Engineering Design Specification

D09 Stormwater Drainage (Design)

Print version is uncontrolled. Current version is maintained on Wingecarribee Shire Council Website in searchable PDF format.

This document is a modified version of AUS-SPEC 0074 Stormwater Drainage (Design)

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1 General

1.1 Introduction

1.1.1 Worksection application

This worksection is applicable to the design and documentation requirements for stormwater drainage systems for urban and rural areas. It covers hydrology and hydraulic design for a total stormwater drainage system and includes Water Sensitive Urban Design, principles of stormwater harvesting and re-use.
These specifications should be read in conjunction with Council's Development Control Plan (DCP) and the latest version of Australian Rainfall & Runoff (ARR). In case of any conflict among these documents, ARR will take precedence. It is expected that standard engineering practices on Hydraulics, Hydrology in urban drainage design will be adhered to.

Flood Studies and Floodplain Risk Management Plans adopted by Council and other relevant state agencies are available on Councils Website. Detailed flood level information for individual properties may be available from Council on request.

1.1.2 Design Life

All stormwater infrastructure is to have a design service life of 100 years. This applies to pipes, pits and all structural elements. It is understood that natural/ naturalistic systems will be subject to natural impacts from weather and nature which are beyond the ability of the designer to account for. In respect of these elements of the stormwater system the above requirements regarding maintenance will apply.

1.2 Responsibilities

1.2.1 General

Requirement: Provide design and documentation for stormwater drainage systems.

1.2.2 Standards

1.2.3 General

- **Standard:** Conform to the current version of the following:
- Rainfall and runoff: Current version of Australian Rainfall & Runoff (ARR), www.ga.gov.au
- Water sensitive urban design: To Engineers Australia, Australian Runoff Qualities (EAARQ).
- Wingecarribee Shire Council Standard Drawings, which can be downloaded from Council's website.
- Floodplain management to current edition of NSW Government Floodplain Development Manual.

1.3 Interpretation

1.3.1 Abbreviations

- General: For the purposes of this worksection the following abbreviations apply:
- AEP: Annual exceedance probability.
- EY: Exceedances per Year.
- ARI: Average recurrence interval.

- GPT: Gross Pollutant Trap.
- IFD: Intensity-frequency-duration.
- HGL: Hydraulic grade line.
- OSD: On-site detention.
- SQID: Stormwater quality improvement devices.
- WSUD: Water sensitive urban design.

1.3.2 Definitions

General: For the purposes of this worksection the following definitions apply:

- Annual Exceedance Probability (AEP): The probability that a given rainfall total accumulated over a given duration will be exceeded in any one year.
- Average Recurrence Interval (ARI): The average or expected value of the period between exceedances of a given rainfall total accumulated over a given duration. It is implicit in this definition that the periods between exceedances are generally random.
- Catchment: A topographically defined area drained by a stream where all outflow is directed to a single point.
- Catchment area of any point: The limits from where surface runoff will make its way, either by natural or man-made paths, to this point.
- Dual drainage: The major/minor approach to street drainage.
- Major system: The network of planned and unplanned drainage routes providing safe, well-defined overland flow paths for rare and extreme storm runoff events. It includes roads, natural channels, streams, culverts, community retention/detention basins and other facilities.
- Minor system: The gutter and pipe network capable of carrying and controlling flows from frequent runoff events. It includes kerb and channels, inlet structures, open drains and underground pipes and on-site detention facilities.
- Primary treatment Stormwater Quality Improvement Devices (SQID): Removal of the majority of gross pollutants and coarse-medium grained sediments by screening or sedimentation, e.g. GPT's, trash racks, sediment trap.
- Redevelopment site: A site that had (or was originally zoned to have) a lower density development than is proposed.
- Secondary treatment SQID: Removal of the majority of coarse, medium and fine grained sediments, as well as a significant proportion of the pollutants attached to sediments, by enhanced sedimentation and filtration, e.g. infiltration basins and wet ponds.
- Stormwater management plan: A plan to manage the stormwater quantity and quality within a catchment or a development and protect receiving water features, such as the protection of existing waterways, lakes and wetlands.
- Sub-catchment: A topographically defined area drained by a tributary or branch drain of a primary stream, river or main draining catchment.
- Tertiary treatment SQID: Removal of the majority of sediments attached pollutants and dissolved pollutants by sedimentation, filtration and biological uptake, e.g. constructed wetlands.
- Time of concentration: The time required for storm runoff to flow from the most remote point on the catchment to the outlet of the catchment or to the inlet of a drainage structure within the catchment.
- Treatment train: Sequencing of SQID's to optimise treatment performance.

- Trunk drains: Flow >=1m3/s for 1% AEP event.
- Water Sensitive Urban Design (WSUD): Design principles aimed at improving the sustainable management of the urban water cycle. It integrates the planning and design of urban water cycle, water supply, waste water, stormwater and groundwater management, urban design and environmental protection.
- Water Course: watercourse consists of a stream with a bed, with banks, and water. That the flow of the water in the stream is intermittent or seasonal will not prevent what would otherwise be a watercourse from being accounted such: but though it is quite true that a watercourse may exist though its bed be dry for some periods, the watercourse must exhibit features of continuity, permanence and unity. It must essentially be a stream and be sharply distinguished from a drainage depression in the contours of the land which serves to relieve upper land of excess water in times of major precipitation, such a drainage depression will lack banks and a bed in the proper sense of that term, that is to say, identifiable margins of a continuous and permanent stream which contribute to its unity whether or not water is in fact continuously flowing over the bed.

2 Pre-design planning

2.1 Land use Planning:

- Refer Council's DCP for restrictions related to flood affected land.
- Refer Councils Local Environment Plan (LEP) for land zoning and flood affected land.
- Refer existing flood and risk management studies for flood affected land in the council website.

2.2 Stormwater management

Requirement: Integrate management activities at the catchment, waterway and local development level in conformance with the NWQMS Document 10 and the following:

- Restore existing stormwater systems.
- Minimise the impacts of stormwater from new developments.
- Hydrological: Minimise the impacts of urbanisation on the hydrological characteristics of a catchment including wet weather and low flows. Mitigate pre-development inappropriate flows where practical.
- To stabilise landform, control erosion and sediment.
- Water quality: Minimise the amount of pollution entering the stormwater system and remove residual pollution by implementing stormwater management practices.
- Vegetation: Maximise the value of indigenous riparian, floodplain and foreshore vegetation.
- Aquatic habitat: Maximise the value of physical habitats to aquatic fauna within the stormwater system.
- Processes for management: Implement processes for management for the following as applicable:
- Runoff.
- Water quality.
- Riparian vegetation.
- Watercourse and aquatic habitat.
- Urban bushland.

- Bridges and culverts across waterways.

Water Sensitive Urban Design (WSUD): Plan and design stormwater drainage using WSUD principles including the following:

- OSD.
- Capture and use of stormwater as an alternative source of water to conserve potable water.
- Use of vegetation for filtering purposes.
- Water-efficient landscaping.
- Protection of water-related environmental, recreational and cultural values.
- Localised water harvesting for re-use.
- Localised wastewater treatment systems.

2.3 Consultation

2.3.1 Council and other Authorities

Requirements: Consult with the Council and other relevant authorities during the preparation of design. In addition to the requirements of this worksection, identify the specific design requirements of these authorities. e.g. OEH, NSW Fisheries, Transport for NSW (formerly RMS).

2.3.2 Utilities service plans

Existing services: Obtain service plans from all relevant utilities and other organisations whose services exist within the area of the proposed development by contacting Dial Before You Dig (DBYD). Plot these services on the relevant drawings including the plan and cross-sectional views.
Location of subsurface utilities: To AS 5488.1 and AS 5488.2.
Requirements for utility services: To the SOCC *Guide to codes and practices for streets opening*.

2.3.3 Calculations

Certified design calculations: Engage a qualified hydrologic and hydraulic design Professional Engineer to perform all required calculations. All plans to be supported by hydraulic calculations.

2.3.4 Major structures

Certified structural design: Engage a Professional Engineer for all bridges, major culvert structures and specialised structures in conformance with *D02 Quality requirements for Design.*

3 Design criteria – Stormwater drainage systems

3.1 General

3.1.1 Overall design

Requirements:
Flooding

- Reduced frequency of flooding of private and public buildings in flood-prone areas.
- Nil increase in flood levels on any other properties downstream. Refer Councils DCP – Flood Liable Land.
- How system functions and stability of major structures in the event of a PMF (PMF only required for sensitive development as defined in the Floodplain Development Manual).
- Impacts as a result of increased rainfall due to climate change.
- Appropriate Blockage Factors & Freeboards.

- Control of surface flows to prescribed velocity/depth limits.
- Control of surface flows to minimise the effect on pedestrians and traffic in more frequent stormwater conditions.
- Retention of incident rainfall and runoff consistent with the planned use of the area, within each catchment.
- Conformance with the current ARR major/minor system concept.
- Minimising impacts of flooding both upstream & downstream.
- A high level of safety for all users.
- Acceptable levels of amenity and protection from the impact of flooding.
- Ensure that the design capacity of downstream drainage systems are not compromised.
- Minimise construction and maintenance costs and avoid the need for future property acquisition;
- Ensure low maintenance and economically sustainable in the long term in relation to operation, maintenance and replacement costs.

Climate Change Considerations

Climate change considerations are important in the design of an asset or structure depending on the design life. A risk assessment is required as described in the current version of ARR, ''Climate Change Considerations'' **Book 1 Chapter 6.**

It is also advised that the designer use the information from the Australian Climate Futures website developed by CSIRO.

Water Quality

- NorBE – Neutral or Beneficial Effect.
- Adoption of WSUD principles.
- Opportunity to improve water quality.

3.1.2 Control of erosion and sedimentation

Requirement: To D11 *Control of erosion and sedimentation (Design)*.

3.1.3 Design for stormwater harvesting and re-use

General: Design for re-use of locally generated roof water, stormwater.

Stormwater re-use scheme: Design the re-use scheme for ease of operation and maintenance. Consider the following when designing for collection, storage, treatment and distribution:

- End use requirements for water quality and quantity.
- Reliability of supply.
- Estimated demand for water with regard to peak flow.
- Assessment of water balance for sizing and storage.
- Storage requirements considering average annual volume and diversion flow rates.
- Treatment system based on:
    - Diversion flow rates before storage.
    - Distribution flow rates both before and after storage.

Roofwater: Provide an integrated design with rainwater tanks, coordinate with the appropriate engineering consultation and conform to Statutory and local authority requirements.

Stormwater runoff: Design for the utilisation of stormwater runoff at the following scales:

- Allotment scale.

- Subdivisional/regional scale.

3.1.4 Stormwater collection

Requirement:

- Extraction of sufficient water to meet the end use requirements without compromise to downstream aquatic eco systems.
- Ability to stop collection in the event that stormwater is contaminated by an incident within the catchment.
- Minimisation of the risk and/or impact of upstream flooding.

3.1.5 Stormwater storage

Requirement:

- Storage of sufficient water to balance supply and demand.
- Minimisation of mosquito habitat, risks to public safety and risks to water quality in above-ground storage.
- Maximisation of dam safety.

3.1.6 Stormwater treatment

Requirement:

- Minimisation of public health risks for the adopted public access arrangements.
- Minimisation of environmental risks.
- Mitigate Pollution run-off.

3.1.7 Stormwater distribution

Requirement: Minimise the potential for:

- Contaminant inputs downstream of the final treatment facilities.
- Public exposure to untreated stormwater.
- Cross-contamination with mains water distribution networks or confusion with mains water supplies.

Irrigation: Design the irrigation system to the following requirements:

- Minimise run off, groundwater pollution and soil contamination.
- Minimise spray to areas outside the access control zone to reduce public health risks, if access control is adopted.
- Application rate of stormwater: Uniform for the irrigation scheme and less than the nominal infiltration rate to avoid surface runoff.

3.2 Hydrology

3.2.1 Design rainfall data

Requirement:

- Design IFD: Available from ARR Data Hub and BOM websites. www.data.arr-software.org/
- ARR2016 AS/NZS 3500.3 Appendix E.
- Bureau of Meteorology IFD tool website www.bom.gov.au.
- Geoscience Australia website www.ga.gov.au.
- Record IFD: Document the adopted IFD data used in the hydrological calculations to the sample summary sheet.

Additional Requirements: Austroads AGRD05.

Record AEP: Document the adopted AEP data in the hydrological calculations to the summary sheet Design Average Exceedance Probability (AEP). For design under the "major/minor'' concept, the design AEPs/EYs are given below:

Land Use Type	Annual Exceedance Probability (AEP)/Exceedances per Year (EY)
Road Drainage (Minor)	
Residential/Industrial	0.2EY
Commercial	10 % AEP
Overland Flows (major)	
Velocity X Depth (pedestrian)	0.40 m2/s for 1% AEP
Velocity X Depth (trafficable)	0.60 m2/s for 1% AEP
Road Culverts/Pipes	
Culvert (Urban)	1% AEP
Culvert (Rural)	20% AEP to 1% AEP (Council may consider variations to the design AEPs)
Site Drainage	
Major System Criteria	1% AEP, same for all developments
Minor System Criteria	
Residential	0.2EY
Residential Units/townhouses	10% AEP
Business & Commercial	10% AEP
Hospitals, Old homes, Schools and hospices	10% AEP
Parks & Recreation areas	1 EY

The following information must be noted while designing urban drainage using 2016 rainfall and the loss models:

Loss Model: Initial and Continuous.

For urban drainage design in accordance with ARR'16, the equivalent impervious area (EIA) of the total impervious areas can be guided from the following:

EIA Values:

Catchments	EIA %
Urban Subdivision drainage	70%
Car Parks	90%
Road	85%
CBD areas	80%

However, the actual impervious areas should be determined. The above figures are guide only and designers' judgments are important.

3.2.2 Catchment area

Catchment definition: To Austroads AGRD05A clause 2.6.3. If detailed survey is not available, determine the extent of the catchment area from current topographical mapping, aerial photographs or field survey.
Site inspection: Verify catchment boundaries, flow paths and existing drainage infrastructure by site inspection.
Catchment area land use: Establish catchment area land use based on current available zoning information.
Record: Document the design to the **Catchment areas plan**.
Extent: The catchment area for a particular point is defined by the limit from where surface run-off will make its way, either naturally or by constructed overland or piped paths, to this point.
Consideration shall be given to changes to individual catchment areas due to the full development of the catchment. Determine the extent of the catchment area from current topographical mapping, aerial photographs or field survey.
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.
Roughness co-efficients 'n*' (not Manning's n) to be used in Kinematic Wave Equation to calculate time of concentration shall be derived from reliable publications values applicable to specific zoning and land use types:

Land use type	Roughness 'n*'
Flow across parks	0.35
Rural residential	0.30
Residential (2a)	0.21
Residential (2b)	0.11
Industrial	0.06
Commercial	0.04
Paved surfaces	0.012
Asphalt roads, Gravel areas	0.02

3.2.3 Methods of analysis

Flows: Determine in conformance with the current ARR and the requirements of this worksection.
Flow studies: Prepare flow studies including the following:

- A relevant range of AEPs for each sub-catchment.
- Calculation of total flows at junctions of existing drainage works.
- Assessment of allowable flows from catchment/sub-catchments for release to downstream areas or drainage systems.
- Assessment of release from detention storages affecting capacity of drainage works to avoid surcharge/inundation.
- AS/NZS3500.3 clause 5.4.6.

Record: Document details of adopted AEP's, temporal patterns, latitude/longitude of the subject catchment.
Equivalent Impervious areas, adopted initial and continuing loss.

Time of concentration: For urban areas, use kinematic wave equation, consider the limitations in relation to slope and flow path length, area: Sufficient modelling to determine the critical storm for the catchment.
Flow time: If the flow path passes through areas having different flow characteristics or includes property and roadway, calculate the flow time of each portion of the flow path separately.
Flow paths to pits: Document the flow path for each collection pit for the fully developed catchment on the catchment area plan. Consider the following:

- Fencing.
- Potential locations of buildings.
- Changes to individual flow paths due to the full development of the catchment.
- Proposed detention works.

Manning's roughness co-efficient ('n') for specific zonings:

- ARRARR 2016 Book VII Section 1 Table 1.
- Austroads AGRD05A Table 5.3.

Modelling:

- Model type required for design: Council uses "DRAINS" software for urban situations and "XPRAFTS" software for urban and rural situations and will consider the use of other models as appropriate.
- Submit details of all program input and output.
- Submit copies of the final data files.

3.2.4 Alternative models and computer analysis

General: Use of other hydrological models or computer analysis is permitted. If using alternative models or computer analysis, conform to the following:

- Satisfy the requirements of the current version of ARR.
- Submit summaries of calculations.
- Submit details of all program input and output.
- Submit copies of the final data files.

3.3 Hydraulics

3.3.1 General

Major/minor drainage concept: To current ARR and Austroads AGRD05A.

3.3.2 Minor system

Criteria:

- The design of the minor system shall take full account of existing downstream systems and flows from upstream catchments.
- 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 must be provided for the properties that cannot discharge to the road drainage. The design AEP and other aspects to be determined in consultation with the development engineers and as detailed in this booklet.

3.3.3 Major system

Criteria:

- The major system shall be via an overland flow path or a combination of overland flow and flow through pipes.
- 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 where the capacity of minor system is exceeded. The major system shall be designed to cater for 1% AEP storms applying appropriate blockage.
- Major systems shall be designed considering appropriate blockage in accordance with Report 11 Engineers Australia (www.arr.ga.gov.au/revision-projects/project-list/projects/project-11) hydraulic structures Allowance shall be made for the resultant afflux, and the resultant surcharge flows shall be accommodated within overland flow paths.
- Surcharging of drainage systems will not be permitted for storms 0.2 EY or below. For storms greater than 0.2EY may.be permitted across the road centreline where the road pavement is below the natural surface of the adjoining private properties.
- 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 is 0.2m and the maximum velocity X depth product of 0.4m2/s.
- For vehicles:
- Maximum velocity X depth is 0.6m2/s.
- 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.

3.3.4 Hydraulic grade line (HGL)

Calculations: To ARR.
Record: Document hydraulic calculations in a summary sheet.

- A summary of design calculations.
- Detailed drawings showing the hydraulic grade line.
- Listing of all program inputs and outputs.

Downstream control: Adopt the appropriate downstream water surface level requirements from the following options:

- Downstream boundary (minor storm) - Where the outlet is an open channel the top of the outlet pipe shall be the downstream boundary.
- Downstream boundary (major storm) - If the outlet is open channel, model as submerged outlet or as high as justified if flood levels are unknown.

Where the outlet is an open channel and downstream flood levels are known, the downstream control shall be the 1% AEP flood level.

The water surface in drainage pits shall be limited to 0.15m, below the gutter invert for inlet pits and 0.15m below the underside of the lid for junction pits for 0.2EY events.

3.3.5 Acceptable gutter flow width

AEP/EY	Flow Width (m)	Velocity X Depth (m^2/s)
0.2 EY	2.5	0.4
0.2EY	0.5 at pedestrian crossings	0.4

Requirements may differ on state RMS roads. Refer current RMS guidelines

Minimum and maximum velocity of flow in stormwater pipelines shall be 0.6m/s and 5m/s respectively. For velocities >5m/s, velocity must be reduced by drop pits.

3.3.6 Conduits

Conduit and Material Standards:

Conduits and materials shall be in accordance with the relevant Australian Standard.

Pipe Bedding and Cover:

For RCC and Fibrocement 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.

Conduit Jointing:

All pipes are to be rubber ring jointed or as appropriate depending on pipe sizes.

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.

3.3.7 Minimum cover pipes

Location	Minimum Cover (mm)	
	Rigid Pipes (Reinforced Concrete) Class 2*	Flexible Pipes (plastic, thin metal)
Residential private property, parks not subject to traffic	300	450
Residential private property, parks subject to occasional traffic	450	450
Footpaths	450	600
Road pavements & under kerb & channel	600	600

Notes:

1. *For special cases, and with the agreement of Council, cover can be reduced by using a higher-class pipe, special bedding, concrete protection or a combination of all of the above. The thickness of the pavement is excluded while calculating the depth of cover.*

2. *Where pipes are to be laid under the footpath consideration should be given to the possibility of future road widening, both in respect of the reduced cover that might result from the widening and vehicle loading.*

3. *Concrete Pipe Association of Australia and pipe manufacturers construction specification should be considered in conjunction with the above table.*

3.3.8 Lateral spacing of pipes

Where multiple pipes are used they should be spaced sufficiently to allow adequate compaction of fill between the pipes. The Council may permit lesser spacing in special circumstances to reduce structure costs, where easement width is limited, or for relief drainage works. The clearance between the outer face of the walls of multiple pipes is shown below:

Diameter of Pipes (mm)	Minimum Clear Spacing (mm)
Up to 600	300
675-1800	600

Notes:

1. *The above minimum spacing may need modification to satisfy structural Considerations, especially when laid at depth, under traffic loads or for pipes greater than 1800mm in diameter.*

2. *Where lean mix concrete vibrated in place or cement stabilised sand is used for backfill, the clear spacing may be reduced to 300mm for all diameters, subject to structural considerations.*

3. *For construction specifications, please refer to Concrete Pipe Association of Australia (CPA) Guidelines.*

3.3.9 Pipe trench compaction

Construction supervisors and stormwater managers are warned about the potential damaging effects of compacting trenches with wheel roller attachments that can impart significant live loads on the pipe. The choice of pipe material and structural grade will depend on the chosen method of installation.
Recommendations on the compaction of earth around concrete pipes may be obtained from the Concrete Pipe Association's web site or Concrete Pipe Selection Software.

3.3.10 Pit design

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.

3.3.11 Pit spacing

Access chambers: Provide as follows:

- For maintenance access.
- At changes of direction, grade level or class of pipe.
- At junctions.

The maximum recommended spacing of pits is given below:

Pipe Size (mm)	Spacing (m)
1050 mm and above	90
600mm-900mm	70
450-525mm	65
375	60
<375	40
Box drains	40

Maximum kerb inlet lengths: 2.4m for side entry pits, 1.8m is preferable, longer lintels may be considered in exceptional circumstances.
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" or Hydrologic Engineering Circular 22 (HEC-22).

3.3.12 Provision for Blockage

The percentage of theoretical capacity allowed in relation to type of pit is given below (ARR 2019 Book 6 Chapter 6)

Type of structure		Blockage conditions	
		Design blockage	Severe blockage
Sag kerb inlets	Kerb inlet only	20%	100% (all cases)
	Grated inlet only	50%	
	Combined inlets	Capacity of kerb opening with 100% blockage of grate	
On grade kerb inlets	Kerb inlet only	20%	100% (all cases)
	Grated inlet only (longitudinal bars)	40%	
	Grated inlet only (transverse bars)	50%	
	Combined inlets	10% blockage of combined inlet capacity on continuous grade	

3.3.13 Hydraulic losses

Pressure change coefficient K:

- Reduction due to benching.
- Pipe bends.
- Clashes with existing sewer mains.
- Pipe junctions without an inlet structure.

Pressure change coefficients using computer programs: should be consistent with the manual supplied with the software.

Pipe friction: Design drainage pipe systems as follows:

- An overall system including upstream and downstream systems, not as individual pipe lengths.
- A gravity system flowing full at design discharge. Pressurise with the use of appropriate pits and joints.

Service entry requirements: For roof and subsoil pipes from private properties entering Council's system, conform to the following:

- Pipe inlets larger than 225mm: Enter the main pipe system at junction pits, finish flush and grout the sideline into the pit wall.
- Smaller inlets: Break into the drainage pipes for interconnection with the main line, finish flush and grout the sideline into the main line.
- Construction of a junction without a structure should be avoided where possible
- Downstream pipes cannot be smaller than upstream pipes.
- All works are to be carried out by a registered plumber.

There are theoretical relationships for pressure changes based on conservation of momentum calculations, but these do not cover all cases. Generally, 1.5 will be a conservative value for k_u in flow through pits. For pits at the top of a line, however, a value of 4 or 5 is appropriate.
Pressure change coefficients can be obtained from sources such as the Missouri and Hare charts. However, a difficulty is that ratios of flows or pit water levels are required in many of these, so that they cannot be accurately determined in advance.

For hydraulic losses, the Queensland Urban Design Manual (QUDM) methods and charts suggest:

1. Run and analyse major or minor storms;
2. Run and revise pit loss coefficients using QUDM method;
3. Open Excel and paste to spreadsheet;
4. Repeat;
5. Run and analyse major or minor storms;
6. Run and revise pit loss coefficients using QUDM method; and
7. Paste to spreadsheet, check convergence and decide whether to repeat.

Note:
All the runs will be done without pit blockages.

3.3.14 Open channels

Design criteria:
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.
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.
Manning's "n" values Open Channels and Pipes:

Concrete/Fibrocement	0.014
uPVC, HDPE	0.013
Concrete box (fair-face)	0.013
Concrete (trowel finish)	0.015
Sprayed concrete (gunite)	0.016
Bricks/pavers	0.016
Pitchers/dressed stone on mortar	0.017
Ruble masonry/rock lining/riprap	0.035
Corrugated metal	0.033
Earth (with weeds, gravel)	0.035
Earth (clear)	0.025
Rock cut	0.040
Short grass	0.035
Long grass	0.050

Maximum side slopes on grassed lined open channels shall be 1 in 4, but 1:6 preferred. Channels in private property shall have a maximum slope of 1 in 6.
Low flow provisions in open channels (man-made or altered channels) will require to be discussed with Council at the time of design.
Transition in channel slopes to be designed to avoid or accommodate any hydraulic jumps.

Open channels/floodways shall be designed for a capacity of 1% AEP event with adequate freeboard. Maximum velocity in grassed channels shall be 1.5m/s for flows for the design event or to safe scouring velocity depending on soli types and standard engineering practice.
Curves on open channels shall have a minimum radius of 30 metres.

3.3.15 Freeboard

For floor levels and levee bank levels from flood levels in open channels, roadways and stormwater surcharge paths are given below:

- A minimum freeboard of 0.5 m shall be provided between the 1% flood level and floor levels on structures and entrances to underground car parks. A higher freeboard may be required in certain circumstances.
- Where the road is infill and overtopping of stormwater through adjacent low side properties may occur during conveyance of the 1% flood 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.
- A minimum freeboard of 0.5 shall be provided between the 1% AEP flood level and floor levels on structures and entrances to underground car parks.
- A minimum freeboard of 0.5m shall be provided between the 1% AEP flood level and floor levels on structures and entrances to underground car parks.
- A minimum freeboard of 0.3 m shall be provided between the 1% AEP food flood level and the top of the channel.

3.3.16 Natural channels

Should include adequate rock protection for the low flows and minimal disturbance to the existing stream regime. The rock sizes to be determined on the basis of velocity for 1% AEP storms (refer QUDM 2013).

3.4 Major structures

3.4.1 General

A major drainage structure will convey flow 10 cumecs or greater.
Minor structures are all structures not defined as major structures.
All major structures shall be designed for the safe passage of the 1% AEP without afflux in urban areas.
Certain level of afflux may be permitted if no property is affected.
Clearance for major Structures:
0.3m for 1% AEP (between water level and soffit of the structure).
Structural design: for major/minor structures shall be carried out in accordance with AUSTROADS Bridge Design Code by qualified structural engineers.
Rock sizes: For scour protection should be determined based on velocity in 1% AEP event in accordance with the latest version of Queensland Urban Drainage Design Manual (QUDM) or any other published material.
The rocks are to be angular and granite/basalt in origin, no sandstones can be used.

3.4.2 Box Culverts

The preferable minimum box culvert size shall be 450mm x 450mm. The preferred minimum height shall be 450mm considering blockage. 300mm high box culverts will be considered for lengths less than 10 metres.

Box culverts may be used where available depth to invert is restricted or to provide maximum waterway area and minimum obstruction to flow.

Blockage Factors for Culverts:

The blockage factors must be considered in designing culverts. Please refer to Project 11, Blockage of Hydraulic Structures, IE Australia.

3.4.3 Retarding basins

A retarding basin or retention basin has permanent water and the volume above the permanent water level is used as detention while the detention basins are dry except during storm events.

For each AEP a range of storm events shall be run to determine the peak flood level, critical Storm and discharge from the retarding basin. At least 12 storms must be run up to 6-9 hours or longer durations depending on the catchment size.

Standard reservoir routing methods must be used in detention basin modelling showing the inflow and outflow hydrographs.

The high level outlet to any retarding basin shall have capacity to allow the passage of a minimum of the 1% AEP 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).

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

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.

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

Freeboard: Minimum floor levels of dwelling shall be 0.5m above the 1% AEP flood level of the basin.

Public safety issues:

Basin side slopes	1:6, steeper slopes may be accepted under exceptional cases with safety provisions
Water depth at 20% AEP	Maximum 1.2m, greater depth may be accepted with safety provisions (refuge mounds etc.,)
Depth indicators if depth>0.3m	Must be provided
Spillway	Signage required indicating hazard
Tree planting	Not allowed on basin walls
Spillway location	Not upstream of existing properties
Referral to dam safety committee	Decided on a case by case basis
Fencing	Basin Depth >=1m
Vehicle Access	Must be provided

Note – appropriate safety measures need to be provided for culvert and pipe inlets / outlets.

3.4.4 On-site stormwater detention

The purpose of stormwater detention is to protect the downstream properties from the extra flow generated due to the developments.

Stormwater Detention may be required for any development site. Council prefers centralised detention basins for subdivisions. Lot-wise individual basins are not accepted for subdivisions with 6 lots/units or over.

Detention not required:

- For demolish and rebuild (not increasing imperviousness over 10%).
- For lots where detention has been provided during subdivision.

- Not exceeding the Permissible Site Discharge (PSD) where PSD is provided within Council's flood study.

In all other cases detention may be required, especially subdivision of an existing lot.
For all situations, the maximum discharge for 20% to 1% AEP storm shall not exceed all of the following:

- Pre-development discharge.
- Permissible site discharge (PSD) where PSD is provided within Council's flood study
- Downstream capacity.

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

Underground Detention:

Underground detention system is not allowed except for:

- CBD areas –when above ground storage is not feasible.
- Strata subdivisions - when above ground storage is not practicable due to safety.

Only where there exists an adjacent underground stormwater system capable of accepting stormwater through a gravity system.
Detention requirements are applicable to urban developments. However, these developments will be assessed on a case by case basis.
Any developments near the catchment outlet, if downstream properties are not affected are exempt from detention requirements.
Pre-development discharge is equal to post-development discharge cannot be a valid criteria as the hydrology and hydraulics of flow are not the same after a development takes place.
It is advised the following:

Size of Development	**Detention Type**
Subdivision up to 5 Lots or 5 units	Any suitable method
Subdivision with 6 lots/6 units and over	Centralised basins are required. Land dedication, ownership and maintenance responsibilities of the centralised system will be assessed on a case-by-case basis. No separate decentralised basins will be considered
Strata subdivisions within 1km of town centres, (lot number criteria apply)	Centralised basin, under or above ground, will be assessed on a case by case basis.
Commercial development in town centres	Centralised, under or above ground
Industrial subdivisions	Centralised preferred, lot-wise may be considered for lots >=4000m^2
Must discharge to Council's drainage network or natural channels. The developer must build the necessary drainage along with the development works.	

For catchments where risk management plans are developed, please follow the recommendations (e.g., Farnborough Drive and Wembley Road, Nattai Ponds etc.) For details please contact the Development Engineer and refer to Council's website.
The basins shall be routed with longer duration storms (up to 6-9 hours) depending on the catchment area using routing software. Hand calculations will not be accepted. The inflow and outflow hydrographs must be shown.

Rainwater tanks:

BASIXs rainwater tanks are not considered as flood retardation measures. Additional storage capacity can be considered as detention if appropriately designed.

Pump-out System:

Pump out system or surcharging on road are not permitted. Council may consider pump out system when no other alternative solutions are available.

Sub-divisions for areas without Council drainage system will be allowed provided that the developer provides adequate drainage up to a safe discharge point.

Infiltration system:

Infiltration systems are not considered as detention for storms 0.2EY to 1% AEP.

Charged system:

Not acceptable, may be considered in exceptional circumstances where it does not affect any property or traffic.

SQID as Detention:

No Stormwater Quality Improvement Devices (SQIDs) will be considered as detention/retention methods. These are grassed swales, rain gardens, rainwater tanks (some exceptions), buffer strips, infiltration trenches etc.

3.5 Interallotment drainage

Inter-allotment 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.

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

Pipe Capacity:

Inter-allotment drainage shall be designed for 0.2EY events. Pits are to be grated unless specifically approved by Council in writing. While designing, the upstream contributing catchment must be considered. The inter-allotment drainage system forms part of the overall drainage system that needs to be checked and approved.

In lieu of more detailed analysis, the following areas of impervious surface are assumed to be contributing runoff for any urban drainage:

Development Type	% of Lot Area
Low Density Residential (R2)	40
Medium Density Residential (R3)	70
Industrial	80
Commercial	90

Pits shall be constructed of concrete, with 100mm thick walls and floor and have a minimum **600 x 600mm** internal dimensions or as agreed corresponding to pipe sizes. Pits shall be fitted with a depressed grated inlet. See council's standard drawings.

Minimum Longitudinal Grade:

The inter-allotment drainage shall have a minimum longitudinal gradient of 1.0%, with an absolute minimum grade of 0.5%.

Pipe Standards:

The inter-allotment drainage shall be constructed from rubber ring jointed RCC or fibre reinforced concrete, HDPE or UPVC pipe which shall conform respectively to the requirements of AS 4139, AS 4058 and AS 1254.

Inter-allotment 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).
Where there is a disparity in level between inverts the spacing is to be submitted for approval.
Where sewer mains are in close proximity to interallotment drainage lines the sewer mains are to be shown on the interallotment drainage plan.
Council will not maintain the interallotment drainage system.
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 Professional Engineer 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.
Drainage augmentation: Required where receiving system does not have a capacity to cater for the discharge from the site.

3.6 Gross pollutant traps (GPT) and sediment traps

3.6.1 General

GPT/sediment trap location: Determine location and catchment size in conformance with EAARQ clause 8.4 and the following:

- Vehicular access for maintenance.
- Available space.
- Proximity to pollutant source areas.
- Outlet approach: Use a single device to treat a whole catchment (up to 200ha or more).
- Distributed approach: Target smaller individual catchments with many traps.
- Site constraints: Including topography, soils and geology, groundwater, space, access, odour problems, visual impacts, safety concerns and vermin.

3.6.2 GPT/sediment trap performance and type

Performance: To EAARQ clause 8.5 including the following:

- Treatment objectives:
  - Gross pollutants: Remove litter and vegetation larger than 5mm.
  - Sediment: Remove particles larger than 0.125mm.
  - Remove 90% of all material greater than 0.125mm.
- Operating design flows: 4EY (98.17 % AEP, 0.25 ARI).
- Flood capacity: Analyse hydraulics of the drainage system including the headloss of the GPT and diversion weir under flood conditions. Review the design of the bypass system for impacts on the local drainage system and consequences on flooding.
- Trapped pollutant storage: Assess the pollutants that are likely to be collected and determine the holding capacity with respect to 4 times per year cleaning frequency.
- Maintenance requirements: Design the GPT for maintainability and operability including the following considerations:
  - Ease of maintenance and operation.
  - Vehicular access to the GPT site.
  - Frequency of maintenance.

Assessment of GPT performance: Include in the maintenance program requirements for validating the GPT performance by field monitoring, physical laboratory models or computer simulation.
Selection of the GPT: To the EAARQ Appendix 8A checklist and the following:

- Life cycle costing.
- Retention volume sine of the unit in relation to 4 cleanings/year.
- Footprint and depth of the unit.
- Occupational health and safety.

Hydrocarbon management: If required, design and size water/oil separators or interception devices in conformance with EAARQ clause 9.7.

3.7 Constructed wetlands and ponds

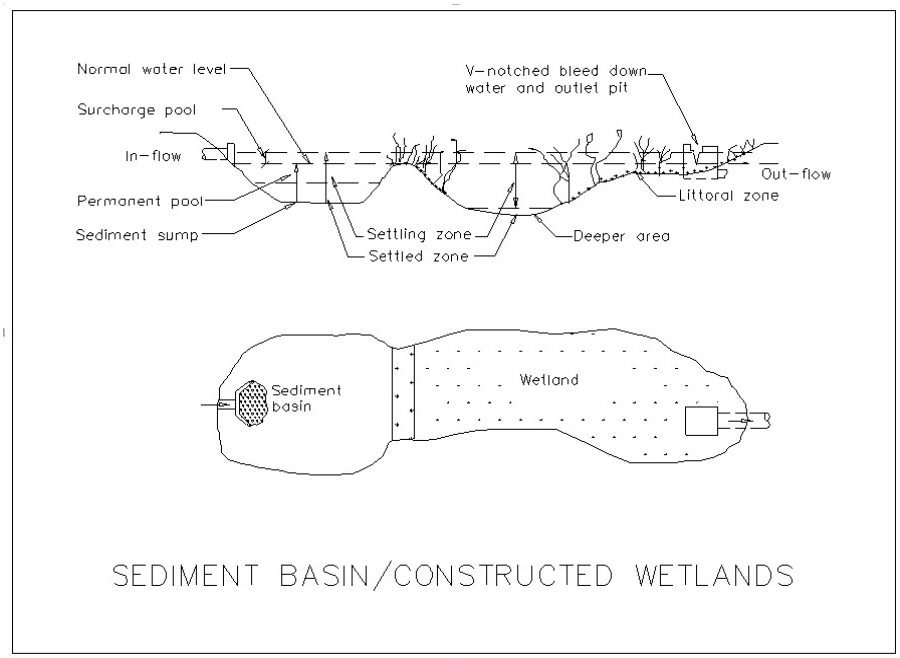
3.7.1 General

Treatment process: Determine in conformance with EAARQ clause 12.3 and the following:

- Sedimentation.
- Filtration.
- Adsorption.
- Biological uptake.
- Pollutant transformation.
- Pollutant storage.

System design: Design the system in conformance with EAARQ clause 12.4 and 12.5 including the following:

- Hydrological effectiveness: Quantify the effects of the interaction between the following:
  - Volume of the detention system.
  - Hydraulic capacity of the outlet structure of the system.
  - Variability of runoff inflow to the system.
- Hydraulic efficiency: Control the flow patterns for uniform distribution throughout the system to provide optimal treatment on the inflow.
- Notional detention time: Select the design detention period.
- Depth of permanent water in the wetland.
- Provide with a GPT at the inlet.
- Select wetland vegetation, fish or fauna.



Sediment trap/constructed wetland

3.8 Buffer strips, vegetated swales and bio-retention systems

3.8.1 Buffer strips

Urban catchments: Grassed areas that direct runoff from adjoining impervious areas to the stormwater discharge location.

Design: To EAARQ clause 10.3 and consider the following:

- Maximum slope: 5%.
- Maximum velocities: 0.4m/s.
- Usage of flow spreaders.
- Vegetation density.
- Distribution/spread of stormwater over the buffer strip.
- Prevention of rill formation through properly designed entry conditions and vegetation.

3.8.2 Vegetated swales

Design: To EAARQ clause 10.4.

Location: At any point in the catchment and as follows:

- At the top of a catchment to serve minor drainage requirements.
- Downstream in the catchment with a parallel underground pipe network.

Geometry: Trapezoidal or parabolic shapes.

Side slopes: No steeper than 1V:3H.

Longitudinal slope: 1 – 4%. If greater or less than 1 – 4%, conform to the following:

- Slopes greater than 4%: Design for check dams.
- Slopes less than 1%: Design for under drains.

Maximum swale width: 2.5m.

Maximum flow velocity: Conform to the following:

- For 63.2% AEP (1 year ARI) 0.5m/s.
- For 1% AEP: 1.0m/s.

Manning's 'n' value:

- For flow conditions where depth of flow is below the height of the vegetation: 0.15 to 0.3.
- For 1% AEP event: 0.03.

3.8.3 Bio retention systems

Design: To EAARQ clause 10.5 with 2 or 3 subsurface layers as follows:

- Base or drainage layer: Coarse and poorly graded material, placed to encase the perforated drainage pipe.
- Transition layer: Prevents filtration media washing into the perforated pipes.
- Filtration layer: Media through which water is filtered, typically consisting of sandy loam.

3.9 Miscellaneous

3.9.1 Development on flood affected land

The Developer is to comply with the Council requirements for development on flood prone land. Different criteria will apply for the type of development based on the hazard category and risk precinct classifications. If the land has been identified as flood affected in the 10.7 (S149) certificate, the developers can do the following:

- apply for a flood certificate (fee applies). or,
- visit the Council website for flooding information applicable to the proposed development, please also refer to the Council DCP for more details.

For the catchments outside Council flood studies, the developers are advised to have their own flood assessment by employing a Professional Engineer having appropriate experience and competence in the relevant registered area of practice. Council has no legal obligation to undertake a flood study for a private development.

Model type required for Floodplain analysis: Council's floodplain modelling has been undertaken using "TUFLOW", software. Council will consider the use of other models as appropriate.

When a development changes the flooding situation where existing flood information is available, the developer must fund Council's nominated consultant, who will be managed by Council, to run the existing flood model under the proposed development conditions.

3.9.2 Easements

Requirement: Identify points of discharge of gutters or stormwater drainage lines or any concentration of stormwater onto adjoining properties. Permission to discharge stormwater drainage onto or over adjoining properties and formalising any required easements is the responsibility of the developer.

Easement width:

- Minimum: 3m for new developments benefitting Council,
- 2m for inter-allotment drainage not benefitting Council (private drainage)
- Maximum: To contain the full width of overland flow or open channel flow in the major system design event. If the 1% AEP flow is 1m3/s or greater, mark it as a drainage reserve.
- Trunk drainage is defined as any structure with a flow >=1m3/s 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
- All trunk drainage is to be located within a Drainage Reserve dedicated to Council and cannot be within an easement through private properties.
- Council may consider variations to the above on merit.

- No structures can be built on stormwater assets (pipes, pits, open channels etc.) on an easement or without.

Easements over private property:

- Do not surcharge major system flows across private property.
- Contain flows for 1% AEP event considering fences,
- Plan and consider how access will be gained to the easement for maintenance purposes. Consideration should be given to the method of works for undertaking maintenance and the impact on private property. For example suitably designed and constructed driveways to cater for plant such as trucks used for maintenance.
- Easements over inter-allotment stormwater drainage pipes only shall be in favour of private properties.
- Trees, landscaping, fencing and other structures shall not be located across or within an easement.

3.9.3 Trench subsoil drainage

Subsoil drainage in pipe trenches: If pipe trenches are backfilled with sand or other pervious material, provide the following:

- 3m length of 100mm diameter agricultural pipes, butt jointed with joints wrapped with geotextile, or slotted PVC pipe of subsoil drain in the bottom of the trench immediately upstream from each pit or headwall.
- Seal the upstream end of the subsoil drain with cement mortar.
- Discharge the downstream end through the wall of the pit or headwall.

Service Life Expectancy:

Asset type	Minimum service life
RCC pits and pipes	100 years
uPVC	50 years
GPTs	50 years
RCC Box culverts	100 years
HDPE	100 years

- pH level: Test backfill, soil and water to AS1289.4.3.1.
- Resistivity: Test backfill, soil and water to AS1289.4.4.1.

Chloride, sulphate and aggressive CO_2 concentration: Test groundwater or soil extract to AS1289.4.2.1.

3.9.4 Legal Point of Discharge and right to discharge stormwater

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

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 discharge of stormwater and the creation of any necessary easements. The developer shall meet the cost of the easement(s).

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 with defined banks 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).

Where the drainage is to discharge to an area under the control of another statutory authority e.g., Public Works, the design requirements of that Statutory Authority are also to be met.
Discharge to public 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 OEH, or alternatively be taken to the nearest trunk stormwater line.

3.9.5 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, provide scour protection measures.
Council has no obligation to undertake any drainage works in relation to a development.

3.9.6 Land tenure of drainage system

Trunk drainage is defined as any structure with a flow >=1m^3/s for the 1% AEP storm.
All trunk drainage is to be located within a Drainage Reserve dedicated to Council and cannot be within an easement over private properties.
All other drainage that is not within a public road or community land shall be located within a drainage easement.
Easements over inter-allotment drains shall be in favour of the properties served. If Council is benefitted shall be in favour of Wingecarribee Shire Council and other properties where appropriate. Consideration is to be given to accessibility and maintenance within older subdivisions. Creation of residue land should be avoided.

3.9.7 Water Quality and Water Sensitive Urban Design (WSUD)

Objectives
WSUD controls must be satisfied for all development applications and integrated into a Water Cycle Management Study when such a study is required by Water NSW or Council. Water NSW should be contacted directly to determine if a Water Cycle Management Study is required as circumstances vary widely.
When planning and designing development within the Shire, reference is to be made to Current Recommended Practices contained within *SEPP (Sydney Drinking Water Catchment*) 2011 and current best practice guidelines and technical documents such as:

- *Technical Guides: Australian Runoff Quality – A Guide to Water Sensitive Urban Design (Engineers Australia, 2006).*
- *Water Sensitive Urban Design Engineering Procedures: Stormwater (Melbourne Water, 2005).*
- *Water Sensitive Urban Design (Landcom, 2009).*

Controls

To achieve this Objective, the following Controls apply.

a) All development within the Shire is to utilise potable water efficiently. For residential dwellings, including houses and units, the requirements of BASIX ensures the development complies with NSW planning requirements to conserve water.

b) Development should not occur within riparian buffer zones outlined in Wingecarribee Shire Council Local Environment Plan 2010 (Clause 7.5 Natural Resource Sensitivity – Water and related maps) and vegetation within the riparian buffer distances is to be maintained and intact.

c) All development within the shire must comply with the requirements of *SEPP (Drinking Water Catchment) 2011* to ensure water quality exiting a site post-development achieves a neutral or beneficial effect (NorBE) in comparison to pre-development water quality runoff.

d) Development which proposes to re-develop an existing, developed site (particularly those used previously for commercial and/ or industrial purposes), must comply with one of the following, whichever provides the greatest treatment of water:

i. Water quality exiting a site post-development must achieve a neutral or beneficial effect (NorBE) in comparison to pre-development water quality runoff (in accordance with *SEPP (Sydney Drinking Water Catchment)* 2011.

e) For proposals to subdivide land, the maximum discharge must not exceed the predevelopment discharge for all storms up to 1% AEP.

f) Development must not pipe or channel riparian corridors or waterways.

g) Current recommended practices outlined in the SEPP (Sydney Drinking Water Catchment) 2011 and current best practice technical guides must be utilised to ensure effective functioning of treatment options.

Water Treatment Train

In order to implement WSUD a 'treatment train' approach is recommended. A WSUD Treatment Train is a number of measures and treatments in a series, rather than one single measure to achieve the objectives of water sensitive design.

An example of a treatment train at a street scale for a proposed subdivision may include:

- Use of permeable surfaces, to allow water to infiltrate soil
- Grassed swales adjacent to road/s,
- Onsite bio-retention system and gross pollutant trap to capture runoff, filter pollutants and discharge water into natural system at a rate similar to predevelopment, and
- Bio-retention system to filter water discharge from any onsite car park.

Ongoing Maintenance of WSUD 'Treatment Train' Devices

WSUD water management devices are only as good as the level of maintenance applied to them. Rain gardens and other stormwater quality devices are requirements imposed on certain development by Water NSW due to much of the Shire being within the Sydney Water Supply Catchment Area. Only Water NSW can vary or remove the condition. Water NSW conditions in respect of stormwater quality devices are often placed on the 88B Instrument as a restriction or covenant on the title. Either Water NSW or Wingecarribee Shire Council will benefit from the devices.

Generally the benefiting party to the restriction or covenant are able to pursue regulatory compliance action where a device has not been maintained or has failed. However, Council also has the right to undertake maintenance at the property owner's expense. Such action would probably be prompted by a complaint to Council.

Therefore, applicants who are required to provide such devices are strongly advised to maintain them in good repair for their own benefit and for the benefit of the community and environment..

The developers will handover the WSUD elements built on public land in a perfect working condition. The developer is to provide Council with an Operating and Maintenance Manual as part of handover.

3.9.8 Innovative Design

Council requires all proposed innovative stormwater systems to be submitted to Council for approval. The following information is required but not limited to:

- life cycle costing compared to conventional systems,
- published papers assessing the performance of the existing systems
- details of similar systems that are available to be viewed by Council
- any other information as required by Council.,
- Concept approval will be required in writing prior to detailed design.
- Impacts on maintenance requirements

3.9.9 Roofwater Disposal

Final means of disposal of stormwater to Council's stormwater system must be approved by Council. The following types of disposal will generally be acceptable:

(a) **Disposal to an interallotment drainage system with connection to the junction provided** Where no junction or inter-allotment stormwater pit is provided, a new 45º sweep is to be laid in the interallotment drain for connection. Any other form of connection is prohibited. The capacity of existing system must be ascertained before any connection.

(b) **Disposal to Council's kerb and gutter by connection into the outlet provided** –
Where no outlet is provided in the kerb and gutter a saw cut of the kerb and gutter will be permitted and pre-fabricated galvanized steel stormwater adapter approved by Council is to be
placed within the kerb. A high strength concrete mix shall be used to reinstate the kerb and this must match the profile of the kerb. Where more than one outlet is to be placed within a kerb a spacing of two (2) metres between the outlets shall occur.

(c) **Disposal to Council's road table drain** may occur provided the pipe is maintained a suitable distance from the road carriageway to ensure damage does not occur. The outlet of the pipe must be protected by the placement of solid protection, such as concrete around the outlet
to prevent damage to the pipe. Other means of disposal to the table drain in areas without kerb and gutter may be accepted by Council. Details are to be submitted and approved.

(d) **Disposal directly to Council's stormwater mains** is permitted subject to certain conditions. Details are to be obtained from Council's Engineering staff. However it depends on the capacity of existing stormwater system.

(e) **On site stormwater disposal** may be permitted on allotments with an area of less than 4000m² a hydraulic consultant's report may be requested by Council to verify that on site disposal can occur without damaging buildings, cause a nuisance to neighbouring properties or create a problem through adding stormwater into the ground surface (A Geotechnical Engineer may also be required to verify this issue).

(f) The disposal trenches shall be located a minimum distance of 5 metres form any adjoining property boundary. In circumstances where there is a larger roof and hardstand area, or soil conditions make disposal unsuitable, other means of disposal will be required.

Stormwater/retention trenches must be located downstream of any septic tank effluent/sullage disposal area. Trenches, drains and pipes shall not traverse or penetrate any effluent disposal area. The typical size of trench for each downpipe is 3 metres long, 600mm wide and 600mm deep however this is dependent on soil conditions. Where concealed gutters, box gutters, high facia gutters (without storm ports) and/or internal downpipes have been installed it is advisable that a surcharge grating mounted above the finished surface be installed adjacent to the base of the downpipe connection of the drain/pipe.

(g) Where adverse falls occur from the roof drainage system to the final disposal point, the proposed method of drainage and disposal is to be submitted to the Council for approval. In these instances the provision of an easement with the fall of the land to Council's stormwater
disposal system, is the most suitable solution. For on-site disposal options see above. *A pump system for conveyance of stormwater will not be permitted.*

(h) **Disposal of stormwater into collection tanks** will be permitted by Council provided the over flow is conveyed to a means of disposal specified in 1-6 above as appropriate. Where the water is to be used for domestic purposes, a first flush system should be installed and must be compliant with all BASIX conditions.

(i) Stormwater runoff from areas where water may become polluted will be subject to suitable pre-treatment measures as specified by Council and other statutory authorities.

4 Documentation

4.1 General

4.1.1 Approvals

Requirement: Document the approval conditions advised by the appropriate authority which contribute to the basis of the design of the stormwater drainage.

4.1.2 Development assessment

Requirements:
Provide a Stormwater Management Plan including the following:

- Catchment plan showing upstream contributing catchments.
- Existing downstream drainage with capacity assessment.
- Proposed detention/retention.
- Concept Design with a background image with an appropriate hydrologic/hydraulic model.
- Proposed easements and drainage reserves.
- Flooding information (for flood liable land).
- Legal discharge point.

4.1.3 Design reports

Requirement: Provide a design report including the following:

- Design criteria.

- Site investigation reports supporting the design.

Provide a design report incorporating the criteria, assumptions, reference documents, supporting information, catchment plans, computer studies, calculations and references supporting the design, Stormwater Management Plan report

4.1.4 Design certification

Requirement: Provide a signed and dated design certificate. Refer D02-Annexure A-Sect 3.1.1

4.1.5 Final certification of completed works

Requirement: Provide a signed and dated design certificate.

4.2 Drawings

4.2.1 General

Requirement: Provide drawings and/or computer output defining the works and assumed operating and maintenance procedures.

4.2.2 Catchment areas plan

Catchment Area Plans: Shall show:

- Contours.
- Direction of grading of kerb and gutter.
- General layout of the drainage system with pit locations, catchment limits.
- Any other information necessary for the design of the drainage system.

Scales: 1:500, 1:4000 or 1:25000.

4.2.3 Drainage system layout

Drainage system layout drawings: Provide drawings showing the following:

- Drainage pipeline location.
- Drainage pit location.
- Number and road centreline chainage.
- Size of opening.
- Drainage easements.
- Reserves and natural water courses.
- Location of buffer strips, vegetated swales and bioretention systems.
- Location and details of infiltration systems.
- Any other information necessary for the construction of the drainage system.
- If appropriate, combine with the road layout plan.

Scale: 1:500.

4.2.4 Longitudinal section

Drainage system longitudinal sections:

- Pipe size.
- Pipe class and type.
- Pipe support type to AS/NZS3725 or AS/NZS2032.
- 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 assessment of the drainage system.

Horizontal scale: 1:500.
Vertical scale: 1:100.

4.2.5 Open channel cross sections

Open channel cross sections: Provide drawings showing the following:

- The direction of the view of cross sections, normally downstream.
- Reduced levels to Australian Height Datum.
- Provide a data input file for the design flow rates.

Scale: 1:100.

4.2.6 Other documentation

Detailed drawings: Provide details including standard and non-standard pits and structures, pit benching, open channel designs and transitions to scales appropriate to the type and complexity of the detail being shown.
Submit hydrology and hydraulic summary sheets: A catchment map must accompany the Stormwater Management Plan with a report showing contributing catchments.
Results of the model run. Computer models should be built on a background clearly visible.
Copies of final computer data files, for both hydrological and hydraulic models shall be provided in formats previously agreed with Council.
Model type required for Design: Council uses "DRAINS" software for urban situations and "XPRAFTS" software for urban and rural situations and will consider the use of other models as appropriate.
Computer data files and output: Submit final hydrological and hydraulic computer data files.
Landscape plans and planting plans: Provide for buffer strips, vegetated swales and bio-retention systems.

4.2.7 Work-as-executed drawings

Work-as-executed drawings: Provide an additional set of final construction drawings for the purpose of recording the work completed by the Contractor.

Provide all required data and electronic files as outlined in WSC "Work as Executed plans specification and attribute requirements" located on Council's website.

4.2.8 Final certification of completed works

Requirement: Council requires the designer or its representative to carry out sufficient site inspections to validate the final certification of the proposed works.
Completed works: The designer to provide evidence that the site inspections were undertaken during construction works and provide final certification that the completed work is consistent with the approved design.

4.3 Specifications

4.3.1 Construction documentation

Requirement: Refer to Council's Engineering Construction Specifications.

5 Annexure

5.1 Annexure A – Summary of Council's drainage design criteria

5.1.1 Record of design requirements

General: The following table outlines the design criteria referenced in this worksection:

5.1.2 Summary of Council's drainage design criteria table

Design requirements	Worksection clauses
Design IFD rainfalls for specific locations and individual zonings	http://data.arr-software.org/
Percentages impervious for specific locations and individual zonings	This specification – Section 3.2
Manning's roughness co-efficient ('n') for specific zonings	This specification – Section 3.3
Inlet capacities	This specification – Section 3.3
Pressure change coefficient	This specification Section – 3.3 and QUDM Method
Road reserve capacity flows to AustroadsAGRD05A	Freeboard Requirements
Culvert Design –Any acceptable program/Nomograph	Best engineering practice/program manual
Pit design	This specification – Section 3.3

5.1.3 Annexure B - Referenced documents

The following documents are incorporated into this worksection by reference:

AS/NZS1254	2010	PVC (UPVC) pipes and fittings for storm and surface water applications
AS1289		Methods of testing soils for engineering purposes
AS1289.4.2.1	1997	Soil chemical tests - Determination of the sulphate content of a natural soil and the sulphate content of the groundwater - Normal method
AS1289.4.3.1	1997	Soil chemical tests - Determination of the pH value of a soil - Electrometric method
AS1289.4.4.1	2017	Soil chemical tests - Determination of the electrical resistivity of a soil - Method for sands and granular materials
AS1926		Swimming pool safety
AS1926.1	2012	Safety barriers for swimming pools
AS/NZS2032	2006	Installation of PVC pipe systems
AS 2200	2006	Design charts for water supply and sewerage
AS/NZS2566		Buried flexible pipelines
AS/NZS2566.1	1998	Structural design
AS/NZS2566.2	2002	Installation
AS/NZS3500		Plumbing and drainage
AS/NZS3500.3	2018	Stormwater drainage
AS/NZS3725	2007	Design for installation of buried concrete pipes
AS/NZS4058	2007	Precast concrete pipes (pressure and non-pressure)
AS4139	2003	Fibre-reinforced concrete pipes and fittings
AS/NZS5065	2005	Polyethylene and polypropylene pipes and fittings for drainage and sewerage applications
ANCOLD	2000	Guidelines on acceptable flood capacity for dams
Austroads AGRD		Guide to road design
AustroadsAGRD05	2013	Drainage – General and hydrology considerations
AustroadsAGRD05A	2013	Drainage – Road surface network, basins and subsurface
AustroadsAGRD05B	2013	Drainage - Open channels, culverts and floodways
ARR	2016	A guide to flood estimation http://www.arr-software.org/arrdocs.html http://arr.ga.gov.au/arr-guideline
BOM		http://www.bom.gov.au/water/designRainfalls/revised-ifd/
EAARQ	2006	Engineers Australia - Australian runoff quality: a guide to water sensitive urban design
NSW OEH		Floodplain Development Manual
RMS		Supplements to Austroads (for main roads infrastructure)
SOCC Guide	2018	Guide to codes and practices for streets opening
NWQMSDoc10	2000	Australian guidelines for urban stormwater management
NSW LANDCOM	2004	Managing Urban Stormwater: Soils and Construction Vol 1 (The Blue Book).