SC6.4.4.4 Stormwater drainage design

SC6.4.4.4.1 Introduction

(1) Objectives

(a) The objectives of SC6.4.4.4 Stormwater drainage design are as follows:

(i) to ensure that inundation of private and public buildings located in flood-prone areas occurs only on rare occasions and that, in such events, surface flow routes convey floodwaters below the prescribed velocity/depth limits;

(ii) to provide convenience and safety for pedestrians and traffic in frequent stormwater flows by controlling those flows within prescribed limits; and

(iii) retain within each catchment as much incident rainfall and runoff as is possible and appropriate for the planned use and the characteristics of the catchment.

(b) In pursuit of these objectives, the following principles shall apply:

(i) new developments are to provide a stormwater drainage system in accordance with the "major/minor" system concept set out in QUDM (Third Edition 2013 – provisional or as amended); that is, the "major" system shall provide safe, well-defined overland flow paths for rare and extreme storm runoff events while the "minor" system shall be capable of carrying and controlling flows from frequent runoff events; and

(ii) redevelopment - where the proposed development replaces an existing development, the on-site drainage system is to be designed in such a way that the estimated peak flow rate from the site for the design annual exceedence probability (AEP) of the receiving minor system is as required for new development however the existing downstream system will be permitted to surcharge for the minor event provided that the system is not surcharging at the boundary of the development.

(2) Scope

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

(3) Reference and source documents

(a) Development manual planning scheme policy sub-sections to be read and applied in conjunction with its sub-section are as follows:

SC6.4.6.4 Stormwater Drainage
SC6.4.6.5 Drainage Structures
SC6.4.6.6 Pipe Drainage
SC6.4.6.7 Precast Box Culverts
SC6.4.6.9 Open Drains

(b) Australian Standards

AS/NZS 1254	*PVC-U pipes and fittings for stormwater and surface water applications.*
AS/NZS 2032	*Installation of PVC pipe systems.*
AS/NZS 2566.1	*Buried flexible pipelines, structural design*
ASNZS 3725	*Design for installation of buried concrete pipes.*
AS/NZS 4058	*Precast concrete pipes (pressure and non-pressure).*
AS 4139	*Fibre reinforced concrete pipes and fittings.*

(c) QLD State Authorities

Department of Natural Resources and Water, *Queensland Urban Drainage Manual* (QUDM), Volumes 1 and 2, 2007.

Note—It is noted that an updated version of Department of Energy and Water Supply QUDM (2013) has now been released as a provisional copy. This document should also be referenced when undertaking the proposed stormwater design.

Department of Transport and Main Roads, *Road Drainage Manual, 2010*

(d) *Other*

Argue, John, 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.

Australian Road Research Board, Research Report ARR368, The collection and discharge of stormwater from the road infrastructure, Allan Alderson, 2006.

Austroads, Guide to Bridge Technology.

Chow, Ven Te, Open Channel Hydraulics, 1959.

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

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

Henderson, FM., Open Channel Flow, 1966.

Insearch Ltd, NSW Institute of Technology (NSWIT), Energy Losses in Pipe Systems, C.M. Hare in Advances in Urban Drainage Design, 1981.

Institute of Engineers, Australian Rainfall and Runoff (AR&R). A guide to flood estimation, Aug 1998.

Institute of Public Works Engineering Australia, Qld Division, Standard Drawings, 2000.

Main Roads Department, Urban Road Design Manual (URDM), Volume 2., Queensland. First Edition 1975 as subsequently amended.

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.

SC6.7 Flood hazard planning scheme policy.

(e) Townsville City Council SC6.4.4.8 Standard drawings

SD-015	Footpath service allocation new streets
SD-020	Concrete kerbing
SD-080	Subsoil drains
SD-085	Drainage connections
SD-200	Precast grated kerb inlet system and cast insitu stormwater manhole
SD-205	Stormwater manhole details
SD-210	Manhole slab top details
SD- 215	Raised grate field inlet manhole

SC6.4.4.4.2 Hydrology

(1) Design rainfall data can be obtained from one of the following methods:

(a) Design intensity-frequency-duration (IFD) rainfall - IFD relationships shall be derived in accordance with Volume 1, Book II, of AR&R, 1998 for the particular catchment under consideration;

(b) The nine basic parameters read from Maps 1-9 in Volume 2 of AR&R shall be shown in the calculations submitted to council, except where the Bureau of Meteorology provides a polynomial relationship for the catchment; or

(c) Design IFD rainfalls can be obtained from the Bureau of Meteorology website for specific locations and these are to be submitted to council.

(2) Design annual exceedence probability (AEP) - For design under the "major/minor" concept, the design AEPs to be used are provided in SC6.4.4.4 Attachment A. The design recurrence interval for the design of the major/minor event depends on the zoning of the land being serviced by the proposed road and the classification of the road crossing the waterway.

(3) Catchment area

(a) The area of land contributing stormwater runoff to the point under consideration. Consideration must be given to likely changes to individual catchment areas caused by the full development of the catchment in accordance with the zonings in the Townsville City Plan.

(b) Where no detailed survey of the catchment is available, contour maps produced from council's GIS are to be used to determine the catchments and to measure areas. A suitable scale shall be chosen.

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

(4) Rational method

(a) Rational method calculations to determine peak flows shall be carried out in accordance with QUDM (Third Edition 2013 – provisional).

(b) All calculations shall be carried out or supervised by a qualified engineer (RPEQ certified) who is experienced in hydrologic and hydraulic design.

(c) Coefficients of discharge shall be calculated as per QUDM (Third Edition 2013 – provisional or as amended) and full details of coefficients utilised shall be provided.

(d) Details of percentage impervious for individual zonings are given in SC6.4.4.4 Attachment A.

(e) The time of concentration of a catchment is defined as the time required for storm run off to flow from the most remote point on the catchment to the outlet of the catchment. Most catchments will have multiple lengths of flow paths and gradients. The longest length flow path may not always govern the critical flow path. The hydrologic design should analyse several paths to assess any sensitivity to the catchment's time of concentration.

(f) 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.

(g) The gradient of the flow path is to be calculated as a "weighted average mean" gradient as outlined in Technical Note 4.6.1 of QUDM (3rd Edition 2013 – provisional or as amended).

(h) The minimum time of concentration shall be taken as 5 minutes urban and 10 minutes rural.

(i) Flow paths to pits must be designed to accommodate the flows from the fully developed catchment and provide for anticipated obstructions such as fences, building pads, buildings and other likely obstructions. Any proposed changes to flow paths must be undertaken on a catchment wide basis to ensure flow paths are not diverted onto other land parcels which may result in damage or loss of enjoyment of the adjoining lands.

(j) Surface retardance "n*" shall generally be derived from information in Volume 1, Book 8 Section 1.5.4 of AR&R 1998. Values applicable to specific zoning types and overland flow path types are given below:

Flow across parks 0.35
Flow across rural residential land (sparse vegetation) 0.30
Flow across park residential (short prairie grass) 0.150
Flow across residential low density 0.21
Flow across residential high density 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.

(k) The design and analysis of stormwater drainage is to be based on the peak runoff flows from sub-catchments and from accumulated catchments. Designers are to show, by the assessment of partial catchment areas, that the peak flows have been identified.

(5) Other hydrological models

(a) Council has carried out flood modelling for most of the urban areas. Hydrological information from these models such as peak flows should be obtained to assist with the design of the stormwater system.

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

Details on the modelling requirements should be obtained from SC6.7 Flood hazard planning scheme policy.
A sample of a summary sheet for hydrological calculations is given in SC6.4.4.4 Attachment B.

(c) Where computer analysis programs are used, copies of the final data files shall be provided on submission of the design to council and with the final drawings after approval by council.

SC6.4.4.4.3 Hydraulics

(1) Hydraulic grade line

(a) Hydraulic calculations shall generally be carried out in accordance with AR&R 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.

(b) The "major" system shall provide a safe, well-defined overland flow path for larger storm events up to the maximum defined flood event. The "minor" system shall be capable of carrying and design flows from the lesser nominated flood events based on the land zoning of the area.

(c) Downstream water surface level requirements are given below:

(i) appropriate levels are obtained from council's current existing flood studies;

(ii) known hydraulic grade line level from downstream calculations including pit losses at the starting pit in the design event;

(iii) where the downstream starting point is a pit and the hydraulic grade line is unknown, details of the downstream system shall be obtained and further analysis performed to determine the hydraulic grade line;

(iv) where the outlet is an open channel and the design storm is the minor event, details of the downstream system shall be obtained and further analysis performed to determine the hydraulic grade line. The top of the outlet pipe or the hydraulic grade line, or mean high water springs shall be the downstream control, whichever is higher;

(v) where the outlet is an open channel, the design storm is the major event and downstream flood levels are not known, details of the downstream system shall be obtained and further analysis performed to determine the hydraulic grade line. The top of the outlet pipe or the hydraulic grade line shall be the downstream control whichever is the higher;

(vi) 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 highest of all duration events for the defined flood event;

(vii) mean high water springs (MHWS) where discharges are to river or creek systems near Cleveland Bay.
In some instances, the downstream water surface level may need to be determined with the development of a flood study. Details on the flood study requirements should be obtained from SC6.7 Flood hazard planning scheme policy; and

(viii) the downstream water surface level used in the calculations should be provided to council.

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

(2) Major/minor system

Design of the drainage system should be in accordance with the major/minor flood management concept which recognises the dual requirements of the drainage system to provide for convenience and the protection of life and property for all storm events up to the defined flood event.

All design work undertaken should follow the guidelines set down in the *Queensland Urban Design Manual*, second edition 2007 unless otherwise instructed in this sub-section.

(3) Minor system criteria

(a) Minimum conduit sizes shall be as follows:

(i) pipes 375mm diameter; and

(ii) box culverts 600mm wide x 300mm high.

(b) Maximum velocity of flow in stormwater pipelines shall be 4m/sec. Minimum velocity shall be determined

by ensuring self-cleansing velocity is achieved; this requirement shall be deemed to be satisfied if the product of slope and diameter (S x D) is not less than 0.0008m where S = slope (m/m) and D is pipe diameter (m).

(4) Pits

(a) Inlet pits shall be spaced so that the gutter flow width is limited in accordance with this sub-section 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 existing driveways, allotments and intersections.

(b) Inlet pits are to be checked against Appendix 3 of QUDM (3rd Edition 2013 – provisional, or as amended). In the minor storm event, all stormwater pits are to be spaced such that there will be at least a single traffic lane (i.e. 3.0 m wide) that can pass along the road without the width of flow encroaching into that 3 m corridor. Absolute maximum width of flow is to be:

Absolute maximum widths of flow on roads

Location of flow	Max. width of flow (m)
Outside lane against kerb and channel (fall to kerb)	2.5
Inside lane against central median (fall to median)	0.5

Note—In the event of concentrated stormwater flows crossing travel lane/s (i.e. in super-elevated sections of the road) - the design must assess and document any potential aqua-planning issues together with any potential risk to road users should that storm event occur. This assessment must be presented to council for consideration and approval.

(c) Other pits shall be provided:

(i) to enable access for maintenance;

(ii) at changes in direction, grade, level or class of pipe; and

(iii) at junctions.

(d) The maximum recommended spacing of pits where flow widths are not critical should be spaced every 80m for ease of maintenance purposes. Kerb inlets shall be constructed in accordance with SC6.4.4.8 Standard drawings SD 200.

(e) Spacing of pits must be based on the capture rates indicated in the documents listed below. Information on pit capacities is available in the following sources:

(i) Queensland Urban Drainage Manual;

(ii) Pit relationships given in Volume 1, Book 7 of AR&R 1998; and

(iii) manufacturers' design specifications.

(f) The percentage of theoretical capacity allowed in relation to type of pit is given in Table SC6.4.4.4.1 below:

Tables SC6.4.4.4.1 Allowable pit capacities

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%

(5) Hydraulic losses

(a) The pressure change co-efficient "Ke" shall be determined from the appropriate charts given in *QUDM* Volume 2.

(b) Allowable reduction in "Ke" due to benching is given in *QUDM* Volume 2.

(c) Computer program default pressure change co-efficient "Ke" shall not be acceptable unless they are consistent with those from the charts in *QUDM* Volume 2. 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.

(d) Bends may be permissible in certain circumstances and discussions with council regarding their use is required prior to detailed design. Appropriate values of pit pressure change co-efficient at bends are given in *QUDM* Volume 2.

(e) Where possible, design should try to avoid clashes between services. However, where unavoidable clashes occur with existing services then the pressure change co-efficient Kp shall be determined from the chart given in *QUDM* Volume 2.

(f) Requirements for private pipes entering council's system are given below:

(i) 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; and

(ii) if a junction has to be added then a junction pit shall be built at this location in accordance with this sub-section.

(g) 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 coefficients Ku, for the upstream pipe and Kl, for the lateral pipe, shall be determined from the chart given in *QUDM* Volume 2.

(h) 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 given in *QUDM* Volume 2.

(i) Drainage pipe systems shall be designed as an overall system, with due regard to the upstream and downstream system and not as individual pipe lengths. Drainage pipeline systems shall generally be designed using the hydraulic grade line method (HGL) i.e. as gravity systems flowing full at design discharge, but may be pressurised with the use of appropriate pits and joints

(6) Major system – minimum freeboard criteria

(a) A minimum freeboard of 300mm shall be provided between the defined flood event and floor levels on buildings and entrances to underground car parks.

Where floor levels of buildings and underground car parks are below kerb level, designs must provide berms which provide at least 300mm of free board to prevent the intrusion of wave action wash from passing vehicles from entering properties unless otherwise agreed by council.

(b) Road capacities and major system flood levels are to be determined adopting the roadway as an open channel. Assessment of flood impacts on adjoining properties must consider any effects of backwater from the adjacent waterway using backwater analysis techniques.

(7) Open channels

(a) 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 sub-section.

(b) Design of open channels shall be in accordance with Volume 1, Book VIII of AR&R 1998. 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.

(c) Friction losses in open channels shall be determined using Mannings "n" values. Mannings "n" roughness co-efficients for open channels shall generally be derived from information in Chapter 14 of AR&R. Mannings "n" values applicable to specific channel types are given in the table below:

Surface Type	Mannings "n"
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 of weeds and debris)	0.022
Earth (with weeds and gravel)	0.028
Rock Cut	0.038

For all grass channels refer to the *Road Drainage Manual* (Chapter 8) for grass retardance factors.

(d) Where the product of average Velocity and average flow Depth for the design flow rate is greater than 0.4 m^2/s, the design will be required to specifically provide for the safety of persons who may enter the channel in accordance with Volume 1, Book VIII of AR&R 1998.

(e) Maximum side slopes on grassed lined open channels shall be in accordance with section 9.5.3 of *QUDM* (3rd Edition 2013 – provisional, or as amended.).

(f) Low flow provisions in open channels (man-made or altered channels) will require low flows to be contained within a pipe system or concrete lined channel section at the invert of the main channel. The width of the concrete lined channel section shall be the width of the drain invert or at least sufficiently wide enough to accommodate the full width of a tractor with a minimum width of 1.5 m being permitted at the discretion of council.

(g) Designers should also ensure that longitudinal grades are sufficient to prevent the ponding of storm water for periods of more than 2 days after a rain event.

(h) Transition in channel slopes is to be designed to avoid or accommodate any hydraulic jumps due to the nature of the transition.

(i) Drop structures shall be designed in open channels were the water velocity exceeds 2m/s. The design shall address the size and location of the structure as well as details of any stilling basins and revetment works surrounding the structure.

(j) Special consideration must be given to erosion control where sodic soils occur. Details of treatment proposals prepared by a competent person must be provided and approved by council.
Drainage reserves and easements must be of sufficient width to allow maintenance access to the drain for appropriately sized plant. Open drain/watercourses less than 5m base width should have at least a 4m wide access path along one bank for access. Open drains which have a base width wider than 5m must have a 4m access path on both side of the drain unless alternative maintenance arrangements are made.

(8) Major structures

(a) All major structures in urban areas, including bridges and culverts, shall be designed for the 1% AEP storm event with minimal afflux. Some afflux and upstream inundation may be permitted in certain rural and urban areas provided the increased upstream flooding does not inundate private property.

(b) A minimum clearance of 0.5m between the 1% AEP flood level and the underside of any structure is required to allow for passage of debris without blockage.

(c) Certified structural design shall be required on bridges and other major culvert structures and may be required on some specialised structures. Structural design shall be carried out in accordance with the SC6.4.4.3 Bridges and other structures.

(d) Culverts (either pipe or box section) shall be designed in accordance with information and charts provided in QUDM 3rd Edition - provisional (as amended).

(e) Safety limitations – overtopping of roadways. All floodwaters overtopping a major structure such as a

culvert or bridge structures within a road are to be checked for safety and stability limitations for both pedestrians and vehicles. Assessment of the waterway crossing safety and stability is to be undertaken based on criteria outlined in *QUDM* 3rd Edition 2013 - provisional (as amended) – Table 7.4.3 and 7.4.4

(9) Detention basins

(a) For each AEP 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 Volume 1, Book III of AR&R. 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.

(b) Flood routing should be modelled by methods outlined in AR&R.

(c) The high level outlet to any retarding basin shall have capacity to contain a minimum of the 1% year 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.

(d) The spillway design shall generally be in accordance with the requirements for Open channel design in SC6.4.4.4.3(7) Open channels and *QUDM* (Chapter 5).

(e) The low flow pipe intake shall be designed in accordance with the requirements of QUDM, Section 5.08.

(f) Freeboard - Minimum floor levels of dwelling shall be 0.3m above the Defined 1% AEP flood level in the basin.

(g) Public safety issues - Basin design is to consider the following aspects relating to public safety:

(i) 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;

(ii) water depths shall be, where possible, less than 1.5m in the defined AEP flood event. Where neither practical nor economic, greater depths may be acceptable. In that case the provision of safety refuge mounds should be considered;

(iii) the depth indicators should be provided indicating maximum depth in the basin;

(iv) signage of the spillway is necessary to indicate the additional hazard;

(v) basins shall be designed so that no ponding of water occurs on to private property or roads;

(vi) no planting of trees in basin walls is allowed;

(vii) no basin spillway is to be located directly upstream of urban areas; and

(viii) submission of Drawings to the Dam Safety Committee is required where any of these guidelines are not met or council specifically requires such submission.

(10) Tidal barriers

The use of tidal barriers on stormwater outlets are required in areas affected by tides. The device used should meet the following criteria:

(a) limited pressure head required to allow the discharge of stormwater from the system without any manual intervention. Specifications of the device used should be supplied to council prior to detailed design;

(b) barriers should not be able to be wedged open to an incoming tide by litter;

(c) council will not accept hinged flap gates as a suitable solution; and

(d) minimal requirements for repairs and maintenance of the device. Any maintenance information for the device should be supplied to council prior to detailed design.

(11) Barriers at inlet and outlets

Provision shall be made for the safety of the public including children in regards to the inlet and outlet of the stormwater system and should be based on the following criteria:

(a) no opening into an underground system shall be wider than 150mm except at head walls to pipes and box culverts;

(b) headwalls on the inlets and outlets to underground drains in which the drain is longer than 30m and has a cross sectional area greater than 0.5m^2 must be protected with hand rails, guard rails or fencing which restricts easy access to the entry structure;

(c) trash screens or other forms of grates are not favoured across the front of inlets and are unlikely to be

approved by council unless there is a tidal barrier on the outlet of the stormwater system – this may be considered by council.

(d) any grates over field inlet pits shall be set above the top of the pit so as to provide a 50mm gap between the top of the pit and the bottom of the grate. In areas of open space, marker posts must be used to identify each corner of the pit; and

(e) under no circumstances, should fixed barriers or grates be placed at the end of stormwater outlet.

SC6.4.4.4.4 Stormwater detention

(1) Installation of stormwater detention is required on all development sites where insufficient capacity in the downstream drainage systems exist and a minimum amount of detention will be that required to ensure no worsening of the flooding situation occurs during the defined flood event.

(2) The requirements for stormwater detention design are outlined in *QUDM.*

(3) The development shall limit any increase in discharge rate for all storm events up to and including the defined flood event unless the following is demonstrated:

(a) the downstream (“minor” or “major”) drainage systems have unutilised or uncommitted capacity greater than the increased peak stormwater discharge from the subject site; and

(b) the drainage capacity planned for or committed to other sites will not be consumed.

(4) Where the downstream drainage capacity is unable to accept an increased stormwater discharge without the following resulting:

(a) flooding; or

(b) increased risk of danger, damage or nuisance to other persons or property; or

(c) exceeding downstream roadway flow width and depth limits.

(5) The developed site must not discharge more stormwater than the discharge calculated for pre-development flows.

(6) Combined sedimentation and detention ponds must be designed in accordance with SC6.4.3.9 Water sensitive urban design guidelines so that remobilisation of sediment is minimised.

SC6.4.4.4.5 Interallotment drainage

(1) Interallotment drainage shall be provided for every allotment which does not drain directly to its frontage street or a natural watercourse.

(2) Interallotment drainage shall be contained within an easement not less than 3.0m wide and the easement shall be in favour of council but the obligation to maintain the easement shall be upon each allotment owner. Also if a stormwater drain is damaged as a result of actions/inactions of any person, council will require the owner to repair the damage or council will undertake the works and recover the costs.

(3) Pipe capacity - the interallotment drain shall be designed to accept concentrated drainage from buildings and paved areas on each allotment for flow rates having a design AEP the same as the "minor" street drainage system.

(4) In lieu of more detailed analysis, the fraction impervious for surfaces contributing runoff to the interallotment drain are as per SC6.4.4.4 Attachment A.

(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 600mm x 600mm internal dimensions. Raised grated

inlets are required at all locations. (including change in direction). Inlet pits must be located at the lowest point of the allotment.

(7) Pipes - minimum grade - The interallotment drainage shall have a minimum longitudinal gradient of 0.5 per cent or as agreed by council.

(8) Interallotment drainage pipe standards - The interallotment drainage shall be constructed from either fibre reinforced concrete drainage pipe, reinforced concrete pipe, or UPVC pipe which shall conform respectively to the requirements of AS 4139, AS/NZS 4058 and AS/NZS 1254.

(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 1.5m between pipe centrelines (where the pipe inverts are approximately equal).

(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 they are to be shown on the interallotment drainage plan.

SC6.4.4.4.6 Detailed design

(1) Conduits

(a) Pipe bedding and cover requirements for reinforced and fibre reinforced concrete pipes shall be determined from the Concrete Pipe Association's *Concrete Pipe Guide* or AS/NZS 3725. For uPVC pipes, the requirements shall be to AS/NZS 2032.

(b) Conduit jointing shall be in accordance with manufacturer's specifications. S.R.C pipes shall use external band joints.

(c) 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 centrally located within easements. Refer to SC6.4.4.8 Standard drawing SD-015.

(d) Drop structures shall be designed on drainage lines where the pipe gradient exceeds 5 per cent or water velocity exceeds 4m/s. The design details shall address the size, and position in the trench as well as spacing along the line.

Note—Buried flexible drainage pipes
Particular situations may be identified during the design of a development for the use of buried flexible pipes instead of the pipes specified in SC6.4.6.6 Pipe drainage.

In such cases, the design will be required to select the flexible pipe type appropriate for the particular application and prepare the relevant technical specification clauses for the supply and construction with reference to AS/NZS 2566.1, Buried flexible pipelines Part 1: Structural design. The proposed additional clauses would then be submitted, as an addendum to the development consent, for review and approval by council.

(2) Pit design
Pits shall be designed in accordance with SC6.4.4.8 Standard drawings SD-200, SD-205, SD 210 and SD-215. Safety and safe access are important in pit design and grates shall be of "bicycle safe" design.

(3) Stormwater discharge

(a) Scour protection at culvert, pipe system or kerb and channel outlets shall be designed in accordance with the guidelines outlined in *QUDM 3rd Edition - 2013 – provisional*, Section 8.7. Council will discourage the use of any outlet structure that proposes ponding at the outlet

(b) Where a developer proposes to concentrate stormwater onto an adjoining property, council will require the Developer to provide written agreement from the adjoining owner(s) granting permission to the

discharge of stormwater through their property and the creation of any necessary easements.

(c) Where it is proposed to discharge runoff to an area under the control of another statutory authority, the design requirements of that statutory authority are also to be met.

(d) The minimum width of a drainage easement shall be 3.0m unless otherwise agreed by council.
The overall width of the easement in council's favour must be of sufficient width to contain the full width of overland flow and sufficient space to access the drain for maintenance

(e) Piped stormwater drainage discharging to recreation reserves is to be taken to a point of discharge nominated by council and in the manner nominated by council.

(4) Trench subsoil drainage
Subsoil drainage should be designed and installed as per SC6.4.4.8 Standard drawings SD 080.

SC6.4.4.4.7 Documentation

(1) Drawings

(a) Catchment area plans shall be drawn to scales of 1:500, 1:1000 or 1:5000, unless alternative scales are specifically approved by council and shall show contours, direction of grading of kerb and channel, general layout of the drainage system with pit locations, catchment limits and any other information necessary for the design of the drainage system.

(b) The drainage system layout plan shall be drawn to a scale of 1:500 for urban areas and 1:1000 rural areas 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.

(c) The plan shall also show all drainage easements, reserves and natural water courses. The plan may be combined with the road layout plan.

(d) The drainage system longitudinal section shall be drawn to a scale of 1:500 horizontally and 1:50 vertically and shall show pipe size, class and type, pipe support type in accordance with AS/NZS 3725 or AS/NZS 2032 as appropriate, pipeline and road chainages, pipeline grade, hydraulic grade line and any other information necessary for the design and construction of the drainage system.

(e) Open channel cross sections shall be drawn to 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.

(f) Details including standard and non-standard pits and structures, pit benching, open channel designs and transitions shall be provided on the drawings to scales appropriate to the type and complexity of the detail being shown.

(g) Work-as-executed drawings shall be submitted to council upon completion of the drainage construction and prior to council's acceptance of completed works. The detailed drawings may form the basis of this information; however, any changes must be noted on these drawings.

(2) Easements and agreements

(a) Evidence of any Deed of Agreement necessary for the diversion of runoff through an adjoining property must be submitted prior to any approval of the engineering drawings required for operational works application. Easements must be created concurrently with the issue of the plan of survey.

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

(3) Summary sheets
A copy of a Hydrological Summary Sheet providing the minimum information set out in SC6.4.4.4 Attachment B.

(4) Computer program files and program output

(a) Computer program output may be provided as long as summary sheets for hydrological and hydraulic calculations in accordance with this design specification are provided with plans submitted for checking and with final drawings.

(b) Copies of final computer data files (electronic and hard copy), for both hydrological and hydraulic models shall be provided for council's data base of flooding and drainage information in formats previously agreed with council.

SC6.4.4.4.8 Drainage easements and drainage reserves

(1) Residential, commercial and industrial areas
All major drainage is to be located within a drainage reserve with the minimum widths of that reserve being capable of containing the 1 per cent AEP design flows plus a 4m strip on each side for maintenance access and safety purposes.

(2) Rural residential areas

(a) Easement must be created over all drains and natural water courses through private property. Unless council determines the land is to be set aside for public use and is to be handed to council.

(b) In rural residential areas adjacent to a major watercourse, council may require drainage reserves or easements to be extended to cover identified areas of riparian vegetation, which maybe beyond the strip required for maintenance access and safety purposes.

(3) Rural areas

(a) Easements or reserves are not required over natural watercourses. However easements must be provided over all drains where stormwater is diverted from the natural flow path and be wide enough to contain the flows from the defined flood event plus adequate width for maintenance and safety purposes.

(b) Where the land falls away from the road, easements for drainage are required through private property over formed drains from road culverts and table drains. The location of these easements shall be fixed during design and approval of operational works for the roadworks concerned.

(4) Maintenance of easements

(a) A drainage easement over a property restricts the use of the area of land contained within the easement for drainage purposes. Council's level of service for drainage easements is restricted to ensuring the drainage easement is capable of performing its purpose of carrying stormwater flows through the property. If an owner desires a higher order of maintenance for other reasons, this will be at the owner's ongoing cost and must not compromise the drainage function of the easement. Altering of the drain in the easement by the owner without the approval of council may result in action being undertaken by council to restore the drainage path at the expense of the owner.

(b) Where subdividers are required to provide drainage easements and reserves over approved drainage paths, then these are to be acquired over the entire land at the first stage of subdivision. Where surcharge paths are terminated at the end of stages then drainage easements are required over balance lands, with such easements being released progressively with future stages that provide the surcharge path down the future roads or drainage reserves.

(5) Instruments relating to the terms – easements upon private property
Standard wording for the instruments setting out the terms for the various types of easements that can be acquired for drainage are to be utilised, with each document being cognisant of council’s needs for future grading and on-going maintenance. The document is to also ensure that the responsibility and definition of maintenance within drains is clearly defined on the instruments that accompany the easement documents. This is particularly important in the rural residential areas where some residents have an expectation that council will maintain the land (easement) to a much higher standard than is needed for drainage purposes. In particular, in relation to inter-allotment drains that are not a part of the public drainage system, provision is to be made in the easement document to state that all maintenance is the owner’s responsibility but with provision being made to enable the council to carry out necessary works at the cost of the defaulting owner.

SC6.4.4.4 Attachment A - Design AEPs and fraction impervious for land use zones

Development Category	Minor System Design AEP%					Major System Design AEP%	Fraction Impervious (*fi*)
Residential Zones Category							
Low density residential	10.0	18.1	39.3	-	39.3	100	0.65
Medium density residential	10.0	18.1	39.3	-	-	100	0.7
High density residential	10.0	18.1	39.3	-	-	100	0.9
Character residential	10.0	18.1	39.3	-	-	100	0.55
Centre Zones Category							
Neighbourhood centre	10.0	18.1	39.3	-	-	100	0.9
Local centre	10.0	18.1	39.3	-	-	100	0.9
District centre	10.0	18.1	39.3	-	-	100	0.9
Major centre	5.0	10.0	18.1	-	-	100	1
Principal centre	5.0	10.0	18.1	-	-	100	1
Specialised centre	10.0	18.1	39.3	-	-	100	0.9
Mixed use	10.0	18.1	39.3	-	-	100	0.9
Recreation Zones Category							
Sport and recreation	10.0	18.1	39.3	-	39.3	50	0.5
Open space	10.0	18.1	63.2	-	63.2	50	0.5
Environment Zones Category							
Environmental management and conservation	18.1	18.1	63.2	-	63.2	50	0.4
Industry zones category							
Low impact industrial	10.0	18.1	-	39.3	-	100	0.9
Medium impact industrial	10.0	18.1	-	39.3	-	100	0.9
High impact industrial	10.0	18.1	-	18.1	-	100	0.9
Other Zones Category							
Community facilities	10.0	18.1	18.1	-	39.3	100	0.95
Emerging community	10.0	18.1	39.3	-	-	100	0.7
Rural	10.0	-	-	-	39.3	50	0.1
Rural residential	10.0	39.3	39.3	-	39.3	100	0.6
Road Hierarchy	Arterial	Collector	Local Street	Industrial	Rural		

SC6.4.4.4 Attachment B - Hydrologic and Hydraulic calculation sheets

Click here to view SC6.4.4.4 Attachment B - Hydrologic and Hydraulic calculation sheets