2. Reserved.

3. Reserved.

4. Termination of Kerb and Gutter and Associated Scour Protection - Kerb and Gutter shall be extended to drainage pit or natural point of outlet. Where outlet velocity is greater than 2.0m per second or where the kerb and gutter discharge is likely to cause scour, then protection shall be provided to prevent scour and dissipate the flow. **Kerb & Gutter Termination**

5. Level spreaders shall be provided at all stormwater outlets. **Level Spreader**

DOCUMENTATION

D5.22 PLANS

1. Catchment Area Plans shall be drawn at appropriate scales normally 1:1000, 1:4000 or 1:25000, unless alternative scales are specifically approved by Council and shall show contours, direction of grading of kerb and gutter, general layout of the drainage system with pit locations, catchment limits and any other information necessary for the design of the drainage system. Refer section D1.06 for plan set list.

Scales for Drawings

2. The Drainage System shall be shown on the road layout plan and shall be drawn at a scale of 1:500 and shall show drainage pipeline location, drainage pit location and number and road centreline chainage, size of opening and any other information necessary for the design and construction of the drainage system. The plan shall also show all drainage easements, reserves and natural water courses.

3. Reserved.

4. The Drainage System Longitudinal Section shall be drawn at a scale of 1:500 horizontally and 1:100 vertically and shall show pipe size, class, jointing and type, pipeline and road chainages, pipeline grade, hydraulic grade line and any other information necessary for the design and construction of the drainage system.

5. Open Channel Cross and Longitudinal Sections shall be drawn at a scale of 1:100 natural and shall show the direction in which the cross sections should be viewed. Cross sections may alternatively be provided electronically in a data format as agreed to with council's Coordinator of Development/Quality.

Open Channels

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

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

Work-as-Executed Plans

D5.23 EASEMENTS AND AGREEMENTS

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

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

D5.24 SUMMARY SHEETS

1. A copy of a Hydrological Summary Sheet providing the minimum information is set out below.

Hydrology

HYDROLOGICAL DESIGN SHEET

Pit	Land Use	Flow Length m	Slope %	"n"	Time Min	Time Min	Intensity mm/h	Code	COEFF	Area ha	C>A ha	Sum Area ha	Q L/s	By Pass L/s	Total Flow L/s	Kinematic Min Time 5 Max Time 20 Coffs	REMARKS
11	2					5 ADP	186 5Yr	-1	.855	.023	.020	.02	10		10		
12	2					5 ADP	186 5Yr	-1	.855	.024	.021	.021	11		11		
6	2					5 ADP	186 5Yr	-1	.855	.029	.017	.017	9		9		
7	2					5 ADP	186 5Yr	-1	.855	.036	.031	.031	16		16		
8	2					5 ADP	186 5Yr	-1	.855	0.41	.035	.035	18		18		
9	2					5 ADP	186 5Yr	-1	.855	0.31	.027	.027	14		14		
10	2					5 ADP	186 5Yr	-1	.855	.0222	.019	.019	10		10		
1	1 2 2	40 05	2 .6		.725 2.152	5	186 5Yr	-.330 -1	.721 .855	.040 .050	.029 .051	0.6	41		41		
2	1 2	85	5	.2	13.379	13.4	126 5Yr	.330 -1	.721 .855	.225 .056	.162 .056	.218	78		78		
2A						5	186 5Yr										
3	1 2	90	5	.2	13.945	13.9	126 5Yr	-.330 -1	.721 .855	.250 .025	.180 .021	.202	71		71		
4	1 2	90	5	.2	13.945	13.9	126 5Yr	0.330 -1	.721 .855	.145 .010	.105 .009	.113	40		4		
5	1 2	75	5	.2	12.222	12.2	133 5Yr	-.330 -1	.721 .855	.080 .020	.056 .017	.075	28		26		
5A						5	186 5Yr										
5B						5	186 5Yr										

HYDROLOGICAL DESIGN SHEET

Pit	Time	Intensity	Areas	Flow	Length	Diameter	Grade	HGL Grade	VEL O/A	K	Head Loss	Vel Cap	Pipe Vel	Pipe Cap	Pipe Time	C.W. - .0006 Max Time 20 Coffs	REMARKS
	min	mm/hr	Ha	L/s	m	mm	%	%	m/s		m	m/s	m/s	L/s	min		
Line 4																	
11-12	5	186 5Yr	.02	10	14	150	1.286	.337	.576	5	.085	1.154	1.02	20	23		
12-58	5.2	183 5Yr	.04	20	47	225	1.266	.162	.516	1.5	.02	1.485	1.18	59	.66		
Line 3																	
6-7	5	186 5Yr	0.17	9	13	150	2.5	.256	.501	5	.064	1.608	1.23	28	.18		
7-8	5/2	194 5Yr	.048	25	41	225	1	.229	.616	1.5	.029	1.32	1.15	52	.59		
8-9	5.8	177 5Yr	.083	41	49	225	1.01	.626	1.03	1.5	0.81	1.327	1.35	53	.6		
9-10	6.4	171 5Yr	.109	52	19	225	1	1.012	1.313	1.5	.132	1.32	1.42	52	.22		
10-58	6.6	169 5Yr	.128	60	26	225	1	1.352	1.52	1.5	.177	1.32	1.32	52	.33		
Line 1																	
1-3	5	186 5Yr	.06	41	7	381	1	.042	.364	5	.034	1.843	1.22	210	.1		
Line 2																	
2-2A	13.4	128 5Yr	.218	78	12	381	10.542	.143	.682	5	.119	5.983	3.46	682	.06		
2A-3	13.4	128 5Yr	.218	78	9	381	1	.142	.68	.6	.014	1.843	1.45	210	.1		
3-4	13.9	126 5Yr	.5	175	26	534	1	.123	.782	1.5	0.47	2.276	1.8	510	.26		
4-5	14.2	125 5Yr	.613	213	31	534	1	.181	.951	.5	.023	2.276	1.92	510	.27		
5-5A	14.5	124 5Yr	.688	237	11	534	1	.222	1.058	.7	.04	2.276	1.98	510	.09		
5A-5B																	

D5.25 COMPUTER PROGRAM FILES AND PROGRAM OUTPUT

1. Computer program output may be provided as long as summary sheets for Hydrological and Hydraulic calculations in accordance with this Specification are provided with plans submitted for checking and with final drawings.
2. Copies of final computer data files, for both hydrological and hydraulic models shall be provided for Council's data base of flooding and drainage information in formats previously agreed with Council.

D5.26 USE OF PUMPS**Pump-out systems for basements car parks**

If a portion of the access ramp to the basement car parking area, (excluding Single Dwelling and Dual Occupancies), cannot be drained by gravity then disposal of stormwater runoff via a pump-out system may be permitted, subject to the following requirements:

- | | |
|---|------------------------------------|
| <ol style="list-style-type: none"> 1. The basement car parking area shall be graded to fall to the sump and pump system with a minimum grade of 1%. | Where pumps are allowable |
| <ol style="list-style-type: none"> 2. The contributing catchment area to the pump out system shall be limited to the basement access ramps and subsoil drainage only. Generally no more than 100 sq. metres of access ramp catchment shall be allowed to drain to the sump. Surface flowpaths from remainder of site shall be diverted away from the basement area. | Contributing catchment |
| <ol style="list-style-type: none"> 3. Two (2) submersible type pump units shall be sized and installed in accordance with AS 3500.3, the capacity of each being calculated to allow for subsoil drainage and any water falling on or draining to access points, ground water from broken water mains and from broken services within the building. Stormwater runoff drainage to the sump and pump system shall be calculated from a 100 year ARI design storm of duration five (5) minutes. | Pump Design |
| <ol style="list-style-type: none"> 4. The two (2) pumps shall be designed to work in tandem to ensure that both pumps receive equal usage and neither pump remains continuously idle. Dual operation is to occur when top water level is reached. | Dual pumps in tandem |
| <ol style="list-style-type: none"> 5. The sump shall be designed and constructed in accordance with AS 3500.3 Pumpout Systems. A minimum volume of water is to be retained in the sump when the pumps are in the "off" position. The sump shall have sufficient capacity to store stormwater runoff from a 100 year ARI design storm of duration 90 minutes. | Sump design |
| <ol style="list-style-type: none"> 6. The pump-out system shall be independent of any gravity drainage lines except at the site boundary inspection pit where a grated surface pit shall be constructed, from which a connection will be permitted to the gravity stormwater system. Direct connection of the rising main from the pumpout system to the kerb will not be permitted. The pumped water must be treated prior to discharge to remove any pollutants before piped across the public footway by gravity. | Connection to pit |
| <ol style="list-style-type: none"> 7. The level of the pump-out system outlet connection to the grated surface pit shall be to the satisfaction of Council's Engineer. | Outlet level |
| <ol style="list-style-type: none"> 8. Storage areas and areas used for purposes other than car parking or access aisles are to be constructed a minimum of 150mm above the level of the surrounding area to achieve additional freeboard above the water level. | Freeboard for storage areas |
| <ol style="list-style-type: none"> 9. Automatic alarms are to be provided which are to be activated during pump failure. | Alarms |

10. Piped discharge from the total site may be connected to the kerb and gutter, provided that the discharge does not exceed 20 litres per second per outlet per 15m run of kerb and gutter for storms up to and including the 100 year ARI. The outlet pipe(s) leaving the site at the street must exit the kerb at an acute angle of less than 45 degrees.

Connection to kerb

11. All concentrated stormwater runoff is to be piped to the nearest public drain, or natural watercourse, to Council's requirements, if:

Connection to pit/pipe system

- (i) concentrated discharge from the site to the street gutter cannot be restricted to 20 l/s at 15m apart, and
- (ii) a direct connection to the public drainage system outside the subject property is not available.

12. Pipe junctions are to be orientated to minimise hydraulic losses. Pits are to be located at changes or direction, at property boundaries, and connection to the public drainage system. Where pits cannot be used, suitable transition structures may be accepted at Council's discretion.

Junctions and pits

13. A positive covenant is to be executed and registered against the title of the lot requiring ongoing maintenance and repair of the pumps and associated drainage system.

Positive covenant

14. An investigation and report is required to be prepared and submitted to Council by a geotechnical engineer determining the level of the water table in all weather, tidal and flood conditions. The report shall also assess the amount of seepage water which can safely be directed to the pump out system without damaging adjacent property foundations. The method of maintaining the level of the water table shall form part of the report.

Geotech report

15. A power failure backup system shall be incorporated into the proposed pump out system.

16. All pumpout systems for basement car parks are to be referred to DIPNR as integrated developments and accordingly will require payment of the appropriate fees at DA lodgement.

17. All pumpout systems shall be designed in conjunction with an onsite detention system capable of holding up to a 1:100 year ARI event in the case of pump failure.

D5.27 RESERVED

D5.28 RESERVED

D5.29 STORMWATER TANKS

1. Stormwater tanks required as part of the NSW Government BASIX requirements shall not be taken into consideration as stormwater detention/retention volume when calculating onsite detention/retention volume for compliance with this specification.

2. (a) Access to underground storage tanks used for stormwater detention/retention must be secured with a grate or cover and fastened to prevent children accessing them.
- (b) The floor of the storage tanks shall be graded so that the storage empties and water does not pool with the tank.
- (c) Tanks shall not be concreted over so as to prevent access to maintenance of

Underground Tanks

the tank.

- (d) The type of tank shall be resistant to the environment in which it is placed. A geotechnical report may be required to verify the site conditions.
- (e) The tank shall not be installed over or immediately adjacent to a water main, sewer main, onsite wastewater system or onsite wastewater disposal field.
- (f) The tank shall not be installed adjacent to large trees or the roots of large trees.
- (g) OSD storage shall not be installed below ground water level.
- (h) Tanks shall have an overflow route for storm events in excess of the 1:100 year ARI event.
- (i) Tanks connected to Council's stormwater network shall have a permissible discharge of less than or equal to the 1:5 year ARI event for the pre-developed catchment based on a 0% level of imperviousness. The remaining stormwater should be either stored within the tank or an overflow route detaining the difference between the pre and the post developed stormwater runoff to meet AUS-SPEC OSD requirements.

APPENDICES