SC6.10 Flood planning scheme policy

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1 Introduction

1.1 Relationship to planning scheme

This planning scheme policy:
(a) provides information the Council may request for a development application;
(b) provides guidance or advice about satisfying an assessment criteria which identifies this planning scheme as providing that guidance or advice;
(c) states a standard for the following assessment criteria identified in the following table:

<table>
<thead>
<tr>
<th>Column 1 — Section or table in the code</th>
<th>Column 2 — Assessment criteria reference</th>
<th>Column 3 — Planning scheme policy provisions</th>
</tr>
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<tr>
<td>Table 8.2.11.3.A</td>
<td>AO4</td>
<td>All</td>
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<td>Table 8.2.11.3.A</td>
<td>PO6</td>
<td>All</td>
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<td>Table 8.2.11.3.C</td>
<td>Table note</td>
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<td>Table 9.4.9.3</td>
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1.2 Purpose

(1) Development on land affected by flooding is to be assessed against the risk, hazard and adverse consequences caused by flooding.

(2) This planning scheme policy provides information, processes, advice and specific design criteria which supports the outcomes required by the Flood overlay code, the Coastal hazard overlay code and the Critical infrastructure and movement network overlay code.

(3) Management of flooding for flood events larger than the flood hazard overlay is undertaken through the Council and State Government's emergency management framework

1.3 Terminology

In this planning scheme policy, unless the context or subject matter otherwise indicates or requires, a term has the following meaning:

**Infill reconfiguring a lot**: refers to a residential reconfiguring a lot where there is no dedication and opening of a road and the reconfiguring a lot creates 6 lots or less. Infill reconfiguring a lot typically occurs in a site with existing road frontage and either is fully or partly surrounded by developed sites.
0.2% AEP flood event: an event approximated by a 13500m³/s flow in the Brisbane River, or a 500 year Average Recurrence Interval (ARI) event in creek/waterway areas.

2 Floodplain risk management

(1) The flood management strategy used by the Council is based on the principles of flood plain risk management to ensure that development on a floodplain occurs having regard to:
   (a) the compatibility of the development type with the flood hazard to minimise the risk to people's safety or structural damage to buildings;
   (b) the social, economic and environmental costs and benefits of developing within a floodplain when balanced against the flood risks.

(2) While development controls may apply to land affected by the defined flood events which is typically, but not always a 1% AEP flood event, significantly larger floods can occur up to a probable maximum flood (PMF). Some types of development that are more susceptible to flooding will need to consider, mitigate or design to floods larger than the 1% AEP.

2.1 Sources of flooding in Brisbane

The five types of flooding that may affect premises in Brisbane are:
   (a) River flooding - This occurs when there is widespread prolonged rain over significant parts of the catchment of the Brisbane River. The extent of flooding may be significantly influenced from Somerset and Wivenhoe Dams depending on where the rain is being generated. However, it is possible for flooding from the Bremer River to also significantly cause flooding in the Brisbane River as its confluence with the Brisbane River is downstream of those dams.
   (b) Creek/waterway flooding - Including those indicated on the planning scheme maps. This is defined as any element of a river, creek, stream, gully or drainage channel, including the bed and banks typically with a catchment area greater than 30 hectares. Waterway flooding occurs when the bank-full capacity of the channel is exceeded. On average Brisbane's natural creeks have a 50-100% chance of exceeding their bank-full capacities in any one year.
   (c) Overland flow flooding – These are shallow gullies or drainage depressions that receive sheet flow runoff during storm events. However, in urban areas this may also occur when components of the stormwater drainage system such as pipes and gully inlets are blocked or design capacity is exceeded.
   (d) Storm tide flooding - The effect on coastal water levels of a storm surge combining with the normally occurring astronomical tide. Storm surge is a rise above normal water level due to the combined effects of surface wind stress and atmospheric pressure fluctuations caused by severe weather conditions such as tropical cyclones.
   (e) Tidal inundation – This is the regular and periodic inundation of estuarine areas typically characterised by land located below the highest astronomical tide level (HAT).

3 Flood hazard

3.1 Flood hazard components

(1) Flood hazard is a measure of safety which is applied to people, vehicles and structures during a flood.

(2) The derivation of flood hazard is based on the determination of hydraulic hazard with the main determinant being related to the momentum of the flow and flood depth.
The degree of hazard is related to the severity of the hydraulic hazard (depth and velocity) but may be influenced by warning time, emergency management and population density.

Hazard characteristics vary within the Brisbane River, waterways/creeks and overland flow paths. As a result, the description of flood hazard and hazard management solutions are also varied.

### 3.2 Flood velocity

1. The velocity of floodwater greatly influences the ability of people to safely wade or evacuate an area, both on foot or by vehicle. It may also limit the ability for emergency services to respond to people at risk. Velocity also has significant impact on the structural integrity of buildings and the resulting damage that may occur, both from the forces of the floodwater itself or from debris impacts on such structures.

2. Within the lower to mid parts of the Brisbane River, flood depth is a greater consideration than flood velocity within many existing developed areas. With the exception of within the River banks, many existing developed areas are subject to very low velocity backwaters. In addition, warning time means that people are less likely to be within higher velocity areas as they flood, or can easily move from those areas before velocity becomes a significant factor.

3. Creeks/waterways and overland flow paths are areas where higher flow velocity is expected. Areas that would typically flood more frequently, such as the 10% AEP flood, are generally at the highest risk of exhibiting unsafe velocity because they represent the floodway of creeks conveying a large proportion of total flood flows. Shallower areas that are not regularly flooded are identified as flood fringe areas.

### 3.3 Flood depth

The depth of floodwater has a direct relationship with people’s safety, accessibility by vehicles and resulting flood damage to building contents. As evident in the January 2011 floods within Brisbane, most areas with the greatest flood damage were affected by the greatest flood depths.

### 3.4 Flood warning time

1. Flood hazard can be reduced by evacuation if adequate warning time is available. Available warning time is determined largely by catchment characteristics with larger and flatter catchments typically exhibiting a slower rate of rise of floodwaters, and therefore a longer available flood warning time. By comparison, in small or steep catchments there is often no available warning time as the rate of rise of floodwaters can be rapid.

2. The key factors in evaluating safe evacuation time include:
   (a) the time required to mobilise SES resources and communicate flood and evacuation warnings to affected areas;
   (b) the preparation time prior to self-evacuation;
   (c) the time available until evacuation routes are cut-off;
   (d) the travel time which depends on the distance to be travelled to a safe area above the defined flood area flood level and the characteristics of the evacuation route.

3. When considering these factors in most instances a minimum of 10 hours or more warning would be required to effectively implement an evacuation. However, for creek/waterway or overland flow flooding there may be at most 2 hours warning time from the issue of a Bureau of Meteorology extreme weather warning, and possibly only minutes available for evacuation from when a major flood event occurs. Therefore, the only flooding sources that are considered to have suitable flood warning time include:
   (a) Brisbane River flooding excluding the Upper Brisbane River sections. The assumed times in these sections are based on approximate flood peak travel times. It is
noted that the time for flood waters to rise is variable within the Brisbane River, with flood peaks at Moggill, for instance, occurring approximately 10 hours before the city centre. Council has a flood forecasting model that utilises Council’s network of real time rainfall and flood level monitoring systems and a flood modelling program, together with the Council’s geographical information system to provide a flood warning and information service to the community;

(b) Storm tide flooding from tropical cyclones and severe low pressure systems are able to be predicted or tracked and advanced warnings provided by the Bureau of Meteorology.

(4) All other flooding sources are not suitable for applying warning time as a consideration to mitigating flood hazard. This is because the time of concentration, critical storm duration and rise of floodwaters, often from minutes to less than a few hours, is too short to allow for adequate warning time. In addition, there is no ability to predict with any certainty how severe a flood would be in small catchments. Therefore, these creeks may already be significantly flooded before an evacuation is clearly required.

3.5 Upper Brisbane River sections

(1) The upper sections of the Brisbane River within Brisbane’s local government area, where the RFL is greater than 12.8m AHD, has been identified as having unique flooding characteristics when compared to the lower sections of the Brisbane River floodplain which particularly relate to its proximity closer to Wivenhoe Dam and the narrower topography of the floodplain within this area. This results in the following:

(a) reduced warning time, which is insufficient for adequate flood evacuation planning;

(b) significant increases in flood level with only minor exceedance of the flow rate used to set the flood planning levels;

(c) higher in-river flow velocity;

(d) isolation of some areas during a flood.

(2) The Flood overlay code requires consideration of the 0.2%AEP flood event, which can be approximated by a peak flow of 13,500m$^3$/s at the Brisbane City gauge.

(3) The 0.2% AEP flood has been chosen because it represents the following:

(a) an extreme flood event above the defined flood event that aids in identifying whether rapid changes to the flood hazard occur from moderate increases in flows, but less onerous than the 0.05% AEP flood or PMF;

(b) a current standard used for regulating some essential community infrastructure such as hospital flood immunity;

(c) approximately a 20% chance of being exceeded in a 100 year period or design life.

(4) Therefore, the 0.2% AEP represents a flood event which has a significant probability of occurrence over the lifetime of a land use, particularly for reconfiguring a lot.

Note—A flood event with an AEP of 0.05% is the equivalent of a 2000 year ARI flood event.

4 Flood overlay code flood planning areas

4.1 Flood planning areas

(1) Land identified in the Flood overlay map is included in flood planning area sub-categories as shown in Table 1.

Table 1—Flood planning area sub-categories

<table>
<thead>
<tr>
<th>Flood planning area 1 sub-category</th>
<th>Brisbane River flooding</th>
<th>Creek/waterway flooding</th>
<th>Overland flow flooding</th>
</tr>
</thead>
<tbody>
<tr>
<td>Within the 10% AEP Brisbane River flood extent; AND Depth by Velocity product $&gt;1.2m^3/s$ in RFL</td>
<td>Within the 10% AEP flood extent; AND Depth by Velocity product $&gt;1.2m^3/s$ in 1% AEP flood</td>
<td>Not applicable</td>
<td></td>
</tr>
</tbody>
</table>
Flood planning area 2 sub-category

<table>
<thead>
<tr>
<th>&gt;1.2m deep OR VD&gt;1.2m²/s in RFL</th>
<th>FPA2A sub-category &gt;2m deep in RFL</th>
<th>Deeper than 1.2m in 1% AEP flood; OR VD&gt;1.2 m²/s in 1% AEP flood</th>
<th>Not applicable</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>FPA2B sub-category 1.2m to 2m deep in RFL</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Flood planning area 3 sub-category

<table>
<thead>
<tr>
<th>0.6 m – 1.2 m deep in RFL; OR 0.6 m²/s&lt;VD &lt;1.2 m²/s in RFL</th>
<th>0.6m – 1.2 metres deep in 1% AEP flood; OR 0.6m²/s&lt;VD &lt;1.2m²/s in 1% AEP flood</th>
<th>Not applicable</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Not applicable</strong></td>
<td></td>
<td></td>
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</tbody>
</table>

Flood planning area 4 sub-category

<table>
<thead>
<tr>
<th>0 to 0.6m deep in RFL; OR VD of &lt; 0.6 m²/s in RFL</th>
<th>0 to 0.6 m deep in 1% AEP flood; OR VD&lt;0.6 m²/s in 1% AEP flood</th>
<th>Not applicable</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Not applicable</strong></td>
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Flood planning area 5 sub-category

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<tr>
<th>From the RFL extent to the 0.2% AEP flood extent</th>
<th>1% AEP flood extent to the 0.2% AEP flood extent</th>
<th>Not applicable</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Not applicable</strong></td>
<td></td>
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</tbody>
</table>

Overland flow flood planning area sub-category

<table>
<thead>
<tr>
<th>Not applicable</th>
<th>Not applicable</th>
<th>Indicative 2% AEP overland flow for local catchments</th>
</tr>
</thead>
</table>

(2) The flood planning area that makes up each category is based on Figure a.

(3) Flood overlay mapping will be amended periodically if required, as new flood studies become available.

![Figure a—Flood hazard hydraulic categories](image)
4.2 Overland flow

(1) Flooding from overland flow sources is substantially different from other flooding types in that it is often associated with flash flooding and has a very high degree of uncertainty with respect to the terrain. Such flow paths may contain obstructions, many of which can be modified over time with no planning approvals such as fences, paving, landscaping. Therefore determining flood hazard often requires a detailed hydraulic assessment of the hydraulic controls and roughness parameters through the study area. In all cases the determination of flood hazard should be based on design Manning’s roughness values, not those used to set flood immunity which often assumes rougher conditions.

(2) The interpretation of flood hazard severity for overland flow flooding is to have consideration of national standards such as Australian Rainfall and Runoff and the Queensland Urban Drainage Manual (QUDM).

(3) At a minimum the hydraulic classification for high hazard flood conditions for overland flow flooding is defined as the following:
   (a) >0.4m²/s for publically accessible areas, pathways, driveways, parking or private open space;
   (b) >0.6m²/s for public roads, drains and flow paths through private property or communal open space areas;
   (c) >600mm flood depth at any velocity.

(4) If any use predominantly involves small children such as a child care centre or educational establishment and those areas are readily accessible to children, a VxD product of >0.2m²/s would be applicable as high hazard flooding.

5 Reconfiguring a lot

5.1 Flood planning levels

(1) The flood immunity standards are intended to create an appropriate level of safety and risk to people and property, eliminate the creation of new lots below the desired flood immunity level and provide unburdened building areas for new buildings.

5.2 Flood hazard management

(1) Flood hazard management seeks to:
   (a) ensure that new lots have an appropriate level of flood hazard, including freedom from existing overland flow paths or similar high hazard flooding for a useable portion of the lot;
   (b) ensure that area of high hazard or greater are not intensified for residential development;
   (c) minimise filling associated with reconfiguring a lot in an area that would be likely to create a flood impact;
   (d) reduce the aesthetic issues associated with level changes for infill reconfiguration of a lot, particularly in land affected by Brisbane River Flooding.

(2) Where filling is undertaken to enable reconfiguring a lot in areas affected by flood hazard, it should be recognised that filling mitigates the hazard for the particular design flood event, but does not remove the flood hazard. Therefore, regard must be given to the impacts of flood events greater than the design event on the development, with specific care to:
   (a) reduce the potential for filling to create islands surrounded by high hazard conditions that could be cut-off early in a flood;
   (b) ensure that new residential subdivisions are not created in an area which would increase hazard to people and property in larger events, such as by enabling filling
in an area which would become a floodway in a larger event or isolated by high hazard flooding as an island.

(3) Figures b and c depict desired reconfiguring of a lot outcomes.

(4) In Figure b, filling is located on a low hazard area on the fringe of the floodplain. As a result, during a defined flood event:
   (a) development is located clear of high hazard flooding;
   (b) lots have good proximity to higher ground;
   (c) development is not isolated.

(5) Figure c depicts the same development in a flood event larger than the defined flood event, such as the 0.2% AEP flood. In this event:
   (a) some flood damages are likely as the flood is greater than the defined flood event;
   (b) development is only affected by low flood hazard conditions;
   (c) high hazard areas are restricted within the waterway.

Note—A flood event with an AEP of 0.2% is the equivalent of a 500 year ARI flood event.

(6) Figure d depicts an unacceptable hazardous reconfiguring a lot outcome. It shows the impacts of larger flood, such as the 0.2% AEP flood. In this event:
   (a) development located in the floodway at the defined flood event subjects residents to much higher hazard conditions in larger floods;
   (b) development is isolated and potentially cut-off early in a flood event, hindering evacuation;
   (c) the development has poor proximity to higher ground for evacuation.

Note—A flood event with an AEP of 0.2% is the equivalent of a 500 year ARI flood event.
5.3 Reconfiguring the boundaries of an existing lot

(1) Where infill configuration occurs that reconfigures the boundaries of a lot without creating additional lots, such as 2 into 2 lots, care is to be taken to manage the flood hazard. An example of a poor reconfiguring a lot would be where the flood free access to the existing lots was reduced, or where the proportion of high hazard area impacting a lot was being increased through the development proposal.

(2) Figure e depicts an acceptable outcome for an existing area with two narrow lots on land sloping away from the road towards the rear of the lot. In this instance:
   (d) flood hazard becomes worse towards the rear of the site, providing no opportunity to locate buildings in a flood free or low hazard area;
   (e) both lots have flood free access to the road;
   (f) there is opportunity to locate buildings in a flood free and low hazard area, with possible suspended structure into the higher hazard areas.

(3) Figure f shows an unacceptable design for reconfiguration of boundaries for the same lots. In this instance:
(a) the new boundaries significantly increase flood hazard on the lower lot to the rear, providing no opportunity to locate buildings in a flood free or low hazard area;
(b) loss of flood free access to the road for one lot;
(c) driveway subject to high hazard flooding;
(d) significant development constraint to locate buildings in flood free and low hazard areas;
(e) any building works or filling are much more likely to result in flood impacts.

Figure c—Example of an existing reconfiguration

Figure f—Example of an unacceptable reconfiguration of boundaries
5.4 Egress and evacuation

5.4.1 Retaining walls and batters

(1) If an overland flow path or area affected by creek/waterway flooding is modified through earthworks, those works are to ensure that the modifications do not impact on flood behaviour and still allow for people to move safely from the area affected by the flooding.

(2) Issues requiring consideration include the following:
   (a) If batters are proposed, typical maximum grades that will facilitate safe egress for people (including children) are 1V:6H;
   (b) Breaks are provided in retaining walls along the length of the flood hazard area to provide safe egress points between the development and flood hazard areas.

5.4.2 Road design considerations for evacuation

If a road is required to act as an evacuation route from a flood or coastal hazard area, the road is designed to:
   (a) provide a rising escape route from the development that will not be cut-off by a smaller AEP flood event;
   (b) have a minimum road level higher than the surrounding lot levels to ensure that it is the last part of the development flooded; which in most cases will require a road at the 1% AEP flood + 500mm where acting as a flood evacuation route.

Note—A flood event with an AEP of 1% is the equivalent of a 100 year ARI flood event.

6 Road trafficability

6.1 New roads

The pavement level of a new dedicated or internal road within a reconfiguration of a lot (freehold lots or community title scheme) is to be sufficient to ensure the safety of people and vehicles during a flood by complying with the minimum flood immunity levels specified in the Flood overlay code.

6.2 Serviceability of existing road network external to the development during floods

If reconfiguring a lot (excluding infill reconfiguring a lot):

(1) The level of serviceability to be provided to traffic at a waterway crossing depends upon the AEP of the flood for which the creek crossing is to be passable to traffic and the duration of the road closure during times of flooding. Trafficability will depend upon the combination of the depth and velocity of flow over a floodway (flood hazard), when the frictional resistance between a vehicle’s tyres and the floodway surface is overcome and the vehicle loses stability.

(2) Trafficable access to the site from at least one suburban road (or higher category road network) is required to maintain emergency services having regard to the number of affected properties and the proposed use of the development with the following trafficability criteria for the road network between the site and the closest district or neighbourhood centre:
   (a) The time of closure for the 2% AEP flood event from all the nominated flooding sources with the exception of Brisbane River, is not to exceed 6 hours;
   (b) The average annual time of closure from all the nominated flooding sources, with the exception of Brisbane River, is not to exceed 2 hours.
6.3 Calculation of time of road closure

(1) Road closure is assumed when the total head (static plus velocity) on a carriageway with a two-way crossfall or across the highest edge of a carriageway with a one-way crossfall exceeds 300mm. For detailed procedures or explanations of terminologies, refer to the publication Waterway Design—A Guideline to the Hydraulic Design of Bridges, Culverts and Floodways (Austroads, 1994).

(2) The time of closure is calculated by drawing a horizontal line on a stage hydrograph or flow hydrograph at the trafficable level (flow or stage) and measuring the time for which the flooding is above this trafficable level.

(3) The time of closure for each AEP event is not necessarily the design hydrograph (refer to ) which produces the highest peak flood level, but rather the critical duration envelope is usually derived from a series different duration flood hydrographs. For example, for a given trafficable capacity, the 24 hour storm may generate the longest time of closure at the crossing rather than the 6 hour critical duration storm that produces the highest peak flood level at the crossing.

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7 Building design

(1) Development is not to create a substantial blockage (such as by filling or erection of a building and retaining wall of an overland flow path) that is to be offset by the provision of an underground drainage system such as pipes to convey major overland flows for the following reasons:
(a) "open" overland flowpaths provide significant conveyance for floods larger than the design storm (up to PMF) which a piped system cannot replicate;
(b) additional maintenance costs are incurred by the Council such as whole of life costs;
(c) the loss of flood storage and potential cumulative impacts;
(d) the potential adverse flooding impacts in extreme storms;
(e) safety hazards at inlets and outlets;
(f) debris blockage (full or partial blockage).

(2) Development is to provide an easement for an overland flow path or creek/waterway within private premises.

7.1 Building undercrofts

(1) A building suspended to allow floodwaters to pass underneath can be subject to a higher flood risk than that of development adjacent to a floodway. Unlike open flow paths (overland flow paths and creek/waterways) that may have the ability to convey a significant proportion of floodwaters up to the PMF, building over a floodway can significantly constrict the ability of that area to convey floodwaters in any design flood event and for extreme floods.

(2) If a building or structure is located within a floodway or overland flowpath, debris carried by the floodwaters could cause an obstruction or blockage to flood flow. These blockages can significantly increase flood levels and cause significant damage to structures or impact flood levels on other premises.

(3) Buildings or structures suspended partially over an overland flow path (or other flood affected area) are to have sufficient clearance between the building structure and ground to convey floodwaters, minimise debris blockages and reduce the risk of structural failure. Sufficient clearance is also required for appropriate and safe maintenance of the undercroft area.

(4) Figures h, i, j, k and l support the undercroft design concepts in this section of the planning scheme policy.
7.2 Undercroft minimum clearances

(1) Building undercroft minimum height criteria in Table 8.2.11.3.E of the Flood overlay code has been determined with the following considerations for low hazard overland flow flood conditions only:

(a) An allowance of 500mm for building structural requirements such as slab, supporting beams and suspended services.

(b) Provision of at least 400mm hydraulic clearance above the 2% AEP flood level to ensure the building structural components such as slabs and beams are located below the energy grade line (velocity head) and allow for debris and partial blockages of the undercroft and some uncertainty in ground level treatments such as irregular riprap and corresponding impacts on flood levels.

(c) An allowance for the design flood depth component.

(d) Provide a total clear height of 1m to allow safe access for maintenance and inspections.

(2) If a site is affected by creek/waterway flooding or if high hazard (or greater) flood conditions exist, the minimum flood depth component and hydraulic clearance is increased due to the greater depth of flooding and higher possibility of debris impacts/blockages.

(3) If it is proposed to reduce the minimum undercroft clearance below those stated in the Table 8.2.11.3.E of the Flood overlay code as a performance outcome, a flood study is required. The study is to demonstrate that the building undercroft is sufficient to provide the greater of 500mm of debris clearance above the 1% AEP flood velocity head level and that an extreme flood event such as the PMF can be conveyed under the structure.

(4) Despite (3), the minimum undercroft from the finished slab level to ground level is to be 1500mm.

(5) The design of an undercroft area is not to increase the flood hazard.

Note—A flood event with an AEP of 1% is the equivalent of a 100 year ARI flood event.
7.3 Building undercroft design and ground treatment

(1) If a building is suspended partially or fully over an overland flow path or an area affected by waterway flooding, the undercroft area is to be suitably stabilised and designed to drain freely. This may be accomplished by providing a concrete slab, gabion or rock riprap surface treatment.

(2) Rock selection is to be based on the velocity or shear stress estimated through the site for design Manning conditions. A minimum d50 rock size of no less than 200mm is to be used.

7.4 Examples of suitable building undercroft designs

(1) Figures i, j, k and l provide acceptable examples of ground treatments if a building is suspended over an area affected by creek/waterway flooding or overland flow flooding.
Note—

- Undercroft height >1.5m at low point from ground level to FFL (or 2m where flow depth >600mm);
- At least 50% of undercroft area meeting 1.5m height requirement;
- Minimum lateral grade of excavated areas of 2% to provide efficient drainage;
- Reduction in height allowable on the fringe of the flow path due to maintaining the existing section profile or grade requirement on base of undercroft area;
- Base to resist scour - be concreted or rock armoured (i.e. no bare earth);
- No significant increase in flood hazard under structure and a depth velocity product of no greater than 0.6m²/s (0.4m²/s applies to high risk areas where there is an obvious likelihood of injury or loss of life).
Note—

- Undercroft height >1.5m at low point from ground level to FFL (or 2m where flow depth >600mm);
- Where excavation is used to obtain the necessary longitudinal clearance a slab cannot be built to boundary and must be setback a minimum of 1m (or as required by the hydraulic analysis) so that any part of the flow transition will not be impeded;
- Where excavated, a desirable longitudinal grade of 1% to facilitate drainage;
- Base to resist scour - be concreted or rock armoured (i.e. no bare earth).

### 7.5 Examples of unacceptable building undercroft design

Figure 1—Undercroft cross section - Significant excavation lower than existing low-point

1. Significant excavation under a structure to achieve the undercroft requirements is not an acceptable outcome as this design:
   (a) shifts the conveyance of floodwaters from primarily outside of the undercroft area to directly under structures by creating a new low-point and channel;
   (b) creates adverse flooding impacts by concentration of flows (and potentially increased hazard) on down-slope premises;
   (c) concentrates flow and increases the likelihood of debris loadings on building structures;
(d) may cause high hazard flood conditions under the structure where none may have existed before; as there are no building standard for structures in high hazard flood areas;
(e) is difficult to match to existing levels at the down-slope boundary;
(f) creates potential obstruction and insufficient clearance for flows travelling laterally across the flow path;
(g) results in maintenance access difficulties and occupational health and safety non-compliance.

8 Built form for flood resilience

Editor’s note—The Australian Building Codes Board has released a draft Construction of Buildings in Flood Hazard Areas which sets out advice for buildings in flood planning areas.

Editor’s note—A list of water resistant materials, is provided in the Growth Management Queensland Factsheet January 2011 – Repairing your House After a Flood (Table 1 – Higher water resistance).

9 Flood risk management

9.1 Flood risk assessment

(1) The Flood overlay code and Table 8.2.11.3.C in the Flood overlay code sets out occasions where a flood risk assessment may be needed to determine the suitability of a land use to the flood hazard or in setting flood immunity levels for specific development types.

(2) A flood risk assessment is only required if:
   (a) a land use is nominated as requiring a risk assessment to ensure its suitability to the flood hazard; or
   (b) a select group of building types nominated in Table 8.2.11.3.D of the Flood overlay code proposed in a site located in an established area that does not meet the prescribed flood immunity standard for the Brisbane River; or
   (c) addressing the performance outcome of the Flood overlay code where the land use is not compatible with the acceptable outcomes of that code.

9.2 Scope of application

(1) The flood risk assessment is a formal means of identifying and managing the existing, future and residual risks of flooding.

(2) A suitably qualified professional consultant is to be engaged to undertake the flood risk assessment in accordance with the framework outlined in AS4360 Risk Management.

(3) The aim is to ensure that risks, including safety, environmental, social and economic associated with the proposed use are compatible with the flood hazard and level of flood immunity. For example a warehouse for the purpose of storing concrete pipes will incur less flood damage losses when compared to a warehouse used to store electrical appliances. The storage of hazardous chemicals may not be an appropriate use given environmental impacts if flooded, even though the economic damages and safety risk maybe low or moderate.

9.3 Risk assessment process

(1) There are instances where the exact use of a development is not known, such as centre activities and industrial activities, and instances where the use is known, such as the lobby of an apartment block. The risk management formulation should cover a range of proposed and likely future uses.
The flood risk management process is to include the following key elements:

(a) Identification of the stakeholders exposed to or affected by the risk of flooding and their compatibility to the risk. For example, residential and special care uses are typically less tolerant to flood risk than industry;

(b) Identification of public and private premises, social systems and environmental elements at risk of flooding;

(c) Identification of all critical electrical services, hazardous storages and other high risk elements;

(d) Estimation of flood risks; that is, the likelihood and consequences of flooding. This evaluation will involve the undertaking of a quantitative analysis that uses numerical values, rather than the descriptive scales used in qualitative and semi-quantitative analysis for both consequences and likelihood. The quality of the analysis depends on the accuracy and completeness of the numerical values used;

(e) Consideration should be given to not only building and contents damages from flooding, but the flood compatible nature of any activities being conducted on the premises and the economic impacts of downtime during flood recovery on business and employees economic resilience during a flood;

(f) Assessment of the acceptability of flood risk. This evaluation is to involve the determination of the total flood damage (potential) for a range of annual exceedance probabilities (0.2%, 1%, 2%, 5%, 10%, 20%, 50% AEP’s), and the average annual damage. Flood damages are generally divided into two categories of tangible and intangible damages:

(i) Tangible damages are financial and can be measured in monetary terms. Tangible damages include the cost of repairing items damaged by floodwaters or the loss in value caused by floodwaters wetting goods and possessions (direct damages), together with the loss of wages and extra outlays incurred during clean-up and in post-flood recovery (indirect damages);

(ii) Intangible damages are usually difficult to estimate in financial terms. Intangible damages include the increased levels of physical and psychological illness and emotional distress caused by the flood. A flood is a traumatic experience for many. The owner (and future owners) must assume all responsibility and all liability for all losses, damages and costs that might be incurred as a result of the reduced flood immunity standards.

(g) Definition of flood risk management strategies is to include:

(i) The proposed method of perpetuating the restricted use and required mitigation measures through appropriate forms of legal documentation, notation on titles, rate notices and methods for conveying the risk management data to future owners and leaseholders;

(ii) The procedure to conduct emergency evacuation and rescue operations including flood emergency management plans.

Development which proposes a lowering of flood immunity standards through a risk assessment (usually an industrial use), is to ensure the building materials are constructed of flood compatible materials.

9.4 Issues requiring consideration

A flood risk assessment is to address the following issues:

(a) Number of people likely to be evacuated;

(b) Hazard in larger floods – the flood risk does not stop at the defined flood event so the suitability of a land use must consider the implications of larger floods;

(c) Flood warning time – within Brisbane the only applicable flooding sources that may have a warning time are the Brisbane River and storm tide flooding;

(d) Evacuation routes – identify applicable routes, if relied upon, and flood immunity of those routes, and an assessment of the safety of people moving to those routes;

(e) Isolation – potential to have evacuation route cut-off early in the flood;

(f) Vertical evacuation – while an important element it cannot be totally relied upon and will require an estimation of extreme floods such as the PMF;
(g) Identify special care uses – the publication Evacuation Planning by Emergency Management Australia (Commonwealth Government 2005) provides a list of special needs groups;
(h) Burden placed on emergency services – while important to allow safe access for emergency services, they cannot be relied upon as a solution to egress difficulties and evacuation;
(i) Special care requirements at evacuation destination – uses focussed on vulnerable people such as children or elderly and their special requirements for care and the ability of evacuation centres to provide that care;
(j) Length of flood recovery and social and economic impacts;
(k) Hazardous goods, mitigation and associated environmental impacts.
(l) Flood resilient design.

9.5 Flood emergency management plans
(1) A flood emergency management plan is one of the tools used to mitigate the residual risk from flooding.
(2) It could form part of a flood risk assessment, but where relied upon for development it is to compromise a stand-alone document.

9.6 Scope of application
• Specific land uses or development conditions may require a flood emergency management plan. These are typically land uses that have higher risks from flooding due to the type of use, often involving elderly, children or people with special care or supervision requirements.

(1) The scope of the flood emergency management plan is to include:
   (a) nature and typical size, characteristics and built form of the development,
   (b) asset or use life.
   (c) population characteristics associated with the use such as vulnerable populations, ease of evacuation, number of people.
   (d) scale of investment in the development.
   (e) potential for adverse environmental, social and economic effects from flooding of land uses.
   (f) discretionary visitation—can people easily choose not to go there.

9.7 Issues requiring consideration and information requirements
Where a flood emergency management plan is required, it is to include:
   (a) a plan of development and site showing evacuation routes and assembly areas (where relevant);
   (b) a description of the triggers to activate evacuation plans for flooding;
   (c) a description of relevant signage and proposed locations in the building;
   (d) a list of any procedures required to manage evacuation;
   (e) contact numbers of relevant local emergency services.

10 Requirements for a flood study

10.1 General
Many waterways have flood level information from flood studies, which are shown within the Floodwise Property Report. Use of that information for assigning flood planning levels is acceptable when a development is not modifying the floodplain. This information may not be suitable for larger developments if the impacts of development are being assessed.
10.2 Preparation of a flood study

(1) A flood study involves hydrological and/or hydraulic assessments where required to estimate catchment flows, flood levels, or demonstrate that the development or any flood mitigation work would not adversely impact on flooding to upstream, downstream or adjacent premises.

(2) A flood study is to be supervised and certified by a Registered Professional Engineer Queensland with demonstrated expertise in hydrology, hydraulic modelling and stormwater engineering. The flood study is to include where applicable:
   (a) site survey plan showing location of buildings and underground stormwater infrastructure (line and level);
   (b) a catchment plan detailing internal and external drainage catchments and their respective areas;
   (c) the location and details of drainage easements associated with underground drainage, open channel drainage or overland flow paths;
   (d) a scaled drawing showing the hydraulic model layout (cross sections) or digital elevation model (DEM) over a cadastral background, also noting details of relevant structures (hydraulic controls);
   (e) scaled drawings showing a comparison of existing and proposed flood inundation extents;
   (f) flood afflux and Manning’s roughness maps, when using 2D modelling techniques;
   (g) detailed plans for any proposed waterway structures;
   (h) detailed earthworks plans for any channel works or flow path modifications proposed by the development;
   (i) location of waterway corridors and relevant flood hazard areas;
   (j) cross sections of existing or proposed basins, embankments, spillways and any other structures that may act as hydraulic controls.

10.3 Choice of hydraulic model

(1) Hydraulic conveyance is a measure of the flow carrying capacity of a watercourse and is a function of the geometry and surface impedance of that watercourse. The loss of conveyance from obstruction or filling is usually characterised by increases in flood levels upstream.

(2) Mathematical models are used to assess the impacts on flood flow conveyance when adverse impacts are being assessed such as the HEC-RAS steady/unsteady state hydraulic model or MIKE-11 hydrodynamic model.

(3) As floodwaters flowing in a watercourse rises during a flood event and overtops the banks, a portion of floodwaters are transferred into storage areas of the floodplain where the flow velocities are small in comparison with the main channel. The loss of critical flood storage from obstruction or filling is usually characterised by increases in flow velocities and flood levels downstream. Mathematical models that are appropriate to assess the impacts of flood storage are to be fully dynamic 1D/2D hydraulic models such as MIKE-11, Mike-21, SOBEK, TUFLOW.

(4) A 2D modelling technique is used where flow paths cannot be adequately represented using 1D modelling techniques, which is often the case with overland flow flooding or where demonstrating the impacts of development that may impact on flood storage such as demonstrating flood impacts of compensatory earthworks in creeks/waterways.

(5) The use of a LIDAR survey is acceptable for 2D hydraulic analysis, particularly for areas outside of the subject. However, critical hydraulic controls must be surveyed. If sections of the floodplain contain channels which could be represented by 1D modelling techniques it is desirable to use an integrated 1D/2D modelling technique if surveyed cross sections can be integrated into the 2D grid.
(6) If the survey is converted into a DEM for use in a 2D hydraulic model, the grid size of the 2D model is selected to meet the objectives of the study which may include suitable simulation times, appropriate hydraulic resolution of key areas and flow conditions. A fine grid resolution is not always the most appropriate scale. The adopted grid size is to be justified.

(7) At a minimum, all 2D flood analysis of existing and developed conditions is to provide for the following:
   (a) a map of digital elevation model (DEM) showing any obstructions and blockages;
   (b) a Manning’s roughness map;
   (c) flood depth maps with velocity vectors to visually indicate the conveyance versus storage areas of the floodplain;
   (d) flood afflux maps to show flood level impacts;
   (e) flood hazard map (velocity x depth product) to show areas of low and high hazard.

10.4 Hydrological model assumptions

The report is to justify the basis of the values adopted for the hydrologic modelling parameters used in the analysis, including the following:
   (a) rainfall loss model values;
   (b) sub-catchment fraction imperviousness (development assumptions);
   (c) routing parameters;
   (d) flow velocity and time of concentration estimates;
   (e) Manning’s ‘n’ roughness values in relation to land use;
   (f) structure capacity and hydraulic headloss assumptions (HGL analysis);
   (g) the capacity of culverts considering inlet/outlet control.

Editor’s note—Where consideration of increased rainfall for climate change is required, refer to current advice from the Queensland Government or in the Australian Rainfall and Runoff.

10.5 Adverse flood impacts

(a) Consistent with the requirements of the Flood overlay code the development is not to cause any adverse flooding with respect to flooding of developed or developable areas, erosion potential, or the general amenity of the area. The applicant should not assume that the downstream drainage will be upgraded at a future date to mitigate any impact from the development.

(8) An adverse flooding impact includes any significant increase in flood level, flood hazard, or a change in velocity that would increase erosion potential (typically flow velocity in excess of 2m/s).

(9) The extent of an allowable afflux as a result of development is often variable, depending on the modelling technique, type of land use, flooding type, catchment characteristics and impact on flood storage and ownership of the land affected. However, no increase in level is preferable in all instances otherwise supporting evidence is to be provided justifying any impact.

(10) Generally larger creek flooding sources and the Brisbane River are not to be impacted by development because impacts are much more likely to extend into many adjacent premises and even a small flood level change may represent significant alterations in floodplain storage.

(11) Overland flow paths have higher uncertainty and impacts are more likely to be localised within the site.

(12) In pedestrian areas, the flood afflux may be less relevant than changes to flood hazard.
10.6 Assessment for creek/waterway flooding

(a) All hydraulic studies used to determine the impacts of filling in a waterway corridor need to use an unsteady flow analysis to estimate the impacts of changes in flood storage.

(13) Large backwater areas or significant flood storage areas will require the use of 2D hydraulic modelling techniques to adequately assess changes to flood storage.

10.7 Estimating flood planning levels for creeks/waterways

(1) All hydrologic and hydraulic calculations for waterways or creeks for the purpose of determining ultimate flood levels, easement widths, development fill or building levels are based on the following:
   (a) 1% AEP (and other relevant events) flows for a fully developed upslope catchment conditions (ultimate development scenario).
   (b) A fully vegetated waterway corridor using a Manning's roughness value of 0.15. The high vegetal roughness coefficient assumed is to allow for generally unrestricted planting of vegetation in the future and is to facilitate orderly development by ensuring the development does not constrain other sites or the Council from planting at these densities in the future.
   (c) A Manning's roughness value of 0.08 is appropriate if a Council endorsed stormwater management plan, waterway management plan or flood study has identified that full revegetation is not possible due to an unacceptable increase in flood levels.

(2) The use of existing or design Manning’s roughness assumptions is only permissible when assessing impacts of development on flood behaviour, such as flood hazard.

10.8 Assessment for overland flow flooding

Particular care is required when determining flood immunity requirements for buildings affected by overland flow flooding sources because of the high flow velocity that may occur and the high degree of hydraulic uncertainty which may occur along such flow paths as a result of fences, retaining walls and landscaping. This may result in situations where the velocity head (energy grade line) is significantly higher than the modelled flood surface level, or possibly higher than the freeboard requirement.

10.9 Estimating flood planning levels for overland flow flooding

(1) All hydrologic and hydraulic calculations for local flooding for the purpose of determining ultimate flood levels, easement widths, development fill or building levels are based on the following:
   (a) assuming a fully developed upslope catchment conditions (ultimate development scenario) for hydrology estimates;
   (b) using a Manning’s roughness ‘n’ of 0.10 to take into account of any future planting and garden beds which may occur, ancillary structures such as fences, sheds which may be erected, and any other obstructions which cannot be regulated;
   (c) modelling that includes significant structures such as buildings, as constrictions between such buildings may significantly influence the flood hazard;
   (d) disregarding the effect of fencing on flow diversions (particularly side boundary fencing) if it would lower a building’s flood immunity requirements.

(2) The use of existing or design Manning’s roughness assumptions is only permissible when assessing impacts of development on flood behaviour, such as flood hazard.
10.10 Parking

(a) Relaxation of flood immunity standards for parking may only occur for vehicular accommodation (limited to uncovered short term car parking bays or unclosed car parking associated with a house) and access area, where there is compliance with the following:

(a) the maximum flood depth is 200mm in a 1% AEP flood;
(b) flooding no more frequent than a 10% AEP flood;
(c) the flood hazard is low with respect to velocity x depth product (<0.6m²/s).

11 Earthworks in a floodplain

11.1 Filling

(a) Development takes account of existing or created overland flow paths and make due provision in the design.

(3) Impacts of filling within an area affected by flooding are assessed by a flood study undertaken by a Registered Professional Engineer Queensland.

(4) If filling in a waterway corridor, the earthworks comply with the Compensatory earthworks planning scheme policy.

11.2 Interface of development to creeks/waterways

- All lot boundaries to a creek/waterway are to provide an interface which is safe and stable during a flood.

(5) The use of battered interfaces to a waterway corridor is preferred.

(6) If a retaining wall is necessary, then it is:

(1) located on the site;
(b) clear of flood flows that could cause damage to the wall;
(c) Stepped to allow for egress out of floodwaters by people.

11.3 Levees

The use of levees in a development involving new premises to satisfy flood immunity standards is not appropriate for the following reasons:

(a) There is no guarantee that the levees will remain with the land.
(b) Levees are not an intrinsic solution to flooding of the development.
(c) Levees may be breached or overtopped in extreme storms, which can lead to an increase in flood damage, and subsequently greater potential for damage.
(d) Levees that overtop in extreme floods can produce a much higher flood hazard to people and structures than if they had not been built in the first place. However, it is accepted that a wall or ramp can be used to provide flood immunity to a basement given that it is part of the building or structure.