



FNQROC DEVELOPMENT MANUAL

DESIGN MANUAL

D4

STORMWATER DRAINAGE

Version No. – 11/19

This work is copyright. Apart from any use as permitted under the Copyright Act 1968, no part may be reproduced by any process without prior written permission from the Far North Queensland Regional Organisation of Councils. Requests and inquiries concerning reproduction and rights should be addressed to the FNQROC Coordinator, PO Box 359, CAIRNS, Qld 4870.

TABLE OF CONTENTS

CLAUSE	CONTENTS	PAGE
GENERAL		1
D4.01	SCOPE	1
D4.02	OBJECTIVES	1
D4.03	REFERENCE DOCUMENTS	1
DESIGN CRITERIA		2
D4.04	GENERAL	2
D4.05	DESIGN AVERAGE RECURRENCE INTERVAL ^{CRC}	3
D4.06	DESIGN RAINFALL DATA	4
D4.07	CATCHMENT AREA	5
D4.08	KERB INLETS AND MANHOLES ^{TRC, MSC}	5
D4.09	PIPES / BOX CULVERTS	6
D4.10	OVERLAND FLOW	6
D4.11	DRAINAGE CALCULATIONS	7
D4.12	OPEN CHANNELS	7
D4.13	ALLOTMENT DRAINAGE / CATCH DRAIN ^{MSC}	7
D4.14	TELEMETRY SYSTEMS	8
D4.15	RETAINING WALLS	8
D4.16	DETENTION BASINS	8
D4.17	HEADWALLS ^{MSC}	8
D4.18	TABLE DRAINS ^{TRC}	9
D4.19	EASEMENTS	9
D4.20	OUTLET / OUTLET PROTECTION	9

APPENDIX A - IFD RAINFALL CHARTS**APPENDIX B - KERB INLET CAPACITY CHARTS**

GENERAL

D4.01 SCOPE

1. This section sets out the minimum standards for the design of stormwater drainage systems for urban and rural areas.
2. The designer needs to make reference to the associated design manuals related to D1 Road Geometry and D5 Stormwater Quality Management.
3. The Queensland Urban Drainage Manual (QUDM) shall be the basis for the design of stormwater drainage, except as amended by these manuals.

D4.02 OBJECTIVES

1. The objectives of stormwater drainage design are as follows:
 - (a) To collect and convey stormwater from a catchment to its receiving waters with minimal nuisance, danger or damage and at a development and environmental cost which is acceptable to the community as a whole.
 - (b) Limit flooding of public and private property, both within the catchment and downstream, to acceptable levels.
 - (c) To provide convenience and safety for pedestrians and traffic in frequent stormwater flows by controlling those flows within prescribed velocity/depth limits.
2. For new developments a stormwater drainage system in accordance with the "major/minor" system concept in accordance with Queensland Urban Design Manual (QUDM); 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.
3. For redevelopment areas where the proposed development replaces an existing development, the on-site drainage system is to be designed in such a way that the estimated peak flow rate from the site for the design average recurrence interval (ARI) of the receiving minor system is no greater than that which would be expected from the existing development and is not concentrated in such a way as to cause nuisance to downstream properties.

D4.03 REFERENCE DOCUMENTS

Note: Where Acts or reference documents are updated, reference should be made to the current version.

Institute of Public Works Engineering Australasia

- Queensland Urban Drainage Manual

Institute of Engineers Australia

- Australian Rainfall and Runoff - A guide to flood estimation.

Queensland Government – Department of Environment and Science

- Environmental Protection Act
- The Environmental Protection (Water) Policy
- Queensland Water Quality Guidelines

Australian Standards

- AS 5065 Polyethylene and polypropylene pipes and fittings for drainage and sewerage applications”
- AS 2566 Buried flexible pipelines Installation

DESIGN CRITERIA

D4.04 GENERAL

1. The Queensland Urban Drainage Manual (QUDM) shall be the basis for design of stormwater drainage except where amended by these manuals.
2. Minor system flows (as defined by QUDM) are to be conveyed underground to a legal point of discharge unless otherwise approved by council.
3. Councils have or are in the process of producing drainage management plans for particular catchments within their boundaries.
4. The design of the stormwater drainage system, for the development shall be such that the upstream drainage is not adversely affected and that the downstream drainage system is capable of adequately catering for the discharge of the modified flow produced as a result of the development.
5. If the downstream system is not capable of carrying the modified discharge, the designer shall indicate the measures proposed to ensure the downstream system is capable of carrying the modified discharge. This will involve negotiation with adjoining landowners for minor creek systems to produce easements over downstream drainage paths. Written approval from the respective property owners is required for the easement and any engineering works on their property from the development site to the legal point of discharge.
6. Alternatively where a development will result in increased peak flows the stormwater drainage system may include on-site measures to such as detention basins, to ensure that the peak discharge from the development area is restricted to a level no greater than that discharging prior to the development.
7. All works proposed within creeks and natural watercourse, or lands under the control of other Authorities must have the approval of all relevant authority prior to commencing the work and evidence of such approvals shall be provided with the design submission.
8. The design of the stormwater drainage system shall accommodate the future developed peak flows from upstream catchments on the basis of development in accordance with the Planning Scheme.
9. The designer shall be responsible for assessing the existing and future developed flow regime entering the development site from upstream catchments and shall provide detailed calculations with the design submission.

10. Unless approved otherwise by the Council, piped drainage systems shall extend to the boundaries of the subject land, with inlet and discharge works within the subject property.
11. All Material and components of the Stormwater Drainage system shall be durable and fit for purpose, with a minimum lifespan 60 years.

D4.05 DESIGN AVERAGE RECURRENCE INTERVAL ^{CRC}

1. Design Average Recurrence Interval (ARI) shall be in accordance with table 4.3 "Recommended Design Average Recurrence Intervals" (modified from QUDM) unless noted otherwise in the Local Authority Specific Requirements.
2. For the purpose of drainage, a major road shall be defined as a major collector or higher order road.

Table 4.3 – Recommended Design Average Recurrence Intervals

(i) MAJOR SYSTEM DESIGN ARI (years)		100 ¹
(ii) MINOR SYSTEM DESIGN ARI (years)		
Development Category		
Central Business and Commercial		10
Industrial		5
Urban Residential High Density - greater than 20 dwelling units/ha		10
Urban Residential low Density - greater than 5 & up to 20 dwelling units/ha		5
Rural Residential – 2 to 5 dwelling unit/ha		5
Open Space – parks, etc.		1
Major Road	Kerb & Channel Flow	10 ²
	Cross Drainage (Culverts)	50 ³
Minor Road	Kerb & Channel Flow	Refer to relevant development category in QUDM
	Cross Drainage (Culverts)	10 ³
<ol style="list-style-type: none"> 1. <i>State Planning Policy</i> recommends adoption of the 1% AEP (Annual Exceedance Probability) flood frequency for waterway flood management planning. 2. The design ARI for the minor drainage system in a major road shall be that indicated for the major road, not that for the Development Category of the adjacent area. 3. Culverts under roads should be designed to accept the full flow for the minor system ARI shown. In addition the designer must ensure adequate public safety controls (e.g. d*V product) exist and that the nominated Major Storm flow does not cause unacceptable damage to adjacent properties, or adversely affect the use of the land. If upstream properties are at a relatively low elevation, it may be necessary to install culverts of capacity greater than that for the minor system ARI design storm to ensure unacceptable flooding of upstream properties does not occur. In addition, the downstream face of causeway embankments may need protection where overtopping is likely to occur. 		

D4.06 DESIGN RAINFALL DATA

1. Design Intensity Frequency Duration (IFD) Rainfall Charts have been developed for the Far North Queensland Area. If the location of the proposed development falls between two IFD Charts or is not covered by the charts, Council should be contacted to confirm the appropriate table to be used. Alternatively IFD Charts can be generated using the Bureau of Meteorology online Rainfall IFD Data System (<http://www.bom.gov.au/water/designRainfalls/ifd/index.shtml>) Table D4.1 shows the location of the appropriate Rainfall Chart to be used for stormwater drainage design (Refer **Appendix A** in this manual).

Table D4.1 IFD Rainfall Charts

Location	IFD Chart
Aloomba, Deeral, Bellenden Ker, Babinda	1
Atherton	2
Cairns, Edmonton, Gordonvale, and Northern Beaches	3
Cape Tribulation	4
Cardwell	5
Chillagoe	6
Cooktown	7
Daintree	8
Dimbulah	9
Herberton	10
Innisfail	11
Julatten	12
Kuranda	13
Malanda	14
Mareeba	15
Millaa Millaa, Tarzali	16
Mt Garnet	17
Port Douglas, Mosman	18
Ravenshoe	19
Tully, Mission Beach	20
Yungaburra, Pearamon	21

2. If the location of a proposed development falls between two IFD Charts or is not covered by the above charts, Council should be contacted to confirm appropriate table to be used.

D4.07 CATCHMENT AREA

1. The catchment area of any point is defined by the limits from where surface runoff will make its way, either by natural or man made paths, to this point. Consideration shall be given to likely changes to individual catchment areas due to the full development of the catchment.
2. The catchment boundary shall be determined by using the most accurate information available and details of catchments shall be provided to Council with the design submission.

D4.08 KERB INLETS AND MANHOLES TRC, MSC

1. Kerb Inlet pits shall be in accordance with Standard Drawings S1050, S1055 and S1060. All pits are to be recessed sufficiently to maintain a continuous lip line in accordance with these drawings. Alternate proprietary kerb inlets systems may be used only where approved by Council.
2. Kerb Inlet capacity design charts have been prepared for the standard kerb inlets (Refer **Appendix B** in this manual). Where an alternate proprietary kerb inlets systems have been approved for use by a Council, a copy of certified inlet capacity design charts for the alternate inlets shall be provided to Council with the design submission.
3. Blockage Factors shall be used for the design of the drainage system as shown in Table D4.2.

Table D4.2 Kerb Inlet Blockage Factors

Inlet Type	Blockage Factor
On Grade - Side Entry, (no Grate)	20%
On Grade - Side Entry, (with Grate)	10%
On Grade – Grate only	50%
Sag - Side Entry, (no Grate)	20%
Sag - Side Entry, (with Grate)	Nil
Sag – Grate only	50%

4. The kerb inlet capacity design charts shall be used in accordance with the following:
 - a. Curves indicated on the charts that are shown in full are considered "Reliable" curves.
 - b. Curves indicated on the charts that are shown dashed up to an Approach Flow of 250 l/sec are considered "Satisfactory" for use.
 - c. Curves indicated on the charts that are shown dashed with an Approach Flow in the range 250 l/sec to 500 l/sec are "Estimates Only" and are to be used with caution in critical locations.
 - d. No extrapolation beyond the limits of these charts shall be permitted.
5. Side entry pits with grates are preferred. Grated inlet pits with no side entry shall only be used in areas with a low risk of consequential damage from blockage and shall be subject to Council approval.
6. Manholes shall be provided on stormwater drainage lines in accordance with the requirements of QUDM. Manholes for pipes up to 1200mm dia shall be constructed in accordance with the Standard Drawing S1065. Council may examine proposals for the use of proprietary manufactured directional changes for stormwater systems and the acceptance of these will be subject to the satisfaction of the Council.
7. Other factors to be considered in the design are as follows:

STORMWATER DRAINAGE

- a. Pits to be free draining.
 - b. Kerb inlet pits at intersections generally are to be located at the tangent point taking into account the position of pedestrian paths and kerb ramps. Inlets shall not be placed on kerb return unless specifically approved by Council.
 - c. Reductions in pipe sizes shall not be permitted.
 - d. Pipework openings are to be located within a single wall. i.e. pipes shall not be permitted to enter through the corner of the pit structure.
8. The desirable maximum inlet pit depth should be limited to 1.5m to enable maintenance,
 9. The desirable minimum and maximum stormwater manhole depth is to be limited to 1.2m and 3.0m respectively
 10. Inlet pits should be located at the mid point of allotment frontages to reduce the likelihood of conflict with service conduits and future driveways

D4.09 PIPES / BOX CULVERTS

1. Stormwater drainage pipes and boxes shall be manufactured from steel reinforced concrete (Fibre Reinforced Concrete(FRC) pipes are not permitted) and constructed in accordance with the following:
 - a. Minimum pipe size 375mm dia, minimum box culvert size 450mm x 300mm.
 - b. Minimum clear cover shall be 600mm in general or in accordance with manufacturers specification, otherwise approved by the Council.
 - c. The minimum vertical and horizontal clearances between a stormwater pipe and any other pipe or service conduit shall be 150mm.
 - d. In areas of high water table, the designer must consider buoyancy uplift in relation to pipe/culvert joints.
 - e. In aggressive environments or where any part of the pipe / box culvert is below the Highest Astronomical Tide (RL 1.80m AHD), pipes / box culverts will have cover to reinforcement in accordance with the exposure classification requirements of AS 3600.
 - f. Where specifically approved for use by Council, polypropylene stormwater pipes may be used. On approval, Pipes must be manufactured in accordance with AS5065, and installed in accordance with AS2566.
 - g. The use of polypropylene(or other flammable material) stormwater pipes under public roads or utilities is not supported in rural areas.

D4.10 OVERLAND FLOW

1. Overland flow paths or emergency relief paths shall be formed and located in accordance with the requirements of QUDM. The following additional requirements shall also be required.
 - a. Where a pathway link is used for overland flow the pathway shall be concrete for its full width, shall have a maximum crossfall of 2.5 per cent and be constructed with a layback kerb and channel or approved equivalent along one edge. The ARI 100 year flow shall be contained completely within the pathway.
 - b. The footpath profile at the overland flow tip out point shall be designed to provide a fall from the kerb at the road edge towards the pathway / park.
 - c. Flows through parks shall have non-erosive velocity or adequate protection against scouring to the satisfaction of Council.

- d. Where a stormwater pit is required to be aligned with a pathway for overland flow, the pedestrian path is to be offset and appropriate measures provided to guide pedestrians away from the pit and remove any potential hazards.
- e. Where flows discharge into receiving waters or drainage reserves, adequate protection against scouring of the batter slope shall be provided to the satisfaction of Council.

D4.11 DRAINAGE CALCULATIONS

1. If a legal point of discharge and tailwater conditions have not been provided by Council as development conditions they shall be confirmed with Council prior to proceeding with detailed design.
2. Hydraulic calculations shall generally be carried out in accordance with QUDM. The calculations shall substantiate the hydraulic grade line adopted for design of the system.
3. Catchment plans and hydraulic calculations including any additional calculations in support of overland flow path capacities, weir flows over kerbs, culvert designs etc shall be provided to Council with the design submission. Where a hydraulic modelling programme is used, calculations to be provided with the design including listings of all programme input parameters.

D4.12 OPEN CHANNELS

1. Generally, open channels will only be permitted where they form part of the trunk drainage system and shall be designed to have smooth transitions with adequate access provisions for maintenance and cleaning. Where Council permits the use of an open channel to convey flows from a development site to the receiving water, such a channel shall be designed in accordance with QUDM.
2. Maximum side slopes on grass lined open channels shall be 1 in 4, with a preference given to 1 in 6 side slopes, channel inverts shall generally have minimum cross slopes of 1 in 10.
3. Low flow provisions in open channels to prevent scouring from trickle flows shall be provided to all grass lined channels. Trickle flow protection shall be contained within a pipe or hard lined channel and shall be designed to cater for the 3 month ARI storm event (60 per cent of the 1 Year ARI storm event flow).
4. Subsurface drainage shall be provided in grass-lined channels to prevent waterlogging of the channel bed.
5. Profiles of all grass lined channels shall such that mowing may be undertaken by a tractor and slasher to the satisfaction of Council.
6. Where the flow velocity and / or depth within an open channel pose a safety hazard, barrier fencing and / or appropriate hazard warning signs shall be provided to discourage access to the channel. The extent of precautions should be determined following consultation with Council.
7. The depth velocity product and the gutter flow widths are to be included in the submitted drainage calculations

D4.13 ALLOTMENT DRAINAGE / CATCH DRAIN ^{MSC}

1. Underground roof and rear of allotment drainage systems as detailed in Section 7.13.3 & 7.13.4 of QUDM are not permitted. All inter allotment drainage works shall be conveyed above ground via open channel catch drains linking to Councils minor drainage system.
2. All lots to drain towards the road reserve, drainage reserve or adjacent creek, stream or defined waterway unless otherwise approved by council. All allotments that do not drain towards a road frontage shall be provided with stormwater services in accordance with the following:

- a. Where the allotment drains to an adjacent creek or drainage reserve, each allotment shall be provided with a 450mm x 450mm concrete or HDPE pit with galvanised grate. Each pit shall have a 150mm class SH UPVC outlet pipe discharging to the adjacent creek or drainage reserve. The pit shall be located at the lowest corner of the allotment and provision to facilitate entry of the roof pipe system for the future dwelling construction. The Outlet pipe shall be protected with a 300mm minimum concrete surround and suitable scour protection works to the creek bank or drainage reserve.
 - b. In instances where the site's characteristics do not lend itself to draining towards the road reserve, drainage reserve or adjacent creek, stream or defined waterway (e.g. hillslope developments), a catch drain shall be provided in an easement in favour of upstream properties unless otherwise agreed by Council. The width of easement shall contain the ARI 100 year storm flow from the upstream catchment or be three (3) metre wide, which ever is greater. Property fences shall be designed to not adversely interfere with the conveyance of stormwater through these catch drains, and/or cause undue blockages. Maintenance of the easement within the property is the responsibility of the property owner.
3. Allotment drainage or catch drains which have a change in horizontal alignment greater than 45 degrees shall be provided with concrete or wire-reinforced rock mattresses at such change points which shall be designed to cater for flows in accordance with QUDM.

D4.14 TELEMETRY SYSTEMS

1. Where required by the Local Authority pump station control panel shall incorporate SCADA equipment for transmission of monitoring data and control to Council's existing master system. Council should be contacted to obtain a copy of their Technical Specification for Telemetry Systems.

D4.15 RETAINING WALLS

1. Where retaining walls are incorporated in the retention of earth batters, adequate drainage shall be incorporated behind the top of the wall to ensure surface stormwater flows do not flow over the top of the wall but are contained in a designed system to pass the wall.
2. Appropriate scour protection is to be provided to the base of the wall.

D4.16 DETENTION BASINS

1. Detention basins may be considered as drainage solutions but shall be subject to approval of Council. Where approved detention basins shall be designed in accordance with QUDM.

D4.17 HEADWALLS ^{MSC}

1. Pipe / Box culvert headwalls shall be in accordance with Standard Drawings S1075, S1080, S1085 and S1090. Proprietary precast headwall may also be used as an alternative to cast insitu structures. Precast headwalls to include a 600 depth x 200 thick cast insitu cut-off wall as detailed in Standard S1075
2. The designer shall ensure that in addition to standard aprons and cut-off walls adequate protection works commensurate with design velocities and flows shall be provided to prevent downstream scouring and erosion.
3. Where floodgates are to be used, headwalls and aprons shall be specifically designed to accommodate the floodgate and minimise the potential for debris and siltation to impede the operation of the floodgate. Most precast headwalls are not suitable for use with floodgates.

D4.18 TABLE DRAINS ^{TRC}

1. Table drains shall generally be constructed with a minimum depth of 600mm or to a depth of 300mm below the pavement subgrade, whichever is greater.
2. Table drain profiles may be either v-shaped or trapezoidal. Reference should be made to the Local Authority Specific Requirements for each Councils preferred profile.

D4.19 EASEMENTS

1. Where stormwater drainage pipes pass through property other than a road reserve an easement shall be provided over the line in favour of the Council. The width of this easement is determined by the depth at which the stormwater pipe is laid and based on twice the depth to the pipe obvert plus the pipe diameter (with a minimum width of three (3) metres) and located centrally over the pipe.
2. If a stormwater pipe passes adjacent to a property and based on the above formula the area of influence passes within the property, an easement over that portion shall be required.

D4.20 OUTLET / OUTLET PROTECTION

1. Outlets into natural watercourse, open channels and tidal areas shall be designed in accordance with the requirements of QUDM.
2. All outlets shall be located to facilitate inspection and maintenance access.
3. Protection works to outlet shall be designed to meet the following criteria:
 - a. Dissipate the outflow velocity to minimise scouring.
 - b. Provide protection from stream flows in receiving waters,
 - c. Provide protection from overland (Major Storm) flows into receiving waters.
 - d. Provide protection from local scouring or undermining of the outlet structure.
4. Where a headwall is located within the tidal splash zone, it will be designed to comply with the exposure classification requirements of AS 3600
5. An energy dissipating outfall shall be provided where the velocity of the outflow or nature of the discharge from the pipe system into the receiving water could cause scouring in the receiving channel.
6. All tidal outlets shall be fitted with floodgates to prevent the intrusion of salt water into the system.
7. Outlets with floodgates shall be designed to ensure that they can operate freely at all times, and are protected from siltation, excessive vegetation growth, debris and the impacts of stream flows in the receiving waters.
8. The designer shall provide calculations to show that they have accounted for losses due to floodgates or other water control devices in the hydraulic design.

APPENDIX A

IFD RAINFALL CHARTS

APPENDIX B

KERB INLET CAPACITY CHARTS