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6.0 STORMWATER DRAINAGE

6.1 GENERAL DRAINAGE ISSUES

Purpose

This chapter is intended to provide supplementary information to expand on some of the elements specified in the Stormwater Management Code of the *Brisbane City Plan*. Therefore **the user must read this chapter in conjunction with the *Brisbane City Plan* to ensure that the development proposal complies in its entirety with the relevant codes, provisions and planning scheme policies**. In particular this chapter sets out Council's minimum standards for stormwater drainage components that are part of any development proposal.

Proprietary Products

Any proprietary product to be used in Brisbane City must be submitted to Council for assessing its suitability for a particular application. When Council is satisfied that a particular product has conformed to all the technical specifications, performance and maintenance objectives, the proponent will be advised in writing of its suitability of use. Notwithstanding this acceptance advice, Brisbane City Council reserves the right to withdraw the approval for use of any product at any time. In order to maintain the highest standards of public integrity and accountability, Brisbane City Council will not promote nor endorse a particular company's product.

Professional and Para-Professional Services

Development applications from para-professionals (called variously Plumbing Consultants or Hydraulic Consultants or even Consulting Hydraulic Engineering Professionals) will only be accepted for non-engineering services where there is no need to recourse to engineering principles. The design of these para-professional services is principally determined by the requirements of the *Sewerage and Water Supply Act* and for building drainage from and including the roof down to a free discharge ie generally the kerb and channel. It should be noted that this service does not extend to the design of major sewerage or stormwater pump stations where gravitational systems are not possible, nor does para-professional service extend to drainage works associated with subdivisions.

Where the application of engineering principles (eg hydrological, hydraulic, structural, traffic, environmental, water supply, wastewater, highway, geotechnical, mechanical, electrical, etc) are required to ensure that a safe, functional and cost effective design is completed, then a suitably experienced Registered Professional Engineer in Queensland (RPEQ) must be engaged to prepare and certify the design. Further the RPEQ must inspect the works during construction to ensure that the design intent is achieved and certify the same.

6.1.1 Design Requirements

Designs of stormwater drainage must be in accordance with *Queensland Urban Drainage Manual (QUDM)* except as amended by Brisbane City Council, Supplement to *QUDM* that is appended to this Chapter.

6.1.2 Major/Minor Drainage Systems

The major and minor drainage systems as described in Section 5.08 of *QUDM* forms the basis of the drainage system within the urban area. The definitions outlined in the Stormwater Management Code are provided below:

- Major drainage system: Part of a drainage system in a catchment which is designed to convey major design storms, eg 50 year ARI and 100 year ARI events. The system may comprise open space, floodway channels, road reserves, pavement expanses, overland flow paths, detention basins and lagoons.
- Minor drainage system: Part of a drainage system in a catchment that controls flows from the minor design storm, eg 2 year ARI and 10 year ARI events. The system usually comprises kerbs and channels, roadside channels, gully inlet pits, underground pipes, manholes and outlets.

6.1.3 Overland Flow Paths

The *Brisbane City Plan* defines overland flow path as:

- Where a piped drainage system exists, the path where floodwaters exceeding the capacity of the underground drainage system would flow.
- Where no piped drainage system or other form of defined watercourse exists, the path taken by surface runoff from higher parts of the catchment. This does not include a watercourse or gully with well defined banks.

Any proposed development, especially those involving filling, needs to take account of existing or created overland flow paths and make due provision in the design. Overland flow paths must be clearly indicated on the drawings.

In conventional residential subdivisions, overland flow paths must be located in roadways, parks or pathways and not through private allotments.

In site developments such as apartment buildings or townhouses where the sites are filled to provide suitable falls to the roadway, the Developer must pay particular attention to the preservation of existing overland flow paths, the obstruction of which may cause flooding or ponding of stormwater on adjoining properties. Particular attention must also be given to overland flow in many of the older inner city areas, as the underground drainage may not meet current standards and there is the likelihood of substantial overland flow paths being associated with the route of the pipe drains through properties. Overland flow paths must be located along the driveways (usually applies to built up inner city areas) and protected by an easement.

Overland flow paths not in designated channels should have a velocity depth product of no greater than 0.6 m^2/s (0.4 m^2/s applies to high risk areas) and a maximum depth of 0.3 m (applicable to vehicular accommodation and access areas). Where these values are exceeded, alternative layout or upgrade to the pipe drainage system must be considered.

Where there is no alternative layout (especially in built up areas) or where the overland flow path is completely blocked (eg by filling, building, retaining walls, etc), underground drainage to Q_{100} capacity must be provided. The inlet capacity must be designed to allow for an additional 50% blockage factor. Details and calculations are required when overland flow within the road reserve is directed into narrow pedestrian pathways. Calculations must demonstrate that overland flow will not enter the adjacent blocks during a Q_{50} flow.

Drainage calculations, cross sections and plan layouts, must be provided for any proposed overland flow path. The Consultant must ensure that the as constructed levels are consistent with those shown on the approved engineering drawings.

Special attention must also be paid to localised overland flow and site drainage in smaller allotment subdivisions or where 'built to the boundary' building envelopes will apply. Additional pipe drainage, easements and concrete lined drains may be required along the rear boundary in such situations.

In all circumstances, easements will be required for overland flow paths within private properties. Proposed easements for the design overland flow must be shown on the engineering drawings. Refer also Section 6.11 - Easements.

Developments within any overland flow paths are generally not permitted unless the applicant can satisfactorily demonstrate compliance with all the flood immunity and trafficability requirements set out in Sections 2.2 and 2.3 of Part B of this document.

6.1.4 Lawful Point of Discharge

When land is subdivided or developed, the roof and surface water runoff from the land and any external catchment, runoff through the subdivision or site development must be discharged to a lawful point of discharge acceptable to Council.

Designs which result in concentration of water onto an adjoining property or rely on the construction of drainage through an adjoining property will not be accepted unless written approval is obtained from downstream owner/s of any affected property. **Evidence of a lawful point of discharge must accompany the engineering drawings for any approval to be given**. If a satisfactory lawful point of discharge cannot be achieved the development cannot proceed. The lawful point of discharge and full details at the outlet must be shown on the engineering drawings.

The effects of the discharge (up to and including the Q_{50} or Q_{100} storms) from a development site on other properties by virtue of increased runoff, increased concentration of runoff, change to the existing overland flow, or change to the existing point of concentration, must be assessed in the design. Any of these effects as well as increased flow depth for the same Average Recurrence Interval (ARI) will require a lawful point of discharge to be obtained. Besides obtaining the downstream owner's permission, it is preferable that easements are acquired over the drainage systems within the downstream properties.

The **lawful points of discharge** may be one of the following, depending on the site situation.

1. To concrete kerb and channel, gullies or existing enclosed stormwater drainage system abutting the allotment. The applicant must obtain permits from the Engineering Officer Development & Regulatory Services for any connection to Council infrastructure. The applicant must also demonstrate compliance with the permissible flow width, flow depth and velocity depth product.
2. To the road reserve provided the concentration of stormwater does not adversely affect the drainage capacity of the road and/or adjoining properties.
3. Through adjoining private property at the rear of the allotment to concrete kerb and channel or existing enclosed drainage system providing written permission is obtained from the downstream adjoining property owner.
4. To an existing enclosed drainage system (excluding any foul water lines) within 100 metres of the site provided the system has the capacity required. Calculations must incorporate future upstream developments.
5. To concrete kerb and channel and thence to a new stormwater inlet to be provided by the Developer at a location removed from the site.
6. To an existing stormwater drain within the property or by written permission of the adjoining property owner, to a stormwater drain in adjoining properties.
7. To kerb and channel or existing enclosed drainage system higher than the allotment from a drainage pit within a site by pumping. This method will only be considered in cases when all other alternatives have been exhausted. Refer to Section 6.12.

6.1.5 Erosion and Sediment Controls

Refer Part C - Water Quality Management Guidelines, in this document.

6.1.6 Types of Open Watercourses

Natural Watercourses, Waterways and Wetlands

A natural landform such as a gully or hollow that concentrates and conveys runoff from a catchment, whether continuous or intermittent can be described as a natural watercourse. The *Brisbane City Plan* defines waterway as any element of a river, creek, stream, gully or drainage channel, including the bed and banks. Waterways are shown on the Planning Scheme Maps. For further details, refer to Section 6.2, and Chapters 2 and 3 of Part B of this document.

Designed Open Cut Channels and Major Overland Flow Paths

For further details, refer to Sections 6.2 and 6.8, and Chapter 2 of Part B of this document.

6.2 SUBDIVISION DESIGN REQUIREMENTS

The Stormwater Management Code of the *Brisbane City Plan* promotes the use of natural channel design and water sensitive urban design principles.

Both the Developer and Council must consider the following factors in the selection of the final drainage treatment:

1. Future maintenance requirements to ensure the waterway continue to meet design performance.
2. Safety of public, in particular children.
3. Erosion and siltation both within and on adjoining properties not increased as a result from the development.
4. The existing treatments of other sections of the drainage system.
5. The general amenity of the area and particular use of parkland.
6. Environmental issues, including vegetation protection orders (VPOs), maintenance of natural channels and buffer vegetation, preservation and rehabilitation of flora and fauna habitats, riparian vegetation, archaeological values, heritage values, water quality and existing features such as wetlands.

6.2.1 Natural Channel Design

The basic principles of Natural Channel Design (NCD) are to maintain the hydraulic conveyance requirements of engineered or affected channels, while improving environmental values. NCD is important in all waterways (whether natural in formation or constructed to appear and operate as natural channels), especially where the waterway provides a link with bushland reserves or forms an important part of an aquatic or terrestrial movement corridor. An **extended maintenance period** may be required until the channel has sufficiently stabilised and vegetative cover is well established.

The desirable style of drainage channel can vary from a grass lined overland flow path for very small catchments, to a fully established river channel for large catchments. Desirable bed conditions in a reconstructed watercourse usually depends on the following factors:

- Catchment area.
- Catchment soil type (infiltration capacity) and erodibility.
- Canopy cover.

Table B6.2.1.1 provides guidance in the selection of typical bed form conditions for clayey soil catchments that are likely to occur in the Brisbane area. Source reference: *Natural Channel Design Guidelines* (Brisbane City Council, 2000).

TABLE B6.2.1.1 TYPICAL (DESIRABLE) CHANNEL FORMS

Catchment Characteristics	Channel Slope	Desirable Bed Condition
Urbanised Catchment <30 ha	Open Canopy	Grassed Bed
	Closed Canopy	Rock and/or Vegetated Bed
Urbanised Catchment 30-100 ha	Steep Channels (>5%)	Rock Lined Bed
	Mild Slopes (1-5%)	Pool/Riffle System (Note: Low flows may not be sufficient to maintain dry weather flows and adequate pool water quality)
	Flat Slopes (<0.2%)	Open Earthed or Vegetated Channel Bed
	Sandy Channels	Sandy Bed, Some Pools & Riffles
Mainly Urbanised Catchment >100 ha	Steep Channels (>5%)	Rock Lined Bed
	Mild Slopes (1-5%)	Pool/Riffle System
	Flat Slopes (<0.2%)	Open Earthed or Vegetated Channel Bed
	Sandy Channels	Sandy, Irregular Beds with Pools
Bushland Catchment <50 ha	Open Canopy	Grassed Bed
	Closed Canopy	Rock and/or Vegetated Bed
Rural or Bushland Catchment >50 ha	Steep Channels (>0.67%)	Rock Lined Bed
	Mild Slopes (<0.67%)	Pool/Riffle System
	Flat Slopes (<0.2%)	Open Channel
	Sandy Channels	Sandy Bed, Some Pools & Riffles

Where rock armour is required to control erosion, partially embedded or grouted natural rocks/boulders should be used. Planting between rocks can soften visual impacts. Boulders placed on the bed of the watercourse can promote habitat diversity. Boulders recessed into the low flow channel or the pools can increase the total submerged surface area, thus increasing the available food supply for aquatic life. Concrete lining is generally unacceptable to Council as this solution does not protect nor enhance environmental values.

6.2.2 Water Sensitive Urban Design

In recent years, the importance of protecting and enhancing waterway health has become widely recognised. Through this change, the industry is witnessing a gradual change in the focus of stormwater management, shifting away from hard engineering solutions to problems associated with drainage, flooding and bank erosion. There is recognition that a developing urbanised area can readily coexist with an area of environmental and habitat significance with careful design consideration.

In general it is considered that water sensitive urban design should be viewed as a design philosophy that encompasses the principle of ecological sustainability, ie the identification and recognition of environmental, drainage and flooding constraints, and designing the development around these constraints whenever possible.

Examples of water sensitive urban design practices include grass swales (as opposed to enclosed drainage), natural channel designs (as opposed to concrete lined open drains), roof water tanks, areas of porous paving and infiltration within private property, etc. Also refer Section 1.5.2, Part C - Water Quality Management Guidelines, in this document.

6.2.3 *Stormwater Drainage Design Criteria*

In certain situations where no internal road dedications are proposed, drainage of stormwater from road reserves fronting the site may discharge onto and through the subject subdivision but only toward a defined natural watercourse. This must be carried out in such a way as to preserve the amenity of the allotments that are affected. Easements are required over drainage outlets from road reserves (minimum 10 metres in from the property alignment by 3 metres wide).

2-5 dwelling units per hectare (typically in Rural/Environmental Protection Areas where predominant uses include house on large allotment and farm)

Minor System Design Standard:	Minimum 2 y ARI
Major System Design Standard:	Minimum 50yARI (less piped flow if applicable)

>5 and ≤ 20 dwelling units per hectare (typically in Low Density Residential Area comprising mainly one or two storey single houses)

Minor System Design Standard:	Minimum 2 y ARI
Major System Design Standard:	Minimum 50yARI (less piped flow if applicable)
Roof Water Drainage:	Level II *QUDM* Section 5.18

>20 dwelling units per hectare (typically in Low-medium to High Density Residential Areas comprising multi-unit dwellings)

Minor System Design Standard:	Minimum 10 y ARI
Major System Design Standard:	Minimum 50yARI (less piped flow if applicable)
Roof and Allotment Drainage:	Level III and IV *QUDM* Section 5.18

Industrial Areas

Minor System Design Standard:	Minimum 2 y ARI
Major System Design Standard:	Minimum 50yARI (less piped flow if applicable)
Roof and Allotment Drainage:	Level IV *QUDM* Section 5.18

For industrial roads that will be major through roads, the minor drainage design will need to increase to 10 year ARI.

New use centre activities (incorporating a wide range of commercial, retail and residential uses)

Minor System Design Standard:	Minimum 10 y ARI
Major System Design Standard:	Minimum 50yARI (less piped flow if applicable)
Roof and Allotment Drainage:	Level IV and V *QUDM* Section 5.18

Major Roads (district access, suburban route, arterial route, major industrial access through road)

Kerb & Channel Flow:	Minimum 10 y ARI
Cross Drainage (Culvert) Flow:	Minimum 20 y ARI (also refer Section 2.3 of Part B of this document)
Roadway Flow Width & Depth Limits:	Refer *QUDM* Table 5.09.1

Minor Roads (local access, neighbourhood access, minor industrial access)

Kerb & Channel Flow:	Refer relevant development category, Min. Q_2
Cross Drainage (Culvert) Flow:	Minimum 20 y ARI (also refer Section 2.3 of Part B of this document)
Roadway Flow Width & Depth Limits:	Refer *QUDM* Table 5.09.1

6.3 SITE DEVELOPMENT DESIGN REQUIREMENTS

6.3.1 General

Driveway Grids

The use of collection grids across driveways at the property boundary is not permitted unless approved by the Engineering Officer Development & Regulatory Services. (Driveway grids usually require high maintenance. The inevitable lapses in maintenance can lead to potential blockage, which may cause inconvenience to road users during a heavy storm.) Wherever possible, the paved area must be shaped in such a manner so as to divert the runoff towards grated field inlets. If driveway grids are used, these must be bolted down.

Pipe Size, Type and Minimum Grades

The minimum pipe size for internal underground site drainage must be 150 mm nominal diameter. Where the pipe also conveys stormwater from an adjoining upstream property (now or in future), the minimum pipe size must be 225 mm diameter.

The pipe types and classes must comply with the following requirements.

- Domestic applications (low density residential) must be in accordance with *AS 1254 - UPVC Pipes and Fittings for Stormwater and Surface Water Applications*.
- Commercial, industrial, medium and high density residential applications must be in accordance with *AS 1260 – PVC Pipes and Fittings for Drain, Waste and Vent Applications*. The minimum pipe class is UPVC sewer class SN6.

The minimum grade of 1%, as specified in AS 3500.3 – Stormwater Drainage, will apply to pipes ≤150 mm diameter. The minimum grade of 0.5% will apply to pipes 225-300 mm diameter. The minimum grade of 0.3% will apply to pipes ≥375 mm diameter. For flow velocity and maximum pipe limits, refer *QUDM* Sections 5.16 and 5.17.

Footpath Crossings

Where the connection to kerb and channel is permitted, drainage footpath crossings other than in the Low Density Residential Area (ie one or two storey single houses), must be via multiple hot dip galvanised rectangular hollow sections (RHS) with 100 mm maximum height and minimum width of 75 mm. Generally the 125/150/200 mm wide x 75 mm high RHS are suitable for this use. Developers must check with suppliers for other available sizes. In multi-unit residential developments, circular pipes may be used only if there is sufficient depth of cover and depth of kerb and if approved by the Engineering Officer Development & Regulatory Services. Kerb adaptors must be used where practicable. Pipes must be located clear of any driveways and must not cross footpaths in front of adjoining properties.

Pipe Drainage Systems

Where the existing underground pipes that service the external catchments traverse the site, these pipes must be preserved from damage or structural loading (refer Section 6.14). In the absence of an Infrastructure Charges Plan that specifies the development contribution for stormwater facilities and where the existing drainage system is inadequate, the Developer is generally responsible for upgrading the pipe drainage to the appropriate design standard in accordance with these Guidelines. Easements will be required as per Section 6.11. In all cases where there is developable land upstream of the site, the development must provide a suitable drainage inlet for future upstream developments and consider these flows in their design. Further cut-off drains and the like must be provided to prevent overland flow from adjacent properties causing problems on the developed land.

Localised Overland Flow Paths

All developments must provide an overland flow path for the Q_{50} design storm less the piped flow. Refer Section 6.1.3 for design limitations. In residential developments where the difference in levels of the dwelling adjacent to the local overland flow path is minimal, calculations must be provided to demonstrate that the habitable floor levels have the required immunity.

Developers must not cause ponding of stormwater or nuisance from discharge of stormwater on adjoining properties. Filling, retaining walls, buildings, fences, or other obstructions must not block overland flow. Furthermore these obstructions must not cause the overland flow to be diverted to, or concentrated onto, another property.

Channels and Watercourses

If open cut channels and natural watercourses are permitted within the site, the same requirements as for subdivisions, will apply. Easements including access areas adjacent to the channel will be required if they are in a private property.

6.3.2 Roof and Surface Water Hydraulic Requirements

Development of a site requires the design and construction of a drainage system to collect roofwater and surface water runoff from within the site and runoff from external catchments traversing or concentrated on the site, and to discharge the water to a legal point of discharge. Even though the focus of this section is on the conventional underground pipe drainage system, the Developer should consider alternative water sensitive urban design techniques.

Pipe drainage of on-site roofwater and surface water from paved and unpaved areas must comply with *AS 3500.3*, *QUDM* Level III, IV and V Section 5.18, Council's supplement to *QUDM* and Standard Drawing No. UMS 353.

The internal pipe drainage system is required to collect the discharge from individual roofwater systems and from the paved common areas, including internal roads and parking bays. If the pipe drainage system collects only 'internal' runoff and roofwater the system is a private drainline and is owned by the property owners. In these circumstances, no easements will be required. Where the underground drainage system collects water from an external road reserve, the drainline ownership must be formally transferred to Council and easements provided.

Provision must be made for the future orderly development of upstream properties with respect to pipe drainage. The need for future developments having to resort to pumping of stormwater to a discharge point rather than by gravitational drainage must be avoided. Pipe drainage must be installed to allow for the future connection by adjoining properties when they are developed, which, by virtue of topography and/or existing developments, must discharge stormwater by gravity feed through the subject site. This drain must be a minimum 225 mm diameter (300 mm diameter for industrial) running from the boundary to the discharge point and must be covered by an easement, a minimum of 1.5 metres wide, in favour of Council.

If drainage cannot be gained by a gravity system a pump will be required. Refer Section 6.12 - Pumps and Storage.

6.3.3 Treatment of Stormwater Runoff

The selection of appropriate Stormwater Quality Best Management Practices (SQBMPs) will assist developments to meet Council's requirements for the protection of water quality in the City's waterways. The SQBMP requirements are site specific. For 'low risk' developments it is usually sufficient to apply best practice techniques, whereas for 'high risk' developments, calculations or pollutant export modelling is usually required to demonstrate compliance with a set of Water Quality Objectives. (Note: For definitions of low risk and high risk developments, refer to Stormwater Management Code of the *Brisbane City Plan*). The aforementioned processes are discussed in detail in Part C - Water Quality Management Guidelines, of this document.

Water quality issues must be addressed at the initial application (conceptual design) stage and not be deferred to the operational works assessment stage, as these issues could influence the development's design, layout and cost.

6.4 PARK AND WATERWAY REQUIREMENTS

The requirements are set out in the publication *Guidelines - Stormwater Outlets in Parks and Waterways* (Brisbane City Council, 2000) where the key performance criteria are grouped into three categories (ie Amenity, Engineering, and Environmental), with maintenance considered to be interactive with all the three categories. It is important that where surcharge pits and inlets and stormwater detention/polishing basins are provided within parklands, they are to satisfy stringent safety and amenity criteria.

The applicant must not assume that drainage channels, overland flow paths, or drainage outlets, energy dissipators or stormwater detention/polishing basins will automatically be permitted in public space (newly created Council asset or existing Council asset). Further, it is unlikely that filling of existing natural drains/watercourses would be permitted without Council approval. Prior to the design of any stormwater discharge facility into Council controlled land, the applicant must consult with the relevant Development Assessment Officers (usually Open Space Planner or Ecologist) to:

- Ensure that the proposal is accepted.
- Ensure that the proposal complies with the park character plans and park objectives.
- Ensure that the proposal complies with the Park Code and Waterway Code of the *Brisbane City Plan*.
- Determine the levels of impact assessment required.

Stormwater outlets in any public space (existing or newly created Council asset) must be addressed at the initial application (conceptual design) stage and not be deferred to the operational works assessment stage, as the method of stormwater conveyance and treatment could influence the development's design, layout and cost.

The applicant must submit concept drawings and checklist (Figure B6.4.1) to Council for initial review at the time of assessing the development application and obtain subsequent preliminary approval during this time. Detail calculations and drawings can be submitted at the later stage of operational work assessment. A site inspection will probably be required prior to construction.

Where the stormwater discharge is across a public space designated for active recreation, piped drainage must be provided for the minimum Q_1 storm to ensure that the function of the amenity is not diminished. The applicant must consider the following issues in the pipe selection process.

- Restricting children access especially for pipes >600 mm diameter.
- Mechanical cleansing is effective for pipes <600 mm diameter.
- Manual cleansing is possible for pipes >900 mm diameter.
- Pipe sizes 600-900 mm diameters are undesirable because of maintenance difficulties.

Where the open space function is not governed by spatial constraint and the catchment is >30 hectares, the opportunity to construct or enhance natural self sustaining drainage channel (as opposed to enclosed pipe drainage) must be maximised.

Where piped drainage is installed and wherever practical, grass swales must be constructed downstream from the pipe outlet to provide additional treatment to stormwater runoff. Because of inherent difficulties associated with the maintenance of grass swales, the visual impacts of any potential grass overgrowth can be minimised by placing the grass swales along the park and riparian vegetation interface. The location of discharge point at the riparian corridor must be selected to minimise disturbance and intrusion.

FIGURE B6.4.1
STORMWATER OUTLET CHECKLIST

	Assessment Steps	Applicable? Yes/No	Addressed? ✔/✗
1	Amenity – Public Usage Applicant must obtain preliminary acceptance of stormwater outlet facility in public space.		
1.1 &1.2	Consult Open Space Planner/Ecologist of the Development Assessment Team?	☐	☐
2	Amenity – Safety Applicant must consider safety when the stormwater facility is readily accessible and likelihood exists that a person may fall more than 1.0m and/or pipe diameter/culvert dimension >600 mm and/or the public space poses a potential flood hazard problem (ie Q_{50} flow depth >0.3 m or velocity depth product >0.6 m^2/s).		
2.1	Fencing	☐	☐
2.2	Vegetation Barrier	☐	☐
2.3	Channel Side Slope	☐	☐
2.4	Pipe Grate	☐	☐
2.5	Signage	☐	☐
3	Amenity – Aesthetics & Landscaping Applicant must consult with Open Space Planner/Ecologist/Landscape Architect or the Development Assessment Team for advice.		
3.1	Outlet Options	☐	☐
3.2	Visual Impact	☐	☐
3.3	Landscaping	☐	☐
4	Engineering – Hydraulic Considerations Applicant must consider all the relevant hydraulic parameters.		
4.1	Design Methodology	☐	☐
4.2	Channel Configuration	☐	☐
4.3	Piped Drainage	☐	☐
4.4	Subsurface Drainage	☐	☐
4.5	Surcharge Chambers	☐	☐
4.6	Detention Storage	☐	☐
4.7	Pipe Velocity	☐	☐
4.8	Outlet Velocity	☐	☐
4.9	Scour Protection	☐	☐
4.10	Tailwater Depth	☐	☐
4.11	Outlet Invert Level	☐	☐
4.12	Drop Outlet & Splash Point	☐	☐
4.13	Outlet Location	☐	☐
4.14	Outlet Angle	☐	☐

	Assessment Steps	Applicable? Yes/No	Addressed? ✔/✗
5	Engineering – Erosion Control Applicant must consider erosion control measures when ▪ average outlet velocity exceeds the permissible velocity and/or ▪ average outlet velocity > 2m/s and/or ▪ unprotected bank is within a distance of < 10 times the pipe diameter or culvert width/height from the stormwater outlet		
5.1	Outlet Scour Formation	☐	☐
5.2	Channel Erosion Control	☐	☐
5.3	Rock Protection	☐	☐
5.4	Energy Dissipation	☐	☐
5.5	Outlet Velocity Reduction	☐	☐
6	Environmental – Ecology Applicant must consider ecological values.		
6.1	Flora and Fauna	☐	☐
6.2	Outlet Velocity	☐	☐
6.3	Water Borne Pollutants	☐	☐
6.4	In Stream Habitat	☐	☐
7	Environmental – Water Quality		
7.1	Water quality is managed in accordance with Council's *Subdivision and Development Guidelines (Water Quality Management Guidelines).* Applicant must consider all the following issues.		
	▪ Water Quality Objectives	☐	☐
	▪ Site Based Stormwater Management Plans	☐	☐
	▪ Stormwater Quality Best Management Practices	☐	☐
	▪ Stormwater Quality Improvement Devices	☐	☐
	▪ Lakes, Ponds and Wetlands	☐	☐
	▪ Sewage Overflows	☐	☐
	▪ On-site Sewage Treatment and Effluent Reuse	☐	☐
	▪ Acid Sulfate Soils	☐	☐
	▪ Bin and Car Washing Areas	☐	☐
	▪ Discharges from Swimming Pools	☐	☐
	▪ Erosion and Sediment Control	☐	☐
	▪ Monitoring Requirements	☐	☐
	▪ Maintenance Plans	☐	☐
	▪ Hand-over of Responsibility for Water Quality-Related Assets	☐	☐

6.5 DETAILS OF UNDERGROUND PIPE DRAINAGE

6.5.1 Pipes

Jointing

Rubber ring joints must be used for pipes smaller than or equal to 600 mm diameter. Flush jointing can only be used for pipes larger than 600 mm diameter.

≥ 375 mm diameter

All Council owned drains must be 375 mm diameter or greater. Service and construction loadings must be calculated in accordance with *AS 3725 – Loads on Buried Concrete Pipes*. In many cases, construction loading will be the critical load case for selection of pipe class. Reference must be made to *AS 4058 – Precast Concrete Pipes (Pressure and Non-Pressure)* for testing requirements or where standard steel reinforced concrete pipes may be exposed to aggressive conditions.

Fibre reinforced pipes are acceptable to Council and are preferred in situations where the pipe may be subject to tidal waters. Use of pipe other than steel reinforced concrete or fibre reinforced concrete must be discussed with the Engineering Officer Development & Regulatory Services.

During the 1994/95 and 1997 audits carried out by Council on a number of subdivisions, the problem of premature cracking of concrete stormwater pipes was found to be widespread in pipes smaller than 900 mm diameter. The major cause was attributed to pipe overload by construction equipment rather than typical service loads for which the pipes were designed. To counteract premature pipe cracking, the Developer must comply with all the following Council requirements.

1. The design and selection of the pipe type and class must consider construction loading, which is usually the critical load case for pipes <900 mm diameter.

2. Drainage plans issued for construction must show, for each drainline, the following:
   - Pipe type and class.
   - Installation type.
   - Construction method (layer thickness, compaction plant).

   Design aids available from concrete pipe manufacturers may be used and are recommended. These include software for calculation of loads on pipes to *AS 3725*, tables and charts. It is recommended that charts showing the relationship between compaction equipment and pipe class are also included with the engineering drawings.

3. Shortly (no more than two weeks) before the On Maintenance inspection and prior to the formal acceptance of On Maintenance, the Developer must undertake closed circuit television camera (CCTV) inspection to demonstrate that the standard of the stormwater system is acceptable to Council. CCTV inspections can be arranged through the Local Asset Services, Brisbane City Council or through other suitably qualified service providers. Any defects identified by the inspection must be repaired or replaced or as directed by the Engineering Officer Development & Regulatory Services. A follow up camera survey is required to demonstrate that remediation measures are satisfactory to Council. The CCTV pipe survey must conform to Council's standard inspection and reporting protocols. All costs must be borne by the Developer. (Also refer Section 6.14 for more details).

4. Although the major causes of pipe cracking occur during the construction process, a 'no cracks' clause has been added to Council's specification for pipe supply to ensure pipes are free of defects prior to installation. The Developer must reject pipes that are cracked when delivered. Hairline or crazing cracks associated with concrete shrinkage are permitted.

< 375 mm diameter

Generally pipes within these diameters are used as roofwater drainage pipes. Fibre reinforced or UPVC (minimum sewer class SN6 must be used for inter-allotment roofwater drainage) pipes are to be used. Galvanised steel RHS are required from development sites across the footpath to the kerb and channel, if permitted.

6.5.2 Pipework Layout

Underground stormwater pipework layout should, in most cases, be the conventional herringbone layout.

6.5.3 Gully to Gully Drainlines/ Gully Manholes

In the gully to gully systems, pipes are connected between gully pits instead of manholes, with both the inlet and outlet pipes connected to the gully pit walls. (Note: The conventional gully pit has only the outlet pipe connection to the main trunk drainage line). Refer Figure B6.5.3.1.

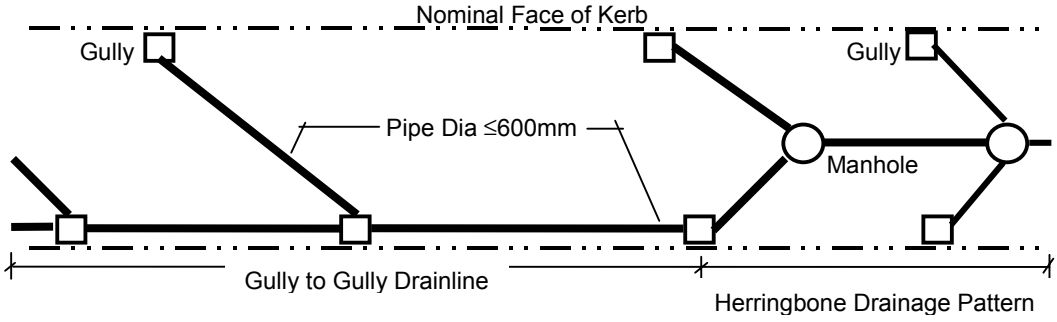

FIGURE B6.5.3.1
TYPICAL GULLY LAYOUT

Gully to gully drainlines are acceptable for pipes 600 mm diameter or less provided that the Developer complies with all the following Council requirements.

1. Gullies are consistent with Council's standard drawings.
2. Acute angles in connecting pipes are avoided to minimise head losses.
3. Potential interference with other utility services on the footpath is avoided.
4. The major drainage line (spine) of the gully to gully system is constructed on one side of the road only. Any gullies on the opposite side of the road must be connected directly across the road. Under no circumstances are spines of gully to gully systems permitted on both sides of the road.
5. The gully pit is appropriately benched.

Gully manholes in Brisbane City are generally not permitted without written approval. The stringent approval process ensures that Council's performance and maintenance objectives are met to maximise the serviceability of the asset, and to achieve sustainable level of ongoing maintenance and replacement program by using standardised components to the maximum practicable extent.

Gully manholes may be approved provided that the Developer demonstrates compliance with all the following Council requirements.

1. The inlet and manhole is at the same point eg at the sag of the road.
2. It is the only alternative to a multi-grated inlet eg in relief drainage works where utility services locations pose major constraints.
3. Written advice from the responsible utility authority is submitted, stating that the existing services will preclude the construction of the conventional herringbone drainage pattern.
4. Council's standard components such as lintels and grates must be used wherever possible. Hydraulic analysis and structural testing data must accompany any request for approval to use alternative components.

6.5.4 Manholes/Chambers

Manholes and chambers must be provided in accordance with Standard Drawing Nos. UMS 321 to UMS 328. Fixed ladder access in accordance with *AS 1657* must be installed to manholes/chambers >1.35 m deep. Step irons must be installed to manholes/chambers ≤3.0 m depth. Access ladder must be installed to manholes/chambers >3.0 m depth.

Unless approved otherwise by Council, the desirable minimum and maximum manhole depths must be limited to 1.2 m and 3.0 m respectively. The nominated maximum depth of 3.0 m is based on the upper physical limit of undertaking an inspection without entering the manhole, and any person entering the manhole must conform to safe working procedures for confined space. Other workplace health and safety provisions that may apply to deep manholes include intermediate landing and ladder cage.

The minimum distance between inlet pipes into a manhole or chamber must be 150 mm. Benching is required on the floor of the manhole (usually half the diameter of the outlet pipe) in order to properly direct the flow of water and prevent silt build up in the corners.

Precast manholes from an approved supplier may be used provided they are installed in accordance with the manufacturer's recommendations. The access hole diameter must conform to Council's standard. Chambers will require certification by a Registered Professional Engineer Queensland (RPEQ).

6.5.5 Inlets/Outlets

Inlets and outlets must be provided generally in accordance with Standard Drawing Nos. UMS 341 and UMS 342. Where safety is an issue precautionary measures should be incorporated. Pillar inlets will be required as temporary inlets at stage boundaries. Special consideration is necessary at inlets and outlets to ensure all measures are taken to produce structures that are safe, with low maintenance and fitting in with the amenity of the area.

6.5.6 Gullies/Field Inlets

Field inlets are usually constructed using standard gully grates or headwalls with a concrete apron surround. Where debris is expected, the Developer may consider a raised grated inlet with a lock down grate. The size of field inlets must be designed with an expected 50% blockage. Special consideration will be necessary in regard to safety, maintenance and amenity of the area.

Standard gullies must not be located on sharp horizontal curves (≤10 m kerb radius) and must be constructed in accordance with Standard Drawing Nos. UMS 331, UMS 332 and UMS 333. Special attention must be considered at the turnouts, to ensure the sag is at the gully and not the turnout. The depth to the pipe crown at the gully pit must be a minimum of 0.45 m, noting that this dimension is not the minimum cover required for construction and service loadings to the pipe. Unless approved otherwise by the Engineering Officer Development & Regulatory Services, the desirable maximum gully depth must be limited to 1.35 m to enable maintenance access.

Antiponding gullies in accordance with Standard Drawing Nos. UMS 334 and UMS 335 are only permitted in special circumstances at intersections when the road geometry does not allow the kerb and channel to drain to the standard gully at the tangent points. The inlet capacities of these gullies must be excluded from the calculations.

6.5.7 Soakage Pits

Most new areas of the city have stormwater connection points accessible to all lots but some older areas do not. In areas without connection points and if the allotment falls away from the street, the preferred method of roofwater disposal is via a drainage line through the downstream properties.

Council will only consider approving soakage pits or rubble pits for one or two storey single houses, if permission to install the roofwater line cannot be obtained from any of the downstream owners. It is the responsibility of the upstream property owner to obtain written advice of acceptance or rejection from adjoining downstream property owners.

The proposed stormwater disposal method must mitigate any potential impacts of worsening the existing conditions either by ponding, concentrating or increasing the flow onto adjoining properties. The acceptable solution may include soakage trenches or a combination of gravity feed pipe via a drowned outlet to the kerb and channel and/or rain water tank under the house. Whenever practicable, the soakage pit must be located at least 3 metres from any building or boundary, and to provide every opportunity for the stormwater flow to broad sheet across the lawn. The removal of stormwater by adsorption or infiltration into permeable soils must be designed to suit the topography and soil type.

6.5.8 Foulwater Lines

Foulwater lines used to drain both the greywater and roofwater from properties. When the sewerage reticulation network in Brisbane was constructed, the greywater was redirected to sewer but the roofwater remained connected to the foulwater lines. However new stormwater connection to foulwater lines is not permitted, nor is it acceptable to assume that these lines are redundant. Therefore the proposed development must not damage these lines and any proposed diversion must connect to the stormwater system.

6.6 DETAILS OF SURFACE DRAINAGE

6.6.1 Overland Flow Paths

Overland flow paths will need to be designed considering the following points:

- Depth by velocity product and maximum flow depth should not exceed the specified values in Section 6.1.3.
- The surfacing must prevent erosion.
- The ongoing functionality must not be affected.
- The amenity of the area must not be affected.

Overland flow paths are not permitted through private property and should be restricted to parks or road reserves or pathways. Overland flow paths within parks must be designed to ensure safety, useability for park purposes when dry, high visual quality, and ease of maintenance.

6.6.2 Table Drains

Table drains are generally only approved in the road reserve when a new half road is constructed and a table drain is required on the side with no kerb and channel. Table drains must be free draining and may need to be lined with concrete, stone pitching or fibre reinforced shotcrete to prevent erosion and minimise maintenance. Table drains must be separated from the carriageway by regular spaced delineator posts.

6.6.3 Swales/Interceptor Drains/Bunds

These drainage structures are used to protect downstream properties from upstream runoff and/or to improve water quality of runoff. Care needs to be taken that collected water is not directed in a concentrated form onto adjoining properties. The long term functionality of the device must be considered. In some cases, a reinforced concrete spoon drain and associated easements may be required.

6.6.4 Concrete Invert at Road Intersection

The use of concrete invert (generally along line of the through street) at any road intersection is not permitted. Instead the road geometry must be designed to accommodate an underground drainage system of gully pits/manholes and pipes as appropriate.

6.7 ROOF AND SURFACE WATER (SUBDIVISIONS)

6.7.1 General

Provision must be made within subdivisions for roofwater to be satisfactorily discharged. Whilst in most cases piping to the street or to an underground pipe system may be the best solution, the Consultant must nevertheless consider alternative ecologically sustainable solutions outlined in Section 6.2.2.

6.7.2 Residential Subdivisions

Lots falling to the street

In residential streets, an approved full height kerb adaptor must be provided in the kerb, 400 mm from the projected low side boundary for each lot. In collector roads or in streets where footpaths will be constructed, kerb adaptors as per above with a length of UPVC pipe (sewer class SN8) extended from the adaptor to beyond the concrete footpath is required as per Standard Drawing No. UMS 354.

Lots falling away from the street

All allotments that do not fall directly towards the road must be provided with a rear allotment roofwater drainage system. This system will also be required where allotments fall towards parkland. Roofwater drainage systems will be classified as private drains with the responsibility for future maintenance lying with the property owners. This system is detailed in Standard Drawing No. UMS 351.

Easements in favour of Council will be required over roofwater lines as shown in Table B6.7.2.1. An easement is required irrespective of pipe size when the roofwater line is designed for more than 3 allotments. Refer Section 6.11 – Easements. The pipes at each property may be sized in accordance with *QUDM* assuming 10 L/s for each 180 m^2 of roof.

TABLE B6.7.2.1 EASEMENTS OVER ROOFWATER LINES

No. Lots (nominal 180 m^2 roof area at each lot)	Minimum Pipe Diameter	Easement Width	Minimum Pipe Slope
1-3	150 mm	Not Required	1.0%
4-6	225 mm	1.5 m	0.5%
7-10	300 mm	1.5 m	0.5%

Roofwater Inspection Pits

Roofwater inspection pits must be in accordance with Standard Drawing No. UMS 352. Roofwater pits/rnanholes must be provided every 100 metres and/or at changes in pipe sizes and/or where direction changes more than 15 degrees and/or where the line terminates.

Connection Points

At least one connection point must be provided on the main line for each property. This connection must be in the form of Y-junctions or directly into an inspection manhole with the property branch line diameter being a minimum of 100 mm. Engineering drawings must have dimensions to show the exact location of the connection points.

Discharge Points

Generally, all rear of allotment (roofwater) drainage reticulation systems of this nature must discharge into the back of a suitably located stormwater gully or manhole in the street. Where the private roofwater reticulation system outlet is so isolated from a stormwater gully or manhole that connection is not reasonable, discharge may be allowed into the kerb and channel from an inspection manhole or inspection opening located 0.6 m maximum inside the property.

The maximum permissible discharge to the kerb and channel must be limited to 30 L/s (ie maximum 3 single house lots), and twin 100 mm diameter pipes (equivalent 150 mm diameter) with approved kerb adaptors must be used. Unless approved otherwise by the Engineering Officer Development & Regulatory Services, discharge into the high side kerb of a one-way crossfall street is generally not permitted. Consideration will only apply to single house roofwater drains.

Kerb Adaptors

Only approved full height kerb adaptors are permitted within Brisbane City. The kerb adaptors must be placed in a location where service pits on the footpath will not conflict with the future pipe location.

Where hot dipped galvanised RHS is used as an alternative to prefabricated kerb adaptors, the ends of the section protruding through the kerb must be cut flush with the face of the kerb and treated with an appropriate corrosion treatment. This configuration is compulsory for industrial and commercial developments.

The opening in the kerb must be sawcut and kerb adaptors must be installed flush with the top of the kerb. Kerb adaptors must be fixed in accordance with the manufacturer's specification and all gaps must be filled with approved materials.

6.7.3 Roof and Surface Water (Industrial/Commercial Subdivisions)

A drainage system must be designed to collect roofwater and runoff from paved areas within an allotment. Treatment of collected water prior to discharge to the street or drainage system will need to be incorporated. This drainline is a private system and is not maintained by Council. At least one suitably sized connection must be provided to each allotment within the subdivision. Refer Sections 6.3.2 and 6.3.3.

6.8 DESIGNED OPEN CHANNELS

6.8.1 General

Designed open channels must not only satisfy hydraulic requirements, but also to enhance the environmental and amenity aspects of the area. In addition to the design requirements set out in Section 8.06 of *QUDM*, the following requirements of Sections 6.8.2, 6.8.3 and 6.8.4 will also apply.