DEVELOPMENT DESIGN SPECIFICATION

D5

STORMWATER DRAINAGE DESIGN

CONTENTS

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STORMWATER DRAINAGE DESIGN

GENERAL

D5.01 SCOPE

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

D5.02 OBJECTIVES

1. The overall objective of Wingecarribee Shire Council's Stormwater policy is to achieve an optimum environment in the context of the principles and guidelines of the total stormwater management plan and as such the provision of stormwater drainage systems shall achieve the following objectives:

(a) To provide safety for the public

(b) To minimise and control local and catchment flooding

(c) To stabilise landform and control erosion and sediment

(d) To minimise the impact of urban runoff on receiving waters by retaining within each catchment as much catchment and as much incident rainfall as possible and appropriate for the planned use and the characteristics of the catchment.

2. In pursuit of these objectives certain requirements are necessary for the piped system, the overland flow path and the discharge to natural watercourses. These requirements may include the provision of gross pollutant traps, construction of grassed waterways/ floodways and detention basins to control the quantity and maintain the quality of urban stormwater runoff both during and after urbanisation.

3. Designers shall comply with the Design Principles for Stormwater Drainage specified in Part F of Appendix One. ***Design Principles***

D5.03 REFERENCE AND SOURCE DOCUMENTS

(a) Council Specifications

D07	-	Sediment & Erosion Control
C220	-	Stormwater Drainage – General
C221	-	Pipe Drainage
C222	-	Precast Box Culverts
C223	-	Drainage Structures
C224	-	Open Drains including Kerb & Gutter
DCP 34		Potentially Flood Affected Land

(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 3500.3.2	-	Property Drainage

(c) State Authorities

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

Department of Land and Water Conservation –
The Constructed Wetlands Manual

Department of Land and Water Conservation –
Principles for Urban Stream Management

NSW Department of Housing –
Managing Urban Stormwater – Soils and Construction
3rd Edition August 1998

(d) Other

AUSTROADS - Bridge Design Code.

Inst. of Eng. - Australian Rainfall and Runoff - A guide to flood estimation.- As updated from 1987 edition.

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

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

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

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

Henderson, FM. Open Channel Flow, 1966.

Chow, Ven Te - Open Channel Hydraulics, 1959.

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

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

DESIGN OVERVIEW

D5.04 LEGAL RIGHT TO DISCHARGE STORMWATER

Easements are required

1. **Council will require proof that downstream easements from the subject property have been obtained for stormwater runoff**. The easement shall be continuous from the subject property through to a watercourse defined on a topographical map or to a Council drain or drainage reserve (only permitted where classification of the land pursuant to the Local Government Act 1993 permits this to occur). Council will not permit a pumped stormwater discharge system in lieu of a stormwater easement and appropriate disposal of stormwater through a gravity system..

D5.05 DESIGN CONCEPT

Major/minor concept

1. Stormwater drainage should be designed according to the major / minor concept.

Major System

(a) Major System

The major system shall be designed assuming blockage of minor systems being 59% or one cell whichever is the greater. The major system shall be via overland flow and shall not be via a piped system.

Onsite detention or other solutions including downstream drainage augmentation may be required to ensure that development does not have adverse impacts on downstream drainage infrastructure and public safety.

The major system shall be designed assuming that 30% of detention facilities and/or Water Sensitive Urban Design systems within a development or subdivision are non functional.

Minor System

(b) Minor System

The design of the minor system shall take full account of existing downstream systems, in particular, the potential for any flows to cause a nuisance to downstream and/or upstream properties or impact on natural systems, or existing and planned infrastructure.

The subdivision design shall make provision for the disposal of stormwater from individual sites in such a way as not to cause a nuisance or damage to any other properties. Interallotment drainage shall be designed so that it is sized for all runoff from the property including impervious areas and pervious areas where flows are to be concentrated. Interallotment drainage pits are to be grated unless specifically approved by Council in writing.

D5.06 LAND TENURE OF DRAINAGE SYSTEM

Trunk Drainage

1. Trunk drainage is defined as any structure with a flow >1m^3/second for the 1% AEP storm, or where an open channel, or any structure where another public facility such as a cycleway is parallel to the drainage structure and within the overflow path

Drainage Reserve

2. All trunk drainage is to be located within a Drainage Reserve and dedicated to Council.

Drainage Easement

3. All other drainage that is not within a public road or community land shall be located within a Drainage Easement. Easements over interallotment drains shall be in favour of the property served. All other easements shall be in favour of Wingecarribee Shire Council and

other properties where appropriate.

4. The width of Drainage Easements shall take into consideration factors such as the size of the drainage structure, access and the proximity to structures, but shall generally be a minimum of 2.0 m wide, including easements over interallotment drainage

5. Council will consider variations to the above on merit, when requested in writing. Documentary evidence as required by Council must accompany this request.

D5.07 WATER QUALITY MANAGEMENT

Sustainable development

1. The drainage system must minimise the environmental impact of urban runoff on receiving waters and on other aspects of the natural environment. Development design including drainage design must take into account the existing natural environment including any existing creeks or wetlands. The drainage and stormwater system must be both environmentally and economically sustainable. All proposed systems must satisfy the requirements of Clause D5.08 Innovative Design

D5.08 INNOVATIVE DESIGN

Concept approval

1. Council encourages innovation in the design of stormwater systems and the implementation of Water Sensitive Urban Design. Council requires all proposed innovative stormwater systems to be submitted to Council for approval. Council will require details including life cycle costing compared to conventional systems, details including published papers assessing the performance of the existing systems, details of other similar systems that are available to be viewed by Council staff and other items as determined by Council's Development Control Engineer. Concept approval will be required in writing prior to detailed design.

HYDROLOGY

D5.09 DESIGN RAINFALL DATA

I-F-D Relationships

1. Design Intensity-Frequency-Duration (IFD) Rainfall - IFD relationships shall be derived in accordance with Chapter 2, Volume 1 or the current edition of AR&R, for the particular catchment under consideration.

2. The nine basic parameters read from Maps 1-9 in Volume 2 of the current edition of ARR 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 for Wingecarribee Shire Council can be calculated using the RARE computer program, available from "Smartkey Solutions". Either a full data set for the Shire or a single point can be purchased from Council. Refer to Council's Fees and Charges for the current pricing.

Average Recurrence Intervals

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

5. Recurrence intervals for minor events depend on the development. The minor system design ARIs shall be selected in accordance with the following: -

LAND USE	ARI
<u>Road Drainage</u>	
Residential Areas	5
Commercial & Industrial Areas	10

Road Crossings

To meet the total requirement of 100 year ARI with VxD<0.4	
Minimum Requirement for culvert crossing	5

Site Drainage

Standard Residential Dwelling	5
Standard Residential Units	10
Commercial/ Industrial Land Use	10
Institutional or Important Site (Hospitals, Town Hall, Schools etc)	10

6. Where a development is designed in such a way that involves surcharge across private property, the downstream system shall be designed to operate in a similar manner to Figure 1.2 of the current version of AR&R (Urban Stormwater Management).

The underground piped system shall be designed to convey the 5 year ARI storm flow and the major system shall be designed to convey the 100 year ARI storm flow, allowing for the appropriate blockage factors for the piped system.

Easements are to be provided in private property over piped systems and surcharge paths.

7.In all situations, overland flow paths are to be designed to cater for the runoff generated by the 100 year ARI storm event. In private land, all overland flow paths are to be wholly located within easements of width and general arrangement acceptable to Council's Development Engineer. A restriction pursuant to Section 88B of the Conveyancing Act is to be placed upon the title of any land to which such an easement is created to secure the overland flow path. Council shall be identified in the instrument/restriction as the sole authority able to vary or modify this easement.

Overland Flowpaths

D5.10 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.

Catchment Definition

2. Where no detailed survey of the catchment is available, 1:4000 orthophoto maps are to be used to determine the catchments and to measure areas.

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

D5.11 RATIONAL METHOD

1. Rational Method calculations to determine peak flows shall be carried out in accordance with Chapter 14, the current version of 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.

Qualified Person

3. Co-efficients of Run-off shall be calculated as per Section 14.5 of the current version of AR&R and full details of co-efficients utilised shall be provided.

Runoff Co-efficients

4. Details of percentage impervious and Co-efficients of Run-off for specific locations and for individual zonings are to be assessed.

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.

Times of Concentration

6. Where the flow path is through areas having different flow characteristics or includes property and roadway, then the flow time of each portion of the flow path shall be calculated separately.

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

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

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

Overland Flow Coefficients

Flow across Parks	0.35
Flow across Rural Residential land	0.30
Flow across Residential (2a)	0.21
Flow across Residential (2b)	0.11
Flow across Industrial	0.06
Flow across Commercial	0.04
Flow across Paved Areas	0.01
Flow across Asphalt Roads	0.02
Flow across Gravel Areas	0.02

D5.12 OTHER HYDROLOGIC MODELS

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

Alternative Models

2. Where computer analysis programs are used, copies of the final data files shall be provided on submission of the design to Council. The data file shall be submitted in a format agreed with Council's Development Engineer.

HYDRAULICS

D5.13 HYDRAULIC GRADE LINE

1. Hydraulic calculations shall generally be carried out in accordance with the current version of Australian Rainfall & 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.

Qualified Person

Calculations

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

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

Downstream Control

(a) Known hydraulic grade line level from downstream calculations including pit

losses at the starting pit in the design event.

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

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

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

(e) Where the outlet is an open channel, the design storm is the major event and downstream flood levels are known, the downstream control shall be the 1% probability flood level.

Water Surface Limits

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

D5.14 MINOR SYSTEM CRITERIA

Gutter Flow Widths

1. The acceptable gutter flow width in the 5-year ARI event is 2.5 metres maximum. Wider flow widths may be approved on roads with grades less than 0.5%, however Velocity x Depth must be less than 0.4.

Conduit Sizes

2. Minimum conduit sizes are given below:

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

Velocity Limits

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

Water Sensitive Urban Design

4. The use of Water Sensitive Urban Design for minor systems only is encouraged, and shall be in accordance with the design principles laid down in "Managing Urban Stormwater" handbook published by the EPA.

D5.15 PITS

Spacing

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

2. Other pits shall be provided:

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

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

	Pipe Size (mm)	Spacing (m)
Generally	less than 1200	100
	1200 or larger	150

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

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

- Roads and Traffic Authority's "Model analysis to determine Hydraulic Capacities of Kerb Inlets and Gully Pit Gratings", with due allowance to inlet bypass due to grade, for grade inlet pits, and recognised orifice or weir formulae for sag inlet pits.
- Pit relationships given in Chapter 14 of the current version of AR&R.

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

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

D5.16 HYDRAULIC LOSSES

1. The pressure change co-efficient "Ke" shall be determined from the appropriate charts. ***Pit Losses***

2. A reduction in "Ke" due to benching can be assessed.

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

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

5. Where possible design should try to avoid clashes between services. However, where unavoidable clashes occur with existing sewer mains then the pressure change co-efficient Kp shall be determined. ***Service Entry Losses***

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

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

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

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

Pipe Junction Losses

7. Construction of a junction without a structure should be avoided where possible. Permission to do this is required by Council prior to detailed design. Where this is unavoidable the pressure change co-efficients Ku, for the upstream pipe and Kl, for the lateral pipe, shall be determined.

Contraction/ Expansion Losses

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

Pipe Friction Losses

9. Drainage pipe systems shall be designed as an overall system, with due regard to the upstream and downstream system and not as individual pipe lengths. Drainage pipeline systems shall be designed as gravity systems flowing full at design discharge. 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 0.3mm for concrete pipes and 0.06mm for FRC pipes.

D5.17 MAJOR SYSTEM CRITERIA

1. Major systems shall be designed for a blockage factor of 50% at all culvert inlets and other major system structures. Allowance shall be made for the resultant afflux, and the resultant surcharge flows shall be accommodated within overland flow paths.

Surcharging

2. 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% 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.

Velocity/ Depth Criteria

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

4. 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 0.5 m shall be provided between the 100-year flood level and floor levels on structures and entrances to underground car parks. A higher freeboard may be required in certain circumstances.

(b) Where the road is infill and overtopping of stormwater through adjacent low side properties may occur during conveyance of the 1:100 year ARI flow, 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: -

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

In Open Channels: -

(a) 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.

(b) A minimum freeboard of 0.3 m shall be provided between the 100-year flood level and the top of the channel.

5. Flow capacities of roads should be calculated using Technical Note 4 in Chapter 14 of the current version of AR&R. ***Roadway Capacities***

D5.18 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 the current version of AR&R, and shall be designed with safety requirements as set out in Section 14.10.4 of the current version of AR&R, as a primary criterion. Open channels will be designed to contain the major system flow less any flow that is contained in the minor system, with an appropriate allowance for blockage of the minor system, as given in 6.13, point 3.

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

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

Concrete Pipes or Box Sections	0.011
Concrete (trowel finish)	0.014
Concrete (formed without finishing)	0.016
Sprayed Concrete (gunite)	0.018
Bitumen Seal	0.018
Bricks or pavers	0.015

Pitchers or dressed stone on mortar	0.016
Rubble Masonry or Random stone in mortar	0.028
Rock Lining or Rip-Rap	0.028
Corrugated Metal	0.027
Earth (clear)	0.022
Earth (with weeds and gravel)	0.028
Rock Cut	0.038
Short Grass	0.033
Long Grass	0.043

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

5. Maximum side slopes on grassed lined open channels shall be 1 in 4, with a preference given to 1 in 6 side slopes, channel inverts shall generally have minimum cross slopes of 1 in 20. Channels in private property shall have a maximum slope of 1 in 6. ***Side Slopes***

6. Low flow provisions in open channels (man-made or altered channels) will require to be discussed with Council at the time of design pursuant to clause D5.08. ***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***

8. Open channels/ floodways shall be designed for a capacity of 100 year ARI storm event with freeboards as specified in D5.12 ***Capacity***

9. Maximum velocity in grassed channels shall be 2.0m/s for flows up to the 100 year ARI storm event ***Velocities***

10. Curves shall have a minimum radius of 30 metres ***Curves***

11. In accordance with the "Design Principles" specified in Part F Appendix One; developers are encouraged to design "natural" channels, where appropriate. Such systems should include adequate rock protection for the low flows and minimal disturbance to the existing stream regime, whilst meeting accepted hydraulic design principles. Where this type of approach is proposed, the developer shall discuss the proposal with Council's staff in the early stages of design such that the suitability and constraints of any such design can be agreed upon. ***"Natural" channels***

D5.19 MAJOR STRUCTURES

1. A major structure is a structure including bridges and culverts that conveys stormwater with a flow rate of greater than 10 cubic metres per second. ***Definition***

2. All major structures shall be designed for the safe passage of the 100-year ARI storm event without afflux in urban areas. Some afflux and upstream inundation may be permitted in certain rural and urban areas provided the increased upstream flooding is negligible, is in accordance with DCP 34, and does not inundate private property. ***Afflux***

3. 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. A minimum clearance of 0.5m 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 when located in roads classified as collector or greater. ***Freeboard***

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

6. Culverts (either pipe or box section) shall be designed with due regard being given to inlet and exit losses, inlet and outlet control and scour protection.

D5.20 MINOR STRUCTURES

1. Minor structures are all structures not defined as major structures. ***Definition***

2. All minor structures shall be designed for the safe passage of the 100-year ARI storm event without afflux in urban areas. Some afflux and upstream inundation may be permitted in certain rural and urban areas provided the increased upstream flooding is negligible, is in accordance with DCP 34, and does not inundate private property. ***Bridges***

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

4. Small bridges/culverts within allotments and floodways shall be designed to convey the 20-year ARI storm event without afflux, together with certification stating that the bridge is capable of withstanding the inundation loadings for up to the 100-year ARI storm event with VxD<0.4. ***Small Bridges Design Storm Event***

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

6. Culverts (either pipe or box section) shall be designed with due regard being given to inlet and exit losses, inlet and outlet control and scour protection.

D5.21 RETARDING BASINS

1. For each ARI a range of storm events shall be run to determine the peak flood level and discharge from the retarding basin. Storm patterns shall be those given in the current version of AR&R Volume II. ***Critical Storm Duration***

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

3. Flood Routing should be modelled by methods outlined in the current version of AR&R. ***Routing***

4. The high level outlet to any retarding basin shall have capacity to allow the passage of 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 generally be in accordance with the requirements for Open Channel Design in this Specification.

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

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

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

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

- Side slopes are to be a maximum of 1 in 6 to allow easy egress. Side slopes of greater than 1 in 4 may require handrails to assist in egress.
- Water depths shall be, where possible, less than 1.2m in the 20-year ARI storm event. Where neither practical nor economic, greater depths may be acceptable. In that case the provision of safety refuge mounds should be considered.
- Depth indicators shall be provided indicating maximum depth in the basin.
- Protection of the low flow intake pipe shall be undertaken to reduce hazards for people trapped in the basin.
- Signage of the spillway is necessary to indicate the additional hazard.
- Basins shall be designed so that no ponding of water occurs on to private property or roads.
- No planting of trees in basin walls is allowed.
- No basin spillway is to be located directly upstream of urban areas.
- Submission of design plans to the Dam Safety Committee is required where any of these guidelines are not met or Council specifically requires such submission.
- Fencing signage issues are to be discussed with Council and may be required pursuant to clause D5.22 (3).

10. In accordance with the "Design Principles" specified in Part F Appendix One; developers are encouraged to design artificial wetlands, where appropriate. Where this type of approach is proposed, the developer shall discuss the proposal with Council's staff in the early stages of design such that the suitability and constraints of any such design can be agreed upon. Such systems should be designed in accordance with the guidelines specified in the "Constructed Wetlands Manual" as referred to in Section D5.03(c). ***Artificial Wetlands***

STORMWATER DETENTION

D5.22 STORMWATER DETENTION

1. Installation of Stormwater Detention may be required for any development site within the Shire. ***Application***

2. For all situations, the maximum discharge for the 1:100 year storm shall not exceed the pre-development discharge, unless it is demonstrated by means of a hydraulic assessment that it is not required. ***Criteria***

The allowable discharge for the 1:10 year storm from a development site is to be limited to 0.04l/s per m^2 of the allotment area where the discharge is to kerb and gutter. A further limitation of 32l/s per discharge point with a minimum spacing of 15 metres between discharge points shall also be applied.

If the stormwater runoff generated from the total developed site is greater than the above criteria an On Site Stormwater Detention System shall be designed so the above requirements can be met.

The contributing catchment and the capacity of the downstream drainage system shall be assessed in the design of the discharge points and detention system.

3. A risk assessment shall be undertaken of the Stormwater Detention storage to ***Access to***

ascertain if fencing or other protection including signage is required. This assessment shall be submitted with the design. As a general principle, if the Stormwater Detention required is greater than 300mm water depth, it will require fencing and the impacts on the total catchment shall be considered. *Detention Storages*

4. The installation of underground detention facilities in residential developments or pumped discharge facilities for any developments will not be approved. *Underground or Pumped Prohibited*

5. Stormwater detention for each single torrens title allotment created by subdivision is required whether in the form of a rainwater tank and/or infiltration unit, or another system as approved in writing by Council.

6. Stormwater detention for public infrastructure may be in the form of oversized stormwater pipes, surcharging wetland systems or detention basins, or another system as approved in writing by Council.

INTERALLOTMENT DRAINAGE

D5.23 INTERALLOTMENT DRAINAGE

1. Interallotment Drainage shall be provided for every allotment where roof water and surface water cannot be discharged directly to the street drainage or a natural watercourse.

2. Interallotment drainage shall be contained within an easement not less than 2.0m wide, and the easement shall be in favour of the benefiting allotments.

3. Pipe Capacity - Interallotment drainage shall be designed so that it is sized for all runoff from the property as defined previously. Interallotment drainage pits are to be grated unless specifically approved by Council in writing, and shall be designed for flow rates having a design ARI the same as the "minor" street drainage system. Interallotment drainage shall include flows from upstream of the property. The interallotment drainage system forms part of the overall drainage system that needs to be checked and approved.

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

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

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

6. Interallotment drainage pits shall be located at all changes of direction. Pits shall be constructed of concrete, with 100mm thick walls and floor and have a minimum 600 x 600 internal dimensions. Pits shall be fitted with a depressed grated inlet. See WSC SD 126. *Pits*

7. Pipes - Minimum Grade - The interallotment drainage shall have a preferred minimum longitudinal gradient of 1.0%, with an absolute minimum grade of 0.5%. *Grade*

8. Interallotment Drainage Pipe Standards - The interallotment drainage shall be constructed from rubber ring jointed pipes of either fibre reinforced concrete drainage pipe, reinforced concrete pipe, or UPVC pipe which shall conform respectively to the requirements of AS 4139, AS 4058 and AS 1254. In public road and recreation reserves where vehicle loads may be encountered, reinforced concrete pipe only shall be used. *Pipe Type*

9. Interallotment Drainage Pipe – Relationship to Sewer Mains - Where interallotment drainage and sewer mains are laid adjacent to each other they are to be spaced 1.0 metre between pipe centrelines (where the pipe inverts are approximately equal). ***Sewers***

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

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

12. Council will not maintain the interallotment drainage system. ***Responsibility for Maintenance***

13. Council will not release the final linen plan of subdivision until such time as Works as Executed plans have been submitted to Council along with certification from a qualified Civil Engineer or Registered Surveyor certifying the operational adequacy of the subdivision drainage system, including any interallotment drainage. The certification shall also certify that any interallotment drainage has been constructed in accordance with the approved drawings and specifications. ***Release of Linen Plan & Certification.***

DETAILED DESIGN

D5.24 CONDUITS

1. Conduit and Material Standards – Conduits and materials shall be in accordance with the relevant Australian Standard.

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. Conduit Jointing – All pipes are to be rubber ring jointed.

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

D5.25 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 current issue of Council's standard drawings. Safety and safe access are important considerations in pit design.

D5.26 STORMWATER DISCHARGE

1. Scour protection at culvert or pipe system outlets shall be specified. ***Scour***

2. At points of discharge of gutters or stormwater drainage lines, or at any concentration of stormwater from 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. The developer shall meet the cost of the easement(s). ***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.

Easements

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, including freeboard, in the major system design event.

5. Discharge to Recreation Reserves (Community Land) - piped stormwater drainage discharging to Community Land shall only occur where the Plan of Management for the land so allows, and is to be taken to a natural watercourse and discharged in an approved outlet structure and in accordance with the requirements of the Department of Planning, Infrastructure and Natural Resources, or alternatively taken to the nearest trunk stormwater line.

D5.27 MISCELLANEOUS

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

Subsoil Drain at Pits

2. In cases where pipe trenches are backfilled with sand or other pervious material, a 3m length of subsoil drain shall be constructed in the bottom of the trench immediately upstream from every pit or headwall. The subsoil drain shall consist of 100mm diameter agricultural pipes, butt jointed, with joints wrapped with hessian or slotted PVC pipe.

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

Kerb & Gutter Termination

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

DOCUMENTATION

D5.28 PLANS

Scales for Drawings

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

2. The Drainage System Master Plan shall be drawn at a scale of 1:500 and shall show drainage pipeline location, drainage pit location and number and road centreline chainage, size of opening and any other information necessary for the design and construction of the drainage system.

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

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
- pipe class and type
- pipeline and road chainages
- pipeline grade
- hydraulic grade line

- existing and proposed public utilities intersecting the drainage line, including approximate levels of the utility
- any other information necessary for the design and construction of the drainage system.

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

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

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

D5.29 SUMMARY SHEETS

1. A copy of a Hydrological Summary Sheet is required. ***Hydrology***

2. A copy of a Hydraulic Summary Sheet is required. ***Hydraulics***

D5.30 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 database of flooding and drainage information and shall be in formats previously agreed with Council.

SPECIAL REQUIREMENTS

D5.31 DEVELOPMENT CONTROL PLAN NO 34 - POTENTIALLY FLOOD AFFECTED LAND

The Developer is to comply with Development Control Plan No 34 – Potentially Flood Affected Land, and Clause 34 of the Local Environment Plan. DCP No 34 details Council's requirements regarding development of potentially flood affected land. Among other requirements, it contains details relating to the submission of flood studies and hazard assessment. ***Potentially Flood Affected Land***