Sunshine Coast COUNCIL

Guideline for improving flood resilience for existing development

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This is a technical report that uses generally accepted industry standard definitions for stormwater and flooding terminology.

This document includes contributions from the following organisations:

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Contents

Acronyms

AEP Annual Exceedance Probability the likelihood of occurrence of a flood of given size or larger occurring in any one year. AEP is expressed as a percentage (%) and may be expressed as the reciprocal of ARI (Average Recurrence Interval).

AHD Australian Height Datum the adopted national height datum that generally relates to height above mean sea level. Elevation is in metres.

ARI The Average Recurrence Interval (ARI) is a statistical estimate of the average period in years between the occurrence of a flood of a given size or larger.

BCA Building Code of Australia is a uniform set of technical provisions for the design and construction of buildings and other structures throughout Australia

BCQ Building Codes Queensland oversee the Building Act 1975 and provide building information on the Building Code of Australia and the Queensland Development Code.

DFE Defined Flood Event The event, measured in terms of the likelihood of occurrence, adopted by the Council to manage development. The DFE incorporates an allowance for future climate change over the design life of the development, through increased rainfall intensities, mean sea level rise

DFL Defined Flood Level A water level derived through mathematical modelling of the Defined Flood Event.

FHL The Flood Hazard Level is the flood level used to determine the height of floors in a building and represents the defined flood level (DFL) plus the freeboard.

HVAC High Voltage Alternating Current

ICA The Insurance Council of Australia is the representative body of the general insurance industry in Australia.

MFV Maximum Flow Velocity is a flow velocity of water that is reasonably expected to be the maximum flow velocity of water for all or part of an area

NCC National Construction Code comprises the Building Code of Australia (BCA) and the Plumbing Code of Australia (PCA).

PMF Probable Maximum Flood the largest flood that could conceivably occur at a particular location. Generally, it is not physically or financially possible to provide general protection against this event. This flood defines the maximum extent of land liable to flooding.

QDC The Queensland Development Code consolidates Queensland-specific building standards into a single document. The code covers Queensland matters outside the scope of, and in addition to, the Building Code of Australia.

Guideline Synopsis

This guideline has been prepared to provide residents, business owners, investors, builders and renovators with a summary of information to improve the flood resilience of an existing development.

This guideline is intended for users who may be considering the purchase of a potentially flood affected property, or who are recovering from flood event and looking to rebuild and renovate or who are simply looking to better understand their flood risk so they can make more informed lifestyle and investment decisions.

The guideline focusses firstly on gathering information to inform users' knowledge of the known or potential flood risk associated with a particular property. It encourages users to undertake their own assessment of flooding risks taking into account the likelihood of various flood events occurring and the corresponding consequence of these events. Guidance is provided on where to find information and how to inform the assessment of flood risk.

With an understanding of the potential flood risk for a particular location, and peoples' tolerance to these risks, more informed investment and lifestyle decisions can be made that may increase the ability to cope and improve the overall resilience to a flood event.

Having gained an understanding of the flood risk the user is then guided through a series of considerations aimed to protect themselves, others, the environment and their assets.

A selection of practical flood resilient building techniques are provided and presented in the context of dry and wet flood proofing. Dry flood proofing essentially aims to keep the flood waters away from buildings and habitable floor areas, whilst wet flood proofing allows the water to penetrate the building and recede with minimal structural damage and clean up.

Finally, the guideline provides advice on what to do during and after a flood event.

An accompanying guideline has also been prepared which provides a series of case study examples for new developments within flood sensitive locations.

It is hoped that these guidelines will assist users with developing an understanding of flood risk and with making informed and practical decisions on how to improve their personal resilience in the event of a flood.

How to find Flooding Information?

Why do you need to know?

Why do people generally need to find out about flooding? The most common reasons for people enquiring about flooding are:

(a) To determine the potential flood risk of a property that they may be interested in purchasing

(b) To satisfy a building regulation or development condition that requires a response to a nominated flood event, such as for all building floor levels to be constructed 500mm above the 1% AEP[1] flood level

(c) To improve the flood resilience of a property as a part of renovations or modifications to the property

(d) To reconcile the value of an insurance premium related to flooding for a property and hence to inform lifestyle choices and investments

(e) To just better understand the nature of flooding in a location so they can be adequately prepared.

Different Types of Floods

Not all floods come from the same source.

For example, flooding can occur from: the blockage of a local stormwater pipe; or the overflow from an overland stormwater flow path; or from a local creek or a regional river. In coastal areas flooding can also come from seasonal tides, storm tides and possibly even tsunamis. Storm tides are often associated with severe weather events such as cyclones and east coast lows. In these situations flooding may arise from a combination of rainfall induced flooding and storm tides.

When you are looking to determine the flood risk for a location it is recommended that you consider each of these possible sources of flooding. Even elevated properties, located well above the local floodplain may still suffer from stormwater flooding and hillside runoff.

Insurance policy disclosure statements will often state whether the policy coverage excludes any of these types of flooding.

The flooding advice you might receive from the Council or State Government will typically refer to flooding from creeks, rivers and the ocean and generally not flooding from stormwater drainage or overland flow paths.

Getting Advice

Getting advice will assist you with gaining an understanding about the flood risk in an area before you make any significant decisions.

However, not all advice is the same and you should rationalise any decisions you make against the reliability of the advice you receive.

Anecdotal advice is often provided with good intentions; however, some care should be taken before making decisions based solely upon such advice. Hearing about someone's firsthand personal experience with regards to flooding may offer some valuable insights into the nature of a historical flood; however, these insights may not accurately reflect the characteristics of a flood for a particular location nor cover the full range of flooding which may be anticipated. Local knowledge can sometimes offer worthwhile information where official records and maps don't.

Why Should You Ask?

Who you should ask and how much effort you invest in seeking out information should be commensurate with the reason you are seeking the information.

Most long term residents and business owners will have witnessed or experienced flooding in the region in the past. Be aware that personal (non-professional) accounts of historical events are likely to reflect the perceptions, recollections and circumstances of the individual and that these conditions may not be the same for you today.

[1] Often also referred to as the 1 in 100 Year ARI flood level.

The local State Emergency Services (SES) group and Queensland Fire and Rescue are likely to have had experience providing assistance at flooding hotspots throughout the region. Whilst their advice would not be offered as an official record it may still provide a valuable insight into local conditions.

If you are considering an investment or building modification you will need to have a reliable and documented source for information regarding known or potential flood conditions at the subject property.

To obtain this you can request a flood information search from the Council or you could consider engaging a Registered Professional Engineer of Queensland (RPEQ) for a more detailed flood study or understanding of the potential flooding conditions of a property. The Board of Professional Engineers of Queensland website has a list of registered professional engineers.

Formal Flooding Information

Formal evidence of flooding information may be required to support a development or building application and may also be useful when seeking flood insurance. Formal flooding information, such as a *flood information search* will provide you with a reliable record of the information available for a property at that time.

Council flood information search

The Sunshine Coast Council offers a flood information search for any property within its jurisdiction. A flood information search will provide evidence of flooding information within Council's possession that can be confidently referred to when making investment, building or development decisions. Be aware that Council does not possess flooding information for every property within its local government area. If it does not possess information this does not necessarily mean that the property is not subject to flooding.

If you are considering purchasing, developing or substantially renovating a property you should submit a flood information search application with the Council

You can apply for a flood information search via the Council's website. There may be a small charge for this service.

A flood information search will include:

- details describing the location of the property for which the flooding information applies;
- a defined flood level for the property if one is available. This level has been calculated;
- a reference to the study that produced the calculated flood level;
- whether a relevant historical level has been recorded for the property and the details of this level such as where it was recorded and for which event;
- where flooding exists, a map indicating the anticipated extent of flooding for the defined flood level;
- details of the required minimum floor level for the property based upon the available flooding information; and
- general definitions and disclaimers.

Council Flood Maps

A variety of flood maps may be accessed from the Council. These maps may represent specific circumstances or serve a particular purpose. If in doubt, request advice from Council on which map may best suit your type of enquiry.

Planning Scheme Maps

The Sunshine Coast Planning Scheme (2014) includes Flood hazard overlay maps. The Flood hazard overlay maps identify areas (flooding and inundation areas) where flood and storm tide modelling has been undertaken by the Council. Other areas not identified by the Flood Hazard Overlay Maps may also be subject to the defined flood event (DFE) or defined storm tide event (DSTE). Definitions of DFE and DSTE are provided in Schedule 1 (Definitions) of the Sunshine Coast Planning Scheme (2014).

In regards to the Flood hazard overlay mapping, it is also important to note:-

- Some areas subject to pre-existing development approvals may have modified flood extents that alter or eliminate the risk of flooding for that area;

- Some areas subject to pre-existing development approvals may retain a residual risk of flooding due to changes in the way in which the defined flood event has been determined over time;
- In certain circumstances pre-existing development approvals may override the operation of an overlay; and
- Overlays provide a trigger for consideration of an overlay issue to be verified by further on-site investigations.

The Flood hazard overlay maps are a planning tool only (ie to regulate new development) and do not specify a level of hazard in different flood events.

These maps act as a trigger within the planning scheme to indicate where flooding may need to be considered for planning and development purposes. When reviewing a Planning Scheme's Flood Hazard Overlay Maps, users should be aware that larger flood events that are not shown on the map can occur. Due to the statutory nature of Planning Schemes, Flood Hazard Overlay Maps are not easily updated. Hence, it is not recommended that these maps be relied upon solely to determine potential flood risk.

Disaster Management Planning Maps

Flood maps may also be available through Council's disaster management planning. Disaster management planning maps may show anticipated flood extents for a range of floods of varying sizes. These maps are used to correlate to an actual or forecasted flood event to plan appropriate responses. These maps will provide an insight into how the flood extent may change with the severity of an event. These maps may depict anticipated flood extents from rainfall and/or storm tides events.

State Government Flood Maps

The Queensland Reconstruction Authority[2] has launched an online interactive flood mapping portal called the *Interactive Floodcheck Map*. This portal has been developed as a reference point for locating available flooding information from across the State. This service is primarily provided for remote and regional areas of Queensland. Council's, such as the Sunshine Coast Council, that have significant urban populations will typically possess more detailed flooding information than is depicted via the Floodcheck portal. The portal also provides a listing of relevant flood studies that may have contributed to the mapping or be available for viewing from the local council.

Flood maps vs. actual flood events

Every flood is slightly different and actual floods may not follow the same pattern as mapping shows.

If river and creek flooding occurs during higher or lower tides than the mapping indicates, the flood inundation experienced may be different to what is shown. However, this impact is limited to coastal areas.

[2] In response to natural disaster events, the Queensland Government established the Queensland Reconstruction Authority under the Queensland Reconstruction Act 2011. The Authority's mission is to reconnect, rebuild and improve Queensland communities and its economy

Catchment based rainfall induced flooding can also be influenced by the timing and distribution of rainfall across a catchment. The timing and distribution of rainfall across a catchment may allow flood peaks from various tributaries to either pass before other tributaries peak or it could exacerbate flooding if the timing of the peaks were to coincide.

What is the basis of flood information?

Historical flood height readings

Information regarding flooding is collected and derived from a variety sources. The most common form of flooding information are flood height readings for historical flood events. Historical flood height readings are often collected after a significant flood event from debris levels and water marks left by the peak of the flood waters. Historical flood height readings offer a snap shot of information about the maximum (i.e. peak) height of flooding observed at a particular location for a particular event. Historical readings contribute towards improving our understanding of historical trends.

Some of the deficiencies of historical flood height readings include:

- historical readings at a particular location may not include the highest or largest flood events for that location;
- the absence of historical records at a location can be misinterpreted that the location does not have a history of flooding;
- historical readings may not reflect changes that have occurred in the catchment or waterway since the historical reading was made;
- how reliably the flood height may have been recorded following the event; and
- inherent inaccuracies in debris levels and water marks that may be present due to local influences.

Regardless of these deficiencies historical flood readings should be carefully considered when making decisions regarding managing your flood risk.

Flood maps are generally based upon the results of computer simulated flood models. These models are required to make assumptions of the catchment and waterway conditions at the time of flooding. Factors such as: debris blockages at waterway crossings, illegal filling within the floodplain; and, changes to the floodplain roughness due to seasonal crops may result in flooding conditions that are different from those depicted on maps.

In the absence of calculated flood levels for a particular location, historical records may sometimes be applied to determine minimum floor levels and development heights. In these cases, an additional freeboard is often added to the historical level to account for possible uncertainties.

Calculated design flood levels

The vast majority of flooding information available today has been calculated using sophisticated computer modelling and terrain mapping. Wherever possible, these computer flood models are validated to reflect historical readings from previous significant events. Once a satisfactory level of validation is achieved a “design” storm event is applied to the model to determine the “design” flood extents and levels. The rainfall patterns used for the determination of design storms originate from the Bureau of Meteorology and Australian Rainfall and Runoff (ARR) a national guideline for the estimation of design flood characteristics in Australia. ARR is published by Engineers Australia. The Sunshine Coast Council has developed a series of duration independent rainfall temporal patterns from the ARR patterns which better reflect the flooding characteristics of its catchments and floodplains.

Design flood levels are typically referred to in regulations for establishing minimum performance standards for the design and construction of infrastructure. Development fill levels, building floor levels, road levels, culvert and bridge sizes are designed to satisfy a minimum design flood level for that location.

Design flood levels are typically referred to by the anticipated statistical frequency (i.e. likelihood) of an event of that size occurring. The most common design flood level referred

to in building and development regulations is the 1% AEP flood level. This design flood event has a 1% chance of occurring in any given year. Smaller flood events with a higher likelihood of occurring may be referred to for some forms of infrastructure such as bike paths and parklands. Similarly, design flood events can refer to much larger, hence less frequent, extreme flood events.

It is important to recognise that larger more extreme flood events can occur and may still impact upon infrastructure or a development that has satisfied a 1% AEP design criteria.

Is there a maximum possible flood level?

Yes, theoretically it is possible to calculate an estimate of the maximum possible flood level for a particular location. The Bureau of Meteorology (BoM) refer to this type of calculation as the Probable Maximum Flood (PMF) estimation.

The modelling of these events permits Local Governments to have an understanding of flood behaviour for events of far greater magnitude than the 1 % AEP. The flood risks which may exist for flood events beyond the 1% AEP are sometimes referred to as the residual flood risk. That is, the risk beyond which standard planning and building provisions cater for.

Knowledge of these extreme events also allows for better flood emergency planning and more responsible floodplain management. By definition, the flood extents defined by the PMF define the extent of a floodplain.

A PMF event is considered to be so extreme that it is generally not assigned a probability.

Can flooding information change over time?

Hydrology is the science that encompasses the characteristics of the waters of the earth and their relationship with the environment. Scientific knowledge and mathematical principles related to hydrology continue to evolve and contribute to our knowledge of flooding and hydrology in general. So yes, overtime flooding information may change.

These changes may be a result of more sophisticated modelling or more recent observations of flood behaviour. Despite the possibility of these changes over time, the information you will receive via a formal flood information search request will reflect the best available information Council has at that time. Similarly compliance with a building or development regulation will be assessed against the best available information at the time also.

If you have received formal flooding information from the council in the past it is worthwhile verifying with the council as to whether the information is still the best available for your location of interest.

Flooding advice greater than 12 months old should be verified before significant decisions are made or commitments are entered into.

Making your own assessment

If you are interested in gaining an understanding of the potential flood risk to a particular property you should consider following the steps presented below to obtain information to inform your assessment.

Step 1

View council's flood maps online through the Council's website. Look for mapping offered under Disaster Management and/or the Sunshine Coast Planning Scheme (2014).

Step 2

If the mapping indicates that the property may be influenced by flooding request a flood information search from the Council. You can request a flood information search by completing a property search request form via Council's website.

If you are unable to confirm from the maps, to you own satisfaction, whether or not the property is potentially flood prone then we recommend requesting a flood information search from Council.

You can also begin making your own assessment of the potential flooding conditions for a particular property by making the onsite observations suggested in the following steps.

Step 3

Check if there is a well-defined watercourse within, adjacent or near to the property?

- If there is, try to observe where flood waters that may exceed the bank to bank capacity of the watercourse are likely to flow?

If there are any watercourses in the general vicinity of a property, you should be vigilant about seeking reliable flood information.

- Remember that flooding can occur from water exceeding the capacity of the local watercourse or it may occur from waters flowing overland to get to the local watercourse.
- Also, look more broadly at the estate or suburb and where a water course might be in relation to your point of interest. Flood waters will often "cut corners" or "take short cuts" between bends and meanders in creeks and rivers. These short cuts could be anything from a less than a hundred metres to several kilometres.

Step 4

Look for any depressions in the land running through or adjacent to the property which may convey overland flow during rainfall events? Ask yourself "where would water flow to if it was to exceed the capacity of the flow path?"

Step 5

Look for evidence of flood debris caught in fences, trees and other vegetation. The orientation of debris may also provide some insight into which direction the water was flowing. The height of the debris will provide some indication of previous (more likely recent) flooding.

Step 6

Look for water stains around any buildings. External water stains will generally fade over time however water stains and possibly silt deposits may remain within wall cavities.

Step 7

Check for warping of flood boards and skirting boards. This may be a sign of them once being inundated.

Step 8

Check for cracks in ceilings and walls which may be a result of damp wall cavities, differential pressure caused during a flood and/or movement of foundations.

Step 9

Check for warped door frame or window frames which may be the result of movement of the building or damp wall cavities.

Step 10

Check for springy floor boards, which may be an indication of a failed stump in an elevated building. Fungal rot of timber floor joists and bearers may also cause a failure in the flooring, however, unless it was already present prior to a flood it may take years for its effects to be detectable.

Step 11

Look for evidence of mould on plasterboard which may indicate damp wall cavities.

Step 12

Check for evidence of lifting ceramic wall tiles which may be associated with dampness, moisture induced glue failure, or moisture induced surface expansion.

Step 13

Look for flaking and blistering paint on plasterboard which may result from damp wall cavities or moisture trapped between the plasterboards and hidden brickwork.

Step 14

Check the garage for signs of water damage. Often the garage floor level will be lower than the habitable floor level of the house and as a result it will flood first.

Step 15

Check the driveway connection to the road. Is there a raised lip or section of the driveway to contain water to the roadway? Roads are intended to convey water and are part of the stormwater network. If floodwaters were to exceed the capacity of the roadway will they flow towards the house and cause damage or nuisance?

Step 16

Look at the building styles of in the area. Are the floors of other buildings raised above the surrounding ground level? If so, by how much and how does this compare to the property of interest?

Step 17

Search the internet for articles, images and videos relating to significant flood events that have occurred in the general area of interest. The contemporary trend of posting videos online bearing witness to significant events of social interest, such as flooding, can offer a substantial source of unofficial but irrefutable flood information.

Step 18

Search the Queensland Reconstruction Authority's Floodcheck online flood mapping portal for mapped inundation details and aerial images of significant historical flood events.

What did you find?

Once you have made the recommended observations and collected any available information you will be in a better position to make a more informed assessment of the potential flood risk for a particular property.

Your research may result in the following outcomes for understanding the potential for flooding at a particular property:

(a) Your research has confirmed to your satisfaction that the property does not flood; or

(b) Your research has confirmed that there is a history of flooding for this property; or

(c) Your research has indicated that there is a potential for flooding of this property; or

(d) Your research has not been able to confirm the potential for flooding for this property or not.

What should you do?

Based upon which of the above outcomes your assessment has led you to, you may then wish to:

- Consider your own tolerance (or the tolerance of those most likely to be effected) for the *flood risk* which has been identified through your assessment.
- Review any insurance coverage related to the property, and possessions to ensure it reflects the nature of the risk.

It is recommended that you review your insurance policy to confirm that it does not exclude the nature of the flooding which may have been identified. Some policies exclude flooding from rivers and ocean.

What is Flood Risk?

Flood risk refers to the combination of: the potential for flooding to occur; and the possible consequences incurred when it does.

Flood risk varies from location to location and also between different flood events.

The potential for a flood of a particular size to occur is generally referred to as the *likelihood* of the flood occurring. Small flood events occur relatively frequently and hence the likelihood of these would be referred to as being high, that is 'highly likely to occur'. Conversely, very large or extreme flood events are relatively rare and hence the likelihood of these occurring is referred to as being low.

The *consequences* of flooding will vary for different flood events and from location to location for the same flood event.

For instance, the consequences for a particular property from a relatively small flood are likely to be different from those of a large flood. Similarly, the consequences of flooding at one location may be relatively minor compared to the consequences at another location for the same flood event.

Therefore, when flood risk is referred to it should be done so with reference to a particular location and a particular size or frequency of flood event.

Understanding the likelihood of flooding

The likelihood of a flood of a particular size occurring is the chance or probability of that flood occurring.

Most people are more familiar with chance and probability when it comes to card games and gambling. For instance, the probability of being dealt four aces in a poker games is very low and hence this outcome would be referred to as having a very low likelihood.

In games of chance and gambling, players make decisions based upon the likelihood of a particular outcome. Similarly, decisions regarding flooding should also be based upon the likelihood of it occurring at a particular location.

The likelihood of a flood occurring at a particular location is generally communicated as either: a time period between the occurrences of flood events of a similar size, usually referred to as the Average Recurrence Interval (ARI); or, as the probability of a flood event of a particular size occurring in any given year. This is usually referred to as the Annual Exceedance Probability (AEP).

The most common example of the use of this terminology is the 1 in 100 year ARI flood event. An event of this size is statistically likely to occur once in every 100 years. However, this terminology is often misinterpreted to mean that if an event of this size has recently occurred then it will be 100 years until it occurs again. This is not a correct interpretation. The more accurate interpretation is that an event of this size has a 1% chance (i.e 1 in 100) of occurring in any given year. That is a 1% AEP flood event.

More frequent flood events, that is to say smaller flood events, are expected to occur at a higher percentage of chance in any given year. For instance a very regular flood event may be referred to as a flood event with a 50% AEP (i.e. a 50% chance of it occurring in any given year).

Conversely, very rare and extreme flood events may have AEPs of much less than 1% in probability of occurring.

The AEP format is now the more favoured terminology for communicating statistical flood likelihood; however the media and the community's familiarity with the ARI terminology (i.e."1 in 100 year flood") means it will continue to appear in flooding communications for some time to come.

Readers of this guideline should also be aware that there is another emerging terminology intended to be applied for more frequent flood events that states the number of exceedances per year expressed as X Exceedances per Year or X EY. For example an event with an expected recurrence interval of 6 months would be presented as 2 EY i.e. twice in a year.

Determining the consequences of flooding

Some of the typical consequences of a flood may include:

- damage;
- injury or death;
- loss of trading;
- loss of stock;
- costs of recovery including clean up;
- loss of functionality;
- loss of productivity;
- lost opportunity;
- loss of access;
- distress; and
- lost mobility, to name just a few.

These consequences may be also be exacerbated by the duration of the loss or impairment, such as: short duration (<6 hours); medium duration (<24 hours); and, long duration (>24 hours).

Determining answers to the following questions may assist with evaluating the potential consequences of flood:

- How much damage (in dollar terms) might occur if flood waters were to inundate the property (but not a building or premises on the property)? Consider damage to items of value (cars, tools, machinery etc) as well as damage to buildings and the likely repair costs.
- How much damage (in dollar terms) would occur if flood waters were to enter buildings: just above the floor height; half a metre above floor height; one metre or higher above floor height?
- What is the potential for injury or death resulting from flood waters to someone who lives, works or frequents the property?
- What level of flooding would result in lost productivity, loss of trading, loss of stock, loss of function of essential equipment?
- What level of flooding would impede access to or from the property? Access may also be restricted due to a local road closure.
- What might be the potential cost (in dollar terms) of cleaning up after a flood?

Figure 1 (over page) depicts a typical flood depth verses dollars of damage relationship for various components of damage to a property.

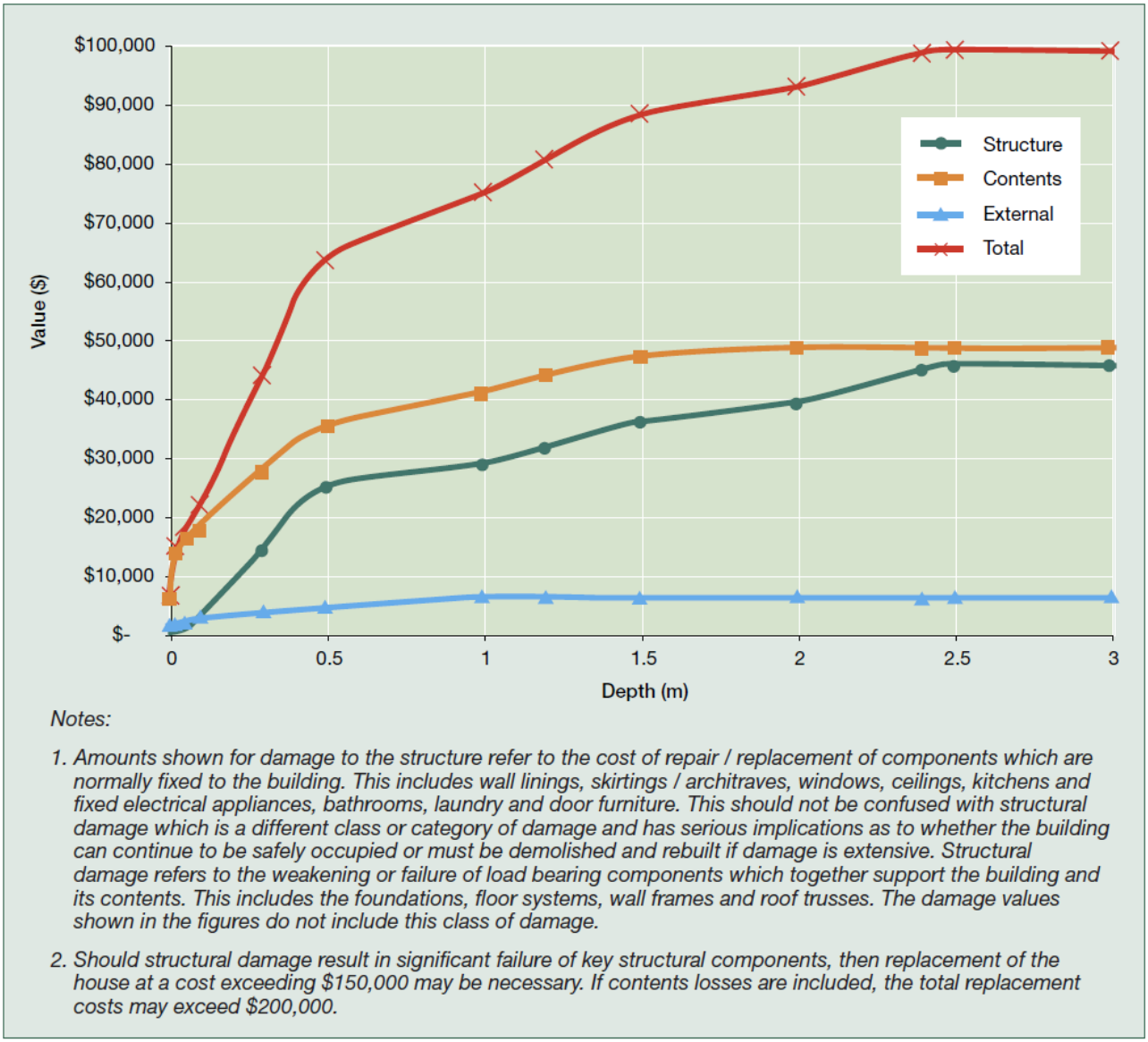


Figure 1 Damage in dollars for a single storey house verses depth of inundation in metres (Hawkesbury-Nepean Floodplain Management Steering Committee, 2006)

Note to Figure 1:

Costs estimates depicted in Figure 1 demonstrate the relative and cumulative relationship of residential flood damage costs. Costs will vary depending upon location, individual construction styles and materials.

Note 2 of Figure 1 refers to building replacement costs due to significant structural failure for the study location in $2006.

Residential building replacement costs on the Sunshine Coast for a single storey, slab on ground home with a double garage range from $368,000 for an average build dwelling to $520,000 and $780,000 for “quality” and “prestige” builds.

Reference: Insurance Council of Australia

http://understandinsurance.com.au/calculator/building-calculator

Evaluating the risk of flooding

When evaluating the risk of flooding it should be remembered that the risk to people is not necessarily the same as the risk to property, as the consequences can differ markedly. The risk to each will need to be considered separately but in parallel.

Combining an assessment of the likelihood and consequences of a particular flood event will provide an insight into the potential flood risk for a location.

Risk = Likelihood x Consequences

Risk is therefore a sliding scale due to the varying degrees of consequences that may occur from different degrees of likelihood.

The following table (Table 1) may be useful in demonstrating the sliding scale relationships between risk, likelihood and consequences. The table can be used as a guide for evaluating risk based upon the likelihood and consequences that you have identified.

To determine a relative degree of risk due to flooding for a property it is recommended that you use two reference points of potential impacts. The first point being the level at which property (external only) damage may occur and the second being the level at which building and/or contents damage may occur.

Through the avenues of enquiries described in previous section (***Making your own assessment)*** determine the likelihood of the anticipated flood events (if any) that are expected to result in flood levels equal to or greater than these two reference points.

For instance; through your enquiries you may determine that the flood event that is anticipated to begin to impact on a property has a 10% annual exceedance probability (AEP). You may also determine that the flood event from which you anticipate flood waters may enter the premises to have a 2% AEP.

Table 1 Risk Reference Table (Degree of Risk)

	Consequences			
Likelihood	***Minor***	***Moderate***	***Major***	***Catastrophic***
Very Unlikely	Low	Low	Low	Medium
Unlikely	Low	Medium	Medium	Medium
Possible	Medium	Medium	**High**	**High**
Likely	Medium	**High**	**High**	**Extreme**

The following descriptions are offered as an interpretation of the levels of *likelihood* shown in Table 1 and as an indication of the commensurate frequency of flooding as described by a flood analysis and often reported in flood certificates as the flood event AEP.

Using the example of the two reference points your enquiries may reveal that the size of the flood event that would enter the property (and potentially cause damage) is a 20% AEP flood event. Using the descriptions offered in **Table 2** this would correspond to a "Possible" level of likelihood for this reference point.

Similarly, **Table 3** (over page) offers an interpretation of the levels of consequences that are referenced in **(**Table 1**).** These interpretations include a financial indication[3] of the loss as a general guide. Using the descriptions provided in **Tabel 3** you can identify the relative *scale of the consequence* as being either *Minor, Moderate, Major* or *Catastrophic*.

Continuing with the example provided above; the expected loss from a flood event entering the property (i.e. first reference point) may be estimated to be less than $5,000 and hence the scale of the consequence would be *Minor.*

Table 2 Interpretation of Likelihood

Likelihood	Description of Likelihood
Very Unlikely	A very rare and event that is not expected to occur. As a guide extremely flood events with a chance of occurring in any given year of **much less than 1%** could be described as being "Very Unlikely".
Unlikely	A relatively rare event that is not expected to occur with any regularity. As a guide large flood events with a **1% or less chance of occurring in any given year** could be described as being "Unlikely".
Possible	An event that is expected to occur less frequently, however, still with a level of reliability that can be depended upon. As a guide moderate sized flood events with between **2% and 50% chance of occurring in any given year** could be described as being "Possible".
Likely	An event that would be expected to occur relatively frequently or with a level of reliability that can be depended upon. Relatively **small flood events with AEPs of 50% or more** would typically be described as being "Likely".

[3] These values are considered reasonable in 2014 dollars. Adjustments to these values should be considered over time.

Table 3 Interpretation of Consequences

Scale of the consequence	Description of loss	Financial indication of loss
Minor	Little or no: damage to assets; or loss of productivity. Little or no financial loss. Little or no injury. Little or no hardship.	< $5,000
Moderate	Some: damage to assets; and/or loss of productivity. Manageable financial cost. Possible minor injuries and related afflictions. Some associated hardship manageable over a relatively short time period.	$5,000 - $25,000
Major	Significant: damage; and/or loss of productivity resulting in a significant financial burden. Possible significant risk of injury and related affliction. Significant hardship with medium to long term implications.	$25,000 - $100,000
Catastrophic	Total loss of assets and/or total loss of capacity to produce. Possible risk of life. Substantial long term hardships generally requiring assistance to overcome.	$100,000+

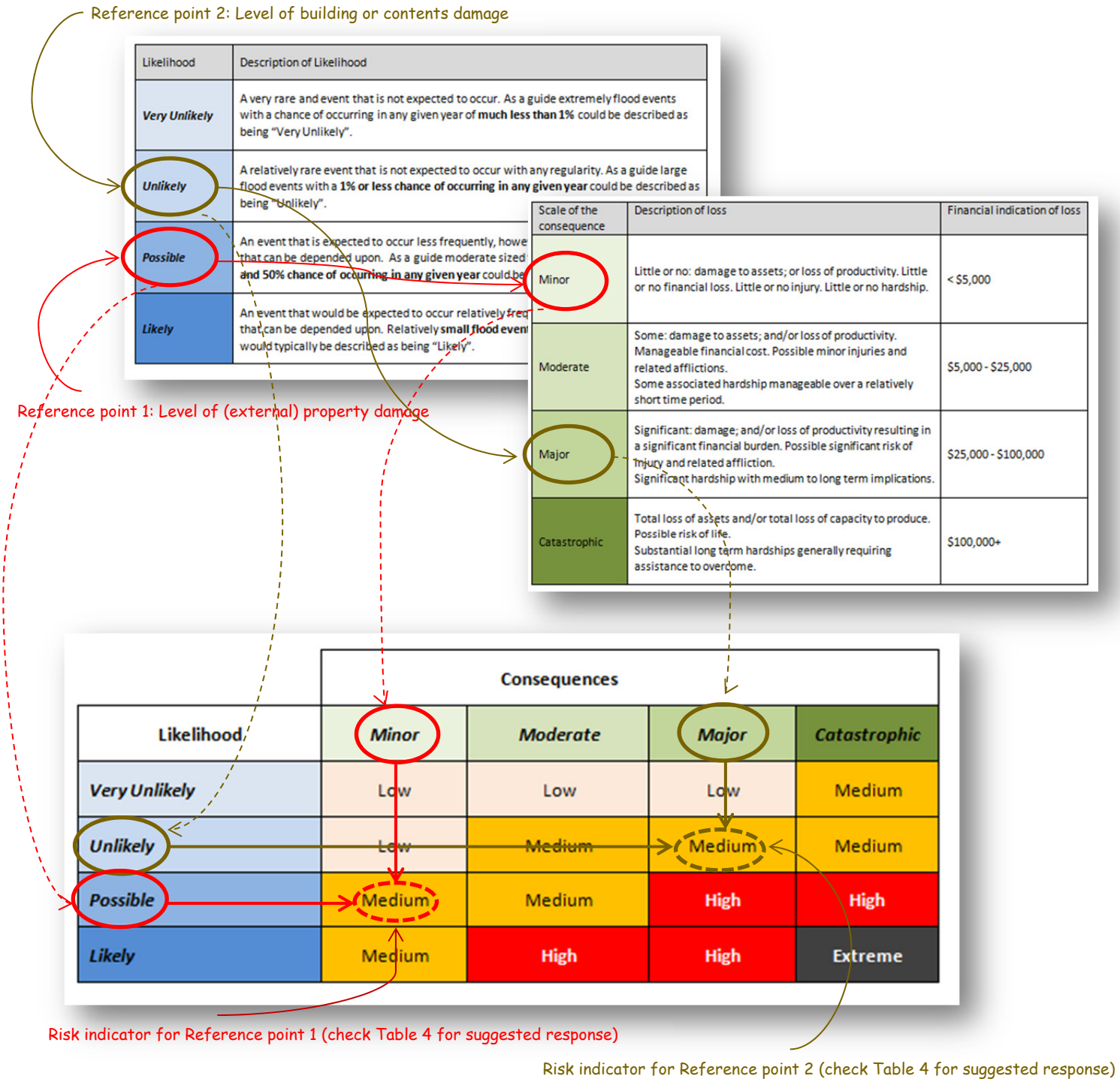
By using the two reference points for damage and the descriptions offered in Table 2 and**Table** 3 determine a degree of risk which equates to each of the reference points from the risk reference table (Table 1 reproduced below).

Table 4 Risk Reference Table (Degree of Risk)

	Consequences			
Likelihood	***Minor***	***Moderate***	***Major***	***Catastrophic***
Very Unlikely	Low	Low	Low	Medium
Unlikely	Low	Medium	Medium	Medium
Possible	Medium	Medium	**High**	**High**
Likely	Medium	**High**	**High**	**Extreme**

The process for determining the relative risk of two reference points is illustrated in **Figure 2.**

Figure 2 Determining relative risk using the risk reference tables



Having determined the relative risk for your points of reference you can now review the suggested responses offered in Table 5 to these levels of risk.

Table 5 provides some suggested responses to the degree of risk determined for each of your reference points.

Table 5 Suggested Flood Risk Response

Degree of risk	Suggested response
Low risk	Be aware of the potential flooding conditions and communicate this to others who may be affected.
Medium risk	Determine if a simple action could reduce the consequence further; such as, storing valuable items above the potential flood depth(s). Review your insurance policies and seek advice on the best type of cover for your circumstances. Consider preparing a flood response plan for your home or business. Consider what needs to be done during a flood event to minimise the impact and hence improve your resilience. Review simple structural modifications that could be made to improve the resilience of the property to flooding. (Refer to this guideline's section on ***Flood Resilient Building Techniques*** for further guidance)
High risk	Make a list of all the things you could do to reduce the consequences prior to a flood event. Prioritise the list and start to implement the actions as soon as possible. Prepare a flood response plan for your home or business of what needs to be done during a flood event. Review your insurance policies and seek advice on the best type of cover for your circumstances. Invest in structural modifications that may reduce or eliminate the consequences of a flood to the property. (Refer to the **Flood Resilient Building Techniques** chapter of these guidelines for more information) Stay informed of severe weather forecasts and follow your plan during a flood event.
Extreme risk	As per the recommended responses to *High risk.* Implement structural modifications to the property to reduce or eliminate the risk. If you are unable to adequately reduce the potential consequences of a flood event it may be time to begin to reconsider your options to relocate your interests or to redevelop the site to a use that is more compatible (i.e. more resilient) to the nature of flooding anticipated.

Tolerance to risk

People will respond to risk in different ways. Some people are naturally cautious and hence more risk adverse. Some people's tolerance to risk might be reduced due to how they perceive their ability to manage the frequency of the consequences.

There are no rules for determining a person's tolerance to risk, however factors such as: age; health; mobility; financial security; dependents; and previous experience and preparedness may influence an individual's tolerance to the risk and hence how they choose to respond. These factors can also change over time as circumstances change and hence tolerance should be periodically re-evaluated.

Some other environmental factors which might also influence a person's tolerance to risk include how the risk would be perceived during darkness; and, the proximity of the person to assistance (i.e. their degree of isolation) should they need help.

Evaluating your flood risk is a personal decision. This guideline will assist you with finding and interpreting available information that you might find useful for determining your flood risk and for how you may choose to respond to that risk.

It is important that you make informed decisions regarding your flood risk that are supported by valid information and realistic judgement.

What does it all mean?

Having an understanding of the potential flood risk for a particular location will allow you to make informed investment and lifestyle decisions that will increase your ability to cope with a flood.

If you have determined the potential flood risk for a location of interest then you can begin to evaluate your response options.

Obviously, you can't stop it from raining and sooner or later a significant flood event will occur in locations identified as being flood sensitive. However, you can begin to make decisions that may improve the protection of yourself, others and your assets from the impact of flooding.

These decisions should be based upon your assessment of the potential damage, financial loss and personal disruption (both physically and emotionally) likely to be incurred by a flood and how much you might be able to reduce (or eliminate) these losses through behavioural and structural modifications.

In existing developed areas, avoidance of an existing flooding condition is difficult to achieve. However; residents, property owners and businesses can begin to improve their flood resilience by making informed decisions and appropriate preparations before the next flood event occurs.

What is Flood Resilience?

Flood resilience refers to:

'the capacity to prevent, mitigate, prepare for, respond to and recover from the impacts of disasters'[4]

The question of flood resilience can be applied to individuals, businesses, towns, cities, entire regions or even national economies.

Flood resilience is difficult to quantify and hence the amount of flood resilience possessed is typically only referred to in general terms. For example; a township that is well prepared for flooding may be referred to as having a high level of flood resilience. Similarly, a business which is at risk from flooding and has no plans or mechanisms to reduce the impact and recover afterwards may be referred to as having a low level of flood resilience.

Improving the overall flood resilience of communities is the fundamental objective of the Queensland Reconstruction Authority (QRA) and council floodplain managers and is core to the content of this guideline.

The pursuit of flood resilience often requires achieving a balance between degrees of exposure and avoidance.

It may not be practical to totally avoid flood sensitive locations and likewise it would be reckless to knowingly expose yourself, others, and your investments to unsustainable likelihoods and consequences of flooding.

Increasing flood resilience is generally also a balance between adaptation and mitigation. Adaptation strategies may include changes to the way you normally do things to reduce the risk of flooding. Mitigation strategies may include structural changes to your property.

Increasing your personal resilience to a flood event is reflected in the Resilience in disaster management cycle depicted in Figure 3 below.

Figure 3 Resilience in the disaster management cycle[5]

[4] (Council of Australian Governments , 2009)

[5] (Queensland Reconstruction Authority)

Prepare

The taking of preparatory measures to ensure that, if a flood event occurs, you (including those you are responsible for) and your assets and livelihood are able to cope with the effects of the event.

Respond

The taking of appropriate measures to respond to a flood event, including action taken and measures planned in anticipation of, during and immediately after a flood to ensure that its effects are minimised.

Recover

The taking of appropriate measures to recover from a flood event, including: appropriate reconstruction of flood damaged buildings and infrastructure; and, measures to restore emotional, social, economic and physical wellbeing.

Prevent

The taking of preventative measures to reduce the likelihood of a flood event adversely impacting upon yourself or your lifestyle.

Reducing the risk of flooding
Your Safety and the Safety of Others

Personal safety is paramount when considering possible responses to flood risk. Your safety and the safety of others should always be given the highest priority. When considering personal safety be aware of your own physical, financial and emotional capacity to deal with a potential flood. You should also consider the limitations of those who may be in your care or who may seek assistance from you during a flood event. Children, the elderly, people with disabilities, injuries or illness will all require special consideration.

Make informed decisions

Begin by make informed decisions when the weather is fine. Avoid making important decisions under pressure.

It is more difficult for people to think clearly and rationally when they are under pressure. So it is wise to take some time to make informed decisions whilst the weather is fine.

It is recommended that you determine your potential flood risk and consider your options to reduce any unacceptable risks well before a flood event occurs. If you haven't done so already, refer this guideline's section on ***Making your own assessment*** to evaluate the potential flooding conditions for your property.

When determining the potential for flooding at a property, firstly develop an understanding of the type of flooding which it may be subjected to. For instance, determine if there is potential flooding from local drainage, local creeks, rivers, seasonal tides or storm tides.

Be aware that flooding information you may receive for building or development compliance purposes (such as from a *Council flood information search*) may only state the highest (i.e. most dominant) flood level for a property and may not reveal the potential for lower levels of flooding from other sources.

In addition to anticipating the potential sources of flooding try to gain an understanding of whether potential flood waters may rise quickly and/or be fast flowing, or are they more likely to rise gradually and be relatively slow moving. As a general rule, smaller drainage catchments will react more quickly than larger catchments and hence warning times will be shorter and the potential rate of rise of flood waters more rapid.

As a guide, if you determine the potential source of flooding for a point of interest is from a local drainage network or a local waterway then it is likely that there will be no warning time when flooding occurs. In these instances your planned response should not be dependent upon you having time to relocate yourself, others or possessions.

Larger regional creeks and waterways usually take longer for flood waters to rise and peak and hence may provide some warning times for potential flooding. Warning times will depend upon the intensity and distribution of the rainfall and may vary from a couple of hours to more than a day. In these circumstances it may be possible to factor in your ability to respond within the available warning times.

Staying Informed

Weather radar

The Bureau of Meteorology (BoM) provides weather radar images of rainfall and wind. These images can be access via the BoM website at www.bom.gov.au/australia/radar/index.shtml.

The Sunshine Coast is situated mid-way between the Brisbane (Mt Stapylton) radar site to the south and the Gympie (Mt Kanigan) radar site to the north. Gympie provides better coverage of the Sunshine Coast however Mt Stapylton is a more sophisticated radar. Together they provide coverage of the Sunshine Coast particularly when one radar is off line.

Flood warning systems

The Council, in partnership with the BoM maintain a network of flood warning gauges across the region. These gauges can record rainfall and water levels and transmit these readings to both organisations. Not all gauges will record both rainfall and water levels however, they generally all record rainfall, with only those positioned close to a waterway or the ocean recording water level.

You can access the location and current readings from these gauges via the BoM website.

www.bom.gov.au/qld/flood/seast.shtml

Whilst the network of gauges is extensive and provides good coverage across the region you may still find that you are located between gauge sites. In this case it is recommended you familiarise yourself with all the relevant gauges in your area.

Where possible learn how to access up to date information about flood events from the BoM website and how this information may relate to your property.

Correlating the reading you observe on the website to your property may not be easy. However, if you can begin to familiarise yourself with the web site's readings during regular rainfall events; and correlate these to your own observations of local conditions, you will begin to gain an understanding of how each gauge's readings relate to your location.

Personal weather stations

Relatively inexpensive personal weather stations can be purchased and installed at your home or place of business. Most of these devices will operate wirelessly and will be capable of transmitting real time rainfall records to a display within your home or business. Some systems will allow this information to be uploaded to the internet via a computer so that you can monitor the readings remotely.

Flood warnings

The BoM are responsible for issuing flood forecasts and flood warnings. These warnings will be available on the BoM website and will often be broadcast through local television and radio media channels.

Flood warnings will typically include a statement about the expected rainfall or water level conditions over a period of time generally with a reference to the existing conditions by using as terms such as increasing, rising, falling or steady. Warnings may also describe a flood as being minor, moderate or major. These are general terms which relate to the overall impact of flooding across the target area. A "minor" flood may still provide risks and hazards at particular locations.

Having a Plan

Once you have familiarised yourself with the potential flooding conditions for your property or point of interest, and any flood warning systems that may inform you of the current conditions, you should prepare a plan for how you should respond during a flood event.

Don't let regular day to day habits put you at risk. Everyday activities such as: leaving work, going shopping, picking up kids, making deliveries. Have alternate plans in the case of a flood event and know when to enact the plan.

A plan for home

In a domestic setting your plan could be as simple as having a discussion with other members of the household as to what you should do during a flood event.

Be sure everyone has a clear understanding of the risks and how to best respond. Discuss contingencies plans for interruptions to your regular routines, such as picking children up from school or returning from work.

Consider any pets and plan for how to best secure or relocate them during a flood and ensure they will have adequate food and fresh water.

The Queensland Government's *getready Queensland* campaign provides a fact sheet on *Preparing your emergency plan* (Department of Community Safety, Emergency Management Queensland and the State Emergency Service).

A plan for businesses

If you are a business and have responsibilities for employees, contractors, tradespersons, customers or delivery people on your premises then you should document your plan and make it available to others.

Your plan should cover some clearly understood and practical triggers for when to leave or to stay at the premises in the event of a flood.

If the premises are susceptible to flooding and there is no safe retreat area, then an early evacuation may be warranted.

If the premises do possess an adequate safe retreat area then it may be appropriate to encourage people to stay rather than to face additional risks moving around during the flood event.

Evacuation routes and how to safely enter and exit the premises should also be covered.

Also, be clear on your expectations for when staff should return to work following a flood. Consider contingencies for staff that may have also been affected in their homes and for interruptions to your suppliers.

These procedures should form part of your staff inductions and periodically discussed and reviewed to maintain familiarity and check their relevance to current business operations. If your flood plan requires actions to reduce the impact on the business, such as moving stock or erecting barriers, it is recommended you allocate the time to practise these actions. Just like a fire drill, introduce a flood drill to your emergency preparedness procedures.

Your plan should also consider any anticipated requirements for the installation of temporary flood protection measures, such as sand bags and other barriers and the availability of these items. Similarly, any items anticipated to be needed to clean the site following the recession of flood waters should also be identified and where practical stock piled to avoid recovery delays due to shortages. Be aware of any special training that may be required to operate recovery equipment.

Install appropriate signage

If your business is subject to a flood risk, consider ways you can effectively communicate the potential risk via signage within the premises. Signage may identify locations within the property that are at risk of inundation, for instance in car parks or storage areas. Depth markers may be appropriate to provide staff and customers with a reference for inundated areas.

Business Continuity Plans

Regardless of the level of risk that your business has to floods it is likely that it will be impacted by interruptions to power supply during severe weather events. To ensure your business is adequately prepared it is recommended that you prepare a business continuity plan.

The QRA has produced a fact sheet on emergency planning and business considerations for Business Owners. (Queensland Reconstruction Authority)

Communications

Whether you are at home or at work it is important to know who to contact if you were isolated by flood waters.

Make a list of emergency contacts and their details and keep the list in a readily accessible location, like on the fridge or in the staff lunch room. You emergency contact list may include family, friends, neighbours, other offices, mobile staff, management and of course emergency personnel such the SES and other emergency services.

Isolation

All homes and businesses should be prepared for either physical isolation and/or the temporary loss of some basic services such as electricity, water supply, telecommunications and means of transportation. Prepare a basic emergency kit to assist you for during and after a severe weather event.

Basic emergency kits

A basic emergency kit should consist of the following items:

- battery-operated radio (with spare batteries)
- torch (with spare batteries), candles and waterproof matches
- first aid kit and manual,
- medications (and repeat prescriptions)

It is also recommended that you have readily available access to the following items:

- sufficient drinking water and non-perishable food for 3 days
- special needs for infants, the aged and people with disabilities and pets
- copies of important family documents (birth certificates, passports and licences)
- credit cards and/or cash

More information on basic emergency kits can be found at the following references:

Preparing for the Unexpected Australian Emergency Management Institute

Prepare your Household Emergency Kit Emergency Management Queensland

Emergency Kit: essential items, all times getready Queensland

Managing expectations

Be realistic in your expectations about your and other's ability to deal with a flood event and the potential aftermath of a flood event. Flood events can be unexpected and may occur at any time of the day or night.

Dealing with Hazardous Substances

Floodwaters are not clean and often contain many undesirable and potentially hazardous pollutants.

Dead animals, raw sewage and general debris are commonly found in flood waters.

Be aware of hazardous substances that are stored on your property or at your business.

Unsecured hazardous substances may be dispersed by flood waters which may cause harm to those who come into contact with those waters or to the environments to which they flow.

Typical hazardous domestic substances may include:

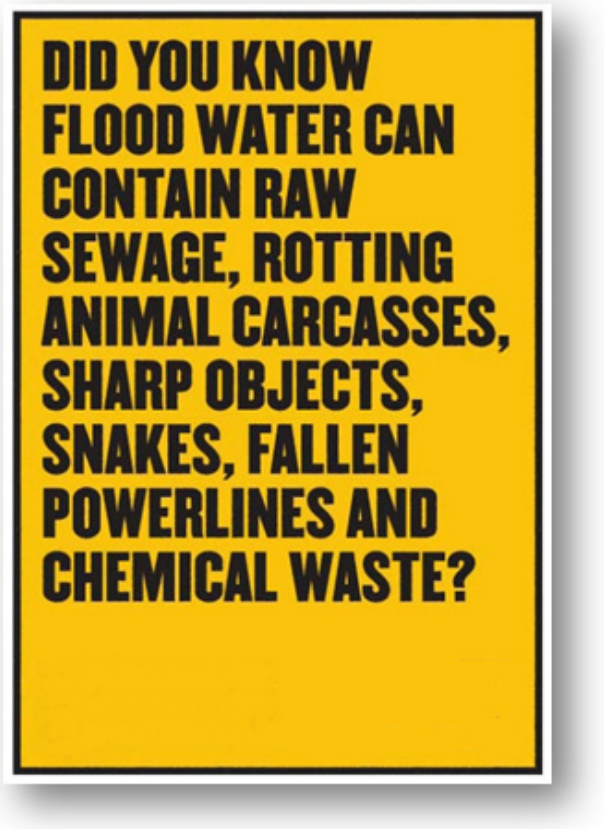
- Pesticides;
- Fuels and Oils;
- Chorine; and
- Cleaning products and solvents

Commercial hazardous substances will often already have been identified as part of a business's normal operating procedures. Ensure these items are stored in secure locations away or above the extent of possible flooding.

Consider adding visible markers to a commercial property or building to use as a guide for planning stock and substance removal leading up to a flood event. This will assist with communications with staff and will also assist with the induction of new staff and for emergency services personnel.

Relocate any potentially hazardous substances that may become inundated and possibly contaminate floodwaters.

If substances cannot be permanently relocated document an action plan for how, where and when to move these substances. Ensure appropriate handling procedures are followed by people qualified to undertake such tasks.



Protecting your Assets

Protecting your assets is an important component of improving your flood resilience. Your primary assets will include your home and contents, vehicles, your business premises, stock, and equipment.

Even before you invest in any of these assets consider the potential flood risk which they may be exposed to and determine your own capacity to reduce that risk or to financially and emotionally recover from them being damaged or destroyed by a flood event.

If you haven't already done so, refer to the **Making your own Assessment** section of this guideline to evaluate of the potential flooding conditions for your property.

Personal safety is paramount and should not be compromised for asset protection.

Protecting Buildings through Government Regulation

At the National Level

Australian Building Codes Board (ABCB)

The Australian Building Codes Board (ABCB) is a Council of Australian Government (COAG) standards writing body that is responsible for the National Construction Code (NCC). The Australian Building Codes Board addresses issues relating to safety, health, amenity and sustainability in the design and performance of buildings through the National Construction Code (NCC) Series, and the development of effective regulatory systems and appropriate non-regulatory solutions.

National Construction Code (NCC)

National Construction Code (NCC) comprises the Building Code of Australia (BCA) and the Plumbing Code of Australia (PCA).

New performance requirements for buildings in flood hazard areas were introduced into the NCC in 2013. The Deemed-to-Satisfy Provisions of both Volumes of the BCA reference the new Construction of Buildings in Flood Hazard Area Standard.

The performance requirements cover most flood hazard situations, however the Deemed-to-Satisfy Provisions do not cover areas subject to storm surge, coastal erosion, landslip or mudslide. In addition to this, the Deemed-to-Satisfy Provisions do not apply where the maximum flood flow velocity exceeds 1.5m/s. Where this limitation is exceeded, an alternative solution must be developed which complies with the relevant Performance Requirements.

The objective of the new requirements is to support health, safety and amenity outcomes for residents during a flood event, by addressing the structural robustness of buildings and the survival of utilities.

A summary of the Deemed-to-Satisfy Provisions is presented in the following table[6]:

[6] (Australian Building Codes Board, November 2012)

Table 6 Deemed-to-satisfy provisions of the NCC

Risk Area	Deemed-to-Satisfy
Injury or fatality to occupants from structural failure of a building due to the effects of water at rest or in motion	Foundations and footings of structures must provide the required support to prevent flotation, collapse or permanent movement resulting from flood action. This is to be determined by a qualified engineer at the design stage. Compliance will require consideration of geotechnical conditions, footing depth, piers, post, columns or pole; and adequate design for use of slabs-on-ground. This is to be determined by a qualified engineer at the design stage. Fill must be designed to ensure support under conditions of flooding. Strength of walls must be able to resist hydrostatic and hydrodynamic actions. Water resistant materials to be used for structural items such as bracing, columns, connections, fasteners, wall framing members, etc. Impacts from horizontal loads caused by debris action must be determined using a rational approach at the most critical location at or below the defined flood level.
Health issues due to the loss of amenity to the household from inundation	The finished floor level of any habitable room must be above the flood hazard level, which includes any required freeboard. Finished floor level on enclosed non-habitable rooms must be no more than 1.0m below the defined flood level.
Injury or illness caused by loss of utilities	Increase protection for utilities, including: Utilities must not be placed below the flood hazard level unless they have been designed to cope with flood water inundation; Buried systems protected from scour and erosion; and Greater level of fixing of HVAC equipment.
Injury, illness or fatalities by failure of a structure or auxiliary structure resulting in additionally damage being caused to the same property or to another property	Decks, patios, stairways, ramps, etc are to be structurally adequate to not reduce the structural capacity of the building they are attached to.
Injury or illness caused by not being able to safely evacuate	Egress from a balcony, verandah, deck, door, window or the like must be available to allow a person to be rescued by emergency services personnel.

Building Code of Australia (BCA)

The Building Code of Australia (BCA) is Volumes One and Two of the National Construction Code (NCC). The BCA is produced and maintained by the Australian Building Codes Board (ABCB) on behalf of the Australian Government and State and Territory Governments. The BCA has been given the status of building regulation by all States and Territories.

Figure 4 National Construction Code Series

The BCA is a uniform set of technical provisions for the design and construction of buildings and other structures throughout Australia whilst allowing for variations in climate and geological or geographic conditions.

The BCA contains requirements to ensure new buildings and structures and, subject to State and Territory legislation, alterations and additions to existing buildings located in flood hazard areas do not collapse during a flood when subjected to flood actions resulting from the defined flood event.

In July 2010, the Building Ministers representing the Australian, State and Territory Governments agreed to the ABCB developing a *standard* for the construction of certain buildings in flood hazard areas together with an accompanying information handbook.

The Construction of Buildings in Flood Hazard Area Standard

The standard *Construction of Buildings in Flood Hazard Areas* (Australian Building Codes Board, 2012) and the accompanying Handbook were developed by the ABCB Office with the assistance of an expert Reference Group.

The Standard covers buildings where people may sleep, reflecting the primary purpose of the standard which is life safety. The Standard is not a stand-alone solution to mitigating life safety risk due to flooding.

The Standard provides additional requirements for buildings in flood hazard areas consistent with the objectives of the NCC which primarily aims to protect the lives of occupants of those buildings in events up to and including the defined flood event.

Flood hazard areas referred to in the Standard are identified by the relevant State/Territory or Local Government authority.

The Standard specifies requirements for flood-resistant design and construction of buildings that are subject to the NCC requirements and that are located, in whole or in part, in flood hazard areas.

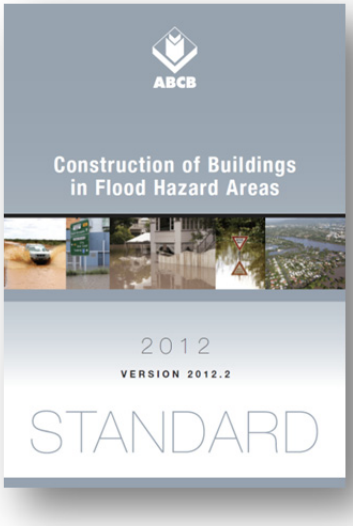


Figure 5 Construction of Buildings in Flood Hazard Areas National Standard

The scope of the Standard is restricted to the current NCC objectives of health, safety, amenity and sustainability. Therefore the Standard primarily focuses on structural safety and life safety, rather than protection of property or building contents.

Section 2 of the Standard provides basic design requirements to be met for buildings within flood hazard area, these include:

1. Designing for Flood Actions
    a) Hydrostatic Actions
    b) Hydrodynamic Actions
    c) Debris Actions
    d) Wave Actions
    e) Erosion and Scour
    f) Combinations of Actions
2. Floor Height Requirements
3. Footing System Requirements
4. Requirements for Enclosures Below the Flood Hazard Level (FHL)
5. Requirements for Structural Attachments
6. Material Requirements
7. Requirements for Utilities
8. Recommendations for Egress

The provisions outlined by the Standard only apply to flood hazard areas: that are not subject to landslip, mudslide, storm surge or coastal wave action; and where the maximum flow velocity is not greater than 1.5 m/s.

This does not mean that buildings cannot be constructed if they fall outside these limits if it is permissible under a planning scheme or planning instrument to do so. It means that such a proposal would need to be considered as an Alternative Solution under the relevant Performance Requirements and must be assessed accordingly.

The Construction of Buildings in Flood Hazard Area Information Handbook

The *Construction of Buildings in Flood Hazard Areas Handbook* (Australian Building Codes Board, 2012) has been developed to foster a greater understanding of provisions in the ABCB Standard for Construction of Buildings in Flood Hazard Areas and to provide additional advisory information outside the scope of the Standard.

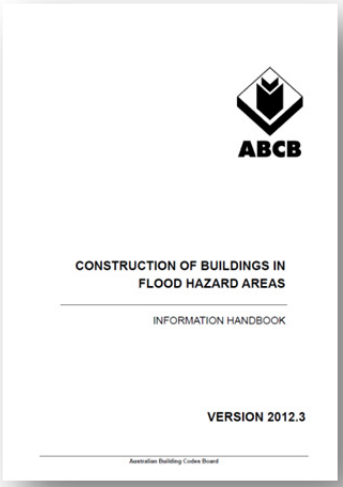


Figure 6 Construction of Buildings in Flood Hazard Areas - Information Handbook

Queensland Government Provisions

The Building Act (1975)

The Building Act 1975 governs all building work in Queensland. The Building Act requires that buildings be constructed in accordance with the Building Code of Australia and, where Queensland-specific provisions are necessary, the Queensland Development Code.

The Building Act stipulates the assessment procedures for building within Queensland.

The Building Act empowers the regulation of certain aspects of buildings and structures (via the Building Regulations 2006) and includes the administrative terms necessary to give effect to the laws.

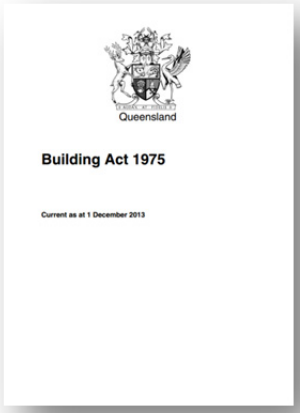


Figure 7 Building Act 1975

Building Regulation 2006

The Building Regulation 2006 adopts the Queensland Development Code (QDC) and allows local government to include information about flood characteristics, for the purposes of the QDC, in planning schemes, temporary local planning instruments or by resolution. It also includes requirements for building development applications proposing lower flood levels or flow velocities than those declared by local government.

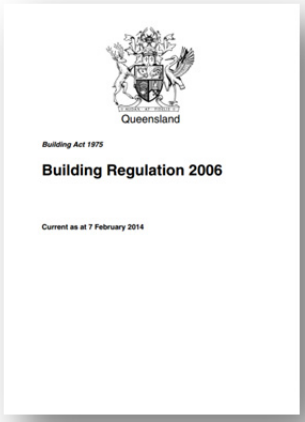


Figure 8 Building Regulations 2006

Queensland local governments are not able to include provisions in local planning instruments that are regulated by the building provisions, including the National Construction Code (NCC). However, Section 13 of the Building Regulations 2006 enables local governments to:

1. designate flood hazard areas; and
2. declare defined flood levels;
   (a) maximum flow velocity of water;
   (b) inactive flow or backwater area;
   (c) freeboards greater than 300mm;
   (d) the finished floor level of residential buildings built in the flood hazard area

When making these designations and declarations a local government must state that these are done so under the Section 13 of the Building Regulations. A designation or declaration must be stated in a planning scheme, temporary local planning instrument or resolution as being made under section 13 of the Building Regulation.

Local government does not set building regulations, it administers them in accordance with the Building Code and planning and building by-laws.

Queensland Development Code

The Queensland Development Code (QDC) consolidates Queensland-specific building standards into a single document. The code covers Queensland matters outside the scope of, and in addition to, the Building Code of Australia, such as requirements for private health facilities.

Queensland Development Code Mandatory Part 3.5

Queensland Development Code (QDC) Mandatory Part 3.5 applies to certain building work carried out in a designated flood hazard area and where a defined flood level is declared for the area. Flood hazard areas can be designated and defined flood levels declared by a local government under Section 13 of the Building Regulations.

QDC Mandatory Part 3.5 - Construction of buildings in flood hazard areas (MP 3.5) commenced on 26 October 2012[7].

The Performance Requirements for the application of MP 3.5 generally cover the construction of new buildings and alterations resulting in additions to existing buildings. The applicability of specific requirements should be checked against **Table 1** of MP 3.5.

Part 3 of MP 3.5 states Performance Requirements (P) and Acceptable Solutions (A) which generally reflect its stated purpose of the provision, which are to ensure:

1. particular buildings located in flood hazard areas—
   (a) resist flotation, collapse or significant permanent movement caused by flood water, refer to P1(a) and A1(a), A1(b); and
   (b) safeguard occupants and other people against illness or injury caused by flood water affecting buildings, refer to P1(b) and A1(a), A1(b); and
   (c) have utilities that are protected from the effects of flood water, refer to P2 and A2(1), A2(2); and
   (d) are protected from backflow, refer to P3 and A3(1), A3(2); and
2. that a customer dedicated substation is designed or located so its ability to function effectively is not affected by flood water, refer to P4 and A4.

Note: The acceptable solution A1(a) only applies to building work carried out on a lot, or part of a lot, located in—

1. an area with a maximum flow velocity not greater than 1.5 metres per second[8]; or
2. an inactive flow or backwater area.

MP 3.5 notes that if building work does not comply with A1, an alternative solution will be required in order to ensure it complies with P1. To formulate an alternative solution, the services of a competent person[9] may be required.

[7] Changes were made to the Building Regulation 2006 on 20 December 2013 to align with the new State Planning Policy 2013 and to refine the operation of MP 3.5.

[8] An unprotected house is unlikely to resist forces much greater than 0.8 to 1.0 metres / second (Hawkesbury-Nepean Floodplain Management Steering Committee, 2006).

[9] Competent person, means—
(a) a person who is a registered professional engineer of Queensland specialising in hydrologic and hydraulic models; or

Building Classes

The QDC MP 3.5 Table 1 describes the application of code in accordance with the NCC building classifications. The classification of a building or part of a building is determined by the purpose for which it is designed, constructed or adapted to be used.

A summary of building classifications is as follows:

Class 1: one or more buildings which in association constitute-

(a) Class 1a - a single dwelling being-

i. a detached house; or

ii. one or more attached dwellings, each being a building, separated by a fire-resisting wall, including a row house, terrace house, town house or villa unit; or

(b) Class 1b - a boarding house, guest house, hostel or the like with a total floor area not exceeding 300 m2 and in which not more than 12 persons would ordinarily be resident, which is not located above or below another dwelling or another Class of building other than a private garage.

Class 2: a building containing 2 or more sole-occupancy units each being a separate dwelling.

Class 3: a residential building, other than a building of Class 1 or 2, which is a common place of long term or transient living for a number of unrelated persons,

Class 4: a dwelling in a building that is Class 5, 6, 7, 8 or 9 if it is the only dwelling in the building.

Class 5: an office building used for professional or commercial purposes, excluding buildings of Class 6, 7, 8 or 9.

Class 6: a shop or other building for the sale of goods by retail or the supply of services direct to the public,

Class 7: a building which is-

(a) Class 7a - a carpark; or

(b) Class 7b - for storage, or display of goods or produce for sale by wholesale

Class 8: a laboratory, or a building in which a handicraft or process for the production, assembling, altering, repairing, packing, finishing, or cleaning of goods or produce is carried on for trade, sale, or gain.

Class 9: a building of a public nature-

(a) Class 9a - a health-care building; including those parts of the building set aside as a laboratory; or

(b) Class 9b - an assembly building, including a trade workshop, laboratory or the like in a primary or secondary school, but excluding any other parts of the building that are of another Class; or

(c) Class 9c - an aged care building.

Class 10: a non-habitable building or structure-

(a) Class 10a - a non-habitable building being a private garage, carport, shed, or the like; or

(b) Class 10b - a structure being a fence, mast, antenna, retaining or free-standing wall, swimming pool, or the like.

(b) a person assessed as a competent person under the Building Regulation, section 17(3).

Building Codes Queensland (BCQ)

Building Codes Queensland (BCQ) oversee the Building Act 1975 and provide building information on the Building Code of Australia and the Queensland Development Code.

BCQ have developed a guideline titled *Guideline for the construction of buildings in flood hazard areas.* (Queensland Government Department of Housing and Public Works, October 2012) which summarises the requirements of the Queensland Development Code's Mandatory Part 3.5 for the Construction of buildings in flood hazard areas.

Figure 9 Guideline for the construction of buildings in flood hazard areas October 2012

Habitable and non-habitable rooms

The relevant codes and standards relating to construction and building within flood hazard areas generally refer to requirements for finished floor levels of *habitable rooms*.

The national Standard[10] defines habitable rooms as:

A room used for normal domestic activities, and

(a) includes a bedroom, living room, lounge room, music room, television room, kitchen, dining room, sewing room, study, playroom, family room, home theatre and sunroom; but

(b) excludes a bathroom, laundry, water closet, pantry, walk-in wardrobe, corridor, hallway, lobby, photographic darkroom, clothes-drying room, vehicle parking area, storage area and other spaces of a specialised nature occupied neither frequently nor for extended periods.

[10] (Australian Building Codes Board, 2012)

Summary of Government Regulations for buildings in flood hazard areas

If you are considering an extension[11] to an existing building or redevelopment of a site you should firstly check to see if the building (not just the property) is located, or proposed to be located, within a flood hazard area designated by the Council under Section 13 of the Building Regulations.

Contact a Council customer service centre for advice on determining if a site is within a flood hazard area designated by the Council under Section 13 of the Building Regulations.

If the building is located either wholly or partially within a designated flood hazard area then it will be subject to the provisions of the QDC MP 3.5.

If it is determined to be subject to the provisions of the QDC MP 3.5 the refer to Table 1 of QDC MP 3.5 to determine which of the Performance Requirements may apply to your building works.

If the building is located either wholly or partially within a designated flood hazard area then determine from Council the Defined Flood Level (DFL) for the building's location.

To determine the minimum habitable floor levels Council will require an additional freeboard of 500mm to be added to the DFL.

Also request the Maximum Flow Velocity (MFV) from Council for the building site.

If the MFV is less than 1.5m/s you can demonstrate that your building work complies with the QDC MP3.5 by complying with the relevant acceptable solutions for each of the Performance Requirements.

If the MFV is greater than 1.5 m/s the basic design requirements offered in the national flood Standard are not applicable. In these circumstances you would be required to formulate an Alternative Solution which complies with NCC Performance Requirements. This will involve the application of engineering practice from first principles in combination with appropriate design considerations as an alternative to the requirements of Clauses 2.3 to 2.10 of the Standard. An Alternative Solution will require designers to apply professional judgment on all design issues.

Regardless of whether the MFV is less than or greater than 1.5 m/s you can still demonstrate your building work complies with the remaining performance requirements (P2 to P4) by complying with the relevant acceptable solutions for each of the performance requirements; or, by formulating an alternative solution that complies with the performance requirement or is shown to be at least equivalent to the relevant acceptable solution.

This process is illustrated in **Figure 10**.

[11] Extension refers only to additional floor area footprint, not additional levels in which case the QDC MP3.5 does not apply.

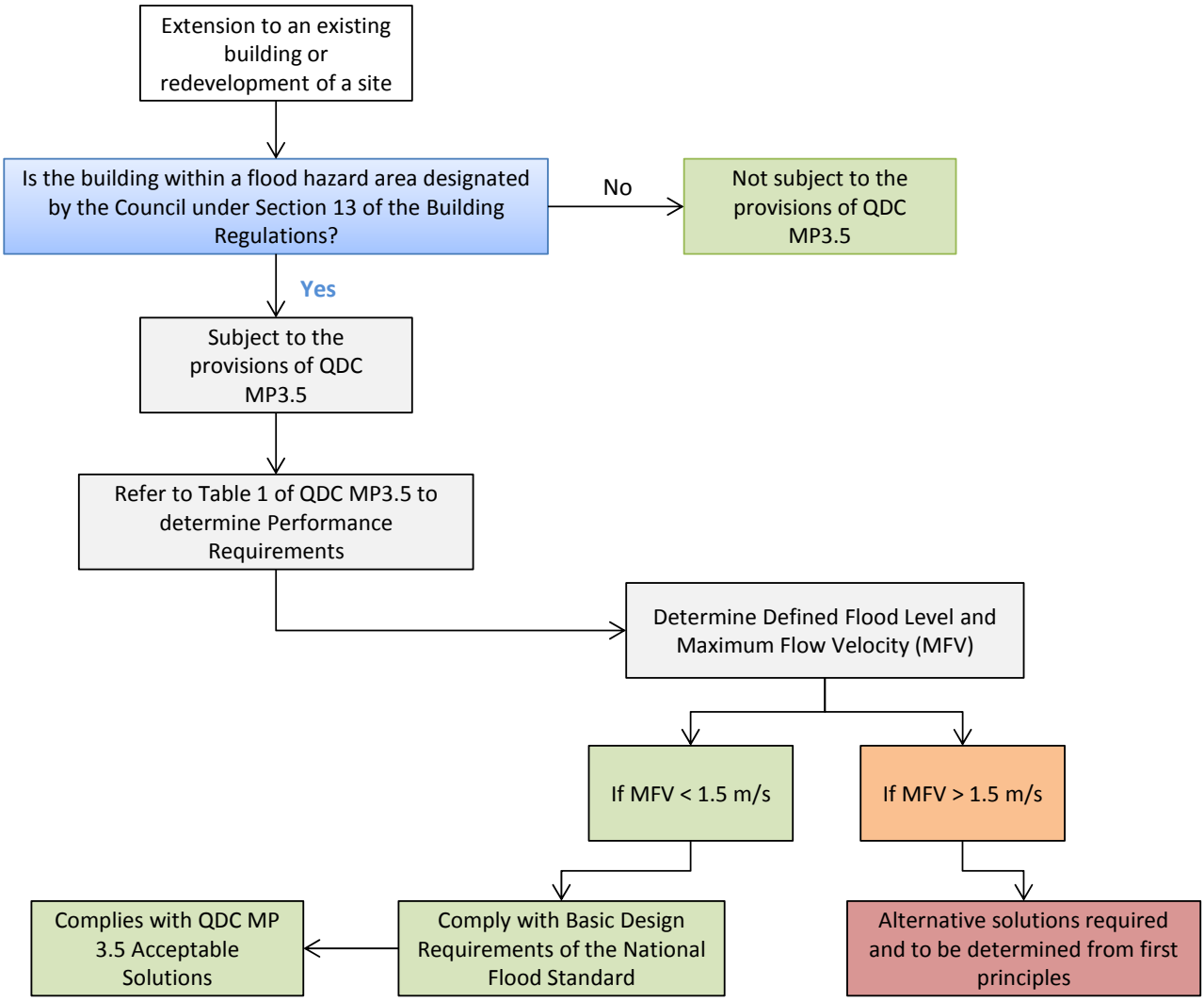


Figure 10 Process for determining the application of QDC MP 3.5

Flood Resilient Building Techniques

For most people, their home is their largest asset and investment and unfortunately (for some) also their most vulnerable. Flooding is recognised as being the most costly, yet most manageable, natural hazard.[12]

Pre-emptive planning and building controls have the potential to be far more cost-effective than retrofitted structural solutions aimed at eliminating flooding or reducing flood frequency or severity. However, the incorporation of flood resilient building techniques and strategies into existing developments in flood prone locations can improve the overall flood resilience of a dwelling or business premises. Flood resilient buildings include a range of measures which will result in reduced damages, facilitate a shorter clean-up periods resulting in an overall increase in resilience to floods.

Causes of flood damage

Flood damages on buildings arise from the following three fundamental actions:

1. *Contact* with water;
2. Inundation from varying water levels – *Immersion*;
3. Fast flowing floodwater to varying depths – *Forces*

The objective of structural modifications to a property for improved flood resilience should be to:

- reduce flood damage to critical structural components which, if damaged, can impair a building's structural performance;
- reduce post-flood repair and cleaning costs;
- allow occupants to return to their home or business more quickly after a flood.

The degree of damage and disruption

For a flood prone property the extent of damage, cost of repairs, inconvenience and cleaning required will depend on many factors which include[13]:

- depth and velocity of the water,
- period of inundation,
- debris loads and silt in the water,
- house location and its orientation to any flow,
- spacing of houses (which influence the velocity of the flow between buildings),
- materials used,
- construction detailing, and
- how quickly the house can be cleaned and completely dried out after a flood.

Flooded buildings that need only superficial repairs and cleaning can be reused quickly. In contrast, houses with major wall damage are difficult to assess structurally, and are likely to require lengthy and expensive reconstruction.

In many cases, modification of a design detail or by simply choosing a more flood-resistant building material, will improve a home's flood performance, as well as avoid high repair costs and prolonged recovery periods. [14]

[12] (Hawkesbury-Nepean Floodplain Management Steering Committee, 2006)

[13] (Hawkesbury-Nepean Floodplain Management Steering Committee, 2006)

[14] (Hawkesbury-Nepean Floodplain Management Steering Committee, 2006)

General Considerations

General considerations for retrofitting buildings or development sites within flood hazard areas include:

- Preventing flood waters from entering;
- Increasing floor levels;
- Modifying building components;
- Increasing structural soundness;
- Avoid increasing flooding on others;
- Maintaining safe car parking and access;
- Maintaining evacuation routes; and
- Ability to isolate power supply.

For industrial and commercial premises these may also include consideration for access to high level storage within the building and the backup and storage of essential records offsite.

Business owners would also be aware of the need to provide a safe working environment for employees, contractors, clients and customers under the requirements of the Occupational Health and Safety legislation.

Typical failure mechanisms in flood damaged buildings

When seeking to improve the flood resilience of an existing building it is worthwhile developing an understanding of the typical failure mechanisms experienced by flood damaged buildings.

Erosion

High flood flow velocities have the potential to erode surrounding natural or filled surfaces to expose the building foundations. Excessive erosion can undermine the foundations causing them to slump or collapse which in turn will structurally damage the floors, walls and ceilings connected to the foundations.

Loss of structural integrity

Timber wall framing, plasterboard, timber floor beams and floor boards will often lose their structure strength after they are immersed in water.

Wet plaster board has no structural integrity and hence any additional bracing offered by the use of plaster board should not be factored into design calculations in locations where there may be a risk of flood inundation.

Hydrostatic forces

When water levels are not equal on either side of a wall, the higher water level exudes unbalanced pressure on the wall. These pressures are often referred to as hydrostatic forces. In many cases of unbalanced hydrostatic forces the water is not moving however, the unbalanced pressure is still sufficient to cause damage and ultimately a failure.

Hydrodynamic forces

Moving water can be very destructive to buildings and structures. The pressures of moving water hitting a building are often referred to as the hydrodynamic forces. The deeper moving flood waters are, the greater the hydrodynamic forces are.

Hydrodynamic forces are capable of ‘pushing’ over/through walls and fences. Often the debris collected by moving flood waters adds to the potential for damage to any structures that are impacted by the debris.

In some instances, hydrodynamic forces can move a building from its footings or foundations. Any objects dislodged and carried by flood waters become a serious hazard to any structures in its flow path.

Structural decay

Porous wall insulation can absorb and hold water reducing the ability to ventilate wall cavities, which may facilitate structural decay and mould. Wall insulation wraps (i.e Sarking) may also hinder access to the cavities that require cleaning after immersion.

Try to avoid the temptation to lower the flood resilience of your property by saving on upfront building costs. Invest in appropriate designs and building materials to improve the long term resilience of your property.

Existing developments

Historical rainfall and flood height records show that the Sunshine Coast is susceptible to severe weather events that cause floods and hence the likelihood of the residents of the coast and the hinterland being affected by a flood in some way is high.

Coastal floodplains are attractive places to live, work and play. As a result, the pressure for land development is high. Substantial floodplain development has occurred on the Sunshine Coast prior to the present understanding of flood behaviour or future climate change. Many existing developments may in time become more exposed to increased levels of flood risk and coastal erosion that would not normally be acceptable.

For these potentially vulnerable existing developments flood resilient building techniques can often still be incorporated in anticipation of future flood events to protect the occupants and the buildings. However, some techniques may only be considered practical during the re-building or refurbishment of a damaged building following a flood or as part of a major renovation.

It is worth noting that if repairs following a flood are sufficiently major then they could qualify as “new work”, and be subject to all provisions of the QDC (MP 3.5) and hence also the NCC.[15] You should check with council or an authorised private certifier to see if your proposed works require a building approval or development application.

Improving the flood resilience of buildings can generally be divided into the following two approaches: dry flood proofing; and wet flood proofing.

Dry Flood Proofing

Dry flood proofing involves protecting habitable areas from exposure to flood water.

This may involve: raising all susceptible structures to be above any expected flood level; or building a perimeter wall or barrier to keep flood waters from entering a property; or by using specially designed doors, gates and seals to keep flood water from entering the interior of buildings.

Unfortunately, not all existing building designs will be suitable for attempting dry flood proofing.

A dry flood proofed building or barrier wall is subjected to significant hydrostatic pressure from the build-up of water on one side. Standard building techniques have generally not anticipated these forces and hence most existing building walls are not structurally capable of withstanding these forces without deflecting and possibly failing.

A dry flood proofing approach is generally not appropriate where anticipated flood depths around a building can be in excess of 1 metre and/or when anticipated flood flow velocities are in excess of 1.5 m/s.

Wet Flood Proofing

Wet flood proofing allows floodwaters to enter and leave a building and includes measures that prevent or reduce possible damage.

Wet flood proofing aims to make a building ‘flood resilient’, allowing water to enter a building via vents and openings that aim to minimise hydrostatic pressure and structural damage.

Wet proofing a building from flood allows water to enter the building without creating unbalanced water pressure on the walls which may lead to failure and collapse.

[15] (Australian Building Codes Board, November 2012)

Recommended reference

The Hawkesbury-Nepean Floodplain Management Steering Committee have published an excellent reference on reducing the vulnerability of buildings to flood damage.

Figure 11 Reducing the vulnerability of buildings to flood damage. (Hawkesbury-Nepean Floodplain Management Steering Committee, 2006)

The approach in these guidelines is to “wet flood proof” a house because depths of inundation in the Hawkesbury-Nepean area are potentially high.

On floodplains where water depth is anticipated to be in excess of 1 metre, it is generally better to allow water to enter the building to reduce water loads, which can cause structural damage or collapse the walls.

The Hawkesbury-Nepean guidelines suggest ways to achieve a reasonable level of protection against serious damage to a house subjected to a combination of water velocity and depth. They aim to provide a higher degree of protection against structural flood damage than exists with a traditional house.

New developments

New homes on the Sunshine Coast are required to have their floor levels 500mm above the anticipated 1% AEP flood level for projected climate and sea level conditions for 2100. These provisions do not guarantee that these homes will be free from flooding from larger events or combinations of conditions that were not designed for.

An accompanying guideline has also been prepared which provides a series of case study examples for new developments within flood sensitive locations.

Dry Flood-Proofing Techniques

The fundamental objective of dry flood-proofing is to protect habitable areas from being inundated by flood waters.

Raising floor levels

The most effective means of protecting habitable areas or work areas with stock and equipment from flood waters is to remove them from the risk of being inundated by raising or relocating these areas to be above the target flood level. The target flood level for a renovation to an existing property may not necessarily be the 1% AEP flood level due to other limitations of the property. Instead it may be a relatively small but frequent flood event. Targeting a smaller flood event may reduce the disruption caused by frequent nuisance flooding if circumstances do not permit larger events from being addressed.

For building renovations and extensions that do not increase the floor area of the building by more than 50% the QDC MP 3.5 does not apply and hence in these circumstances it is possible to adopt a target floor level to raise an existing floor to (or to add an additional floor over the same building foot print) that is lower than the 1% AEP flood level.

Adding an additional storey to a dwelling or business provides an opportunity for owners and occupants to protect themselves and their belongings from damage from inundation.

Raising the floor of an existing development may not be a practical consideration, especially for slab on ground developments. However, for some light weight buildings with framed constructions it may be plausible to raise the existing floor level.

Suspended timber floors may allow flood waters to pass beneath the building and are more adaptable to facilitate further raising of the floor level over time. If the timber elements of the flooring do become inundated then they may lose some of their structural integrity. They may also retain moisture and swell. Buildings with timber floors are significantly lighter and hence may also be more prone to movement and uplift from flood waters if they reach levels above the floor height.

Floor levels may only need to be raised enough to allow for flood waters to pass beneath the building. However, raising a floor level well above the anticipated flood level may also allow the space beneath to be utilised for more resilient activities such as

car parking or the temporary storage of goods and materials that are easily relocatable prior to a flood. Be aware that narrow or winding staircases may hinder the transfer of some items in an emergency.

Figure 12 Light weight house construction raised above target flood level

Figure 13 House with suspended timber flooring above defined flood level

When raising an existing building all the building material and surface treatments added below the 1% AEP flood level should be resistant to water damage and should avoid wall cavities that may be susceptible to the intrusion of water and sediment.

In some instances buildings that are raised above a target flood level may be required to include an appropriate form of screening around the building to ensure the underside of the building is not visible from the street. Consideration should be given to ensure that any screening does not impede the flood flows.

Figure 14 Raised timber framed house with flood resilient lower level building materials

Figure 15 Raised timber house with understorey screening

Highset construction

In high risk locations, including areas closest to the coast that may also experience storm surges, high-set construction is always recommended.

The Queensland Reconstruction Authority provides the following advice[16] for highset construction in storm tide prone areas. This advice is also relevant to areas of creek and river flooding, especially where high velocity flood waters may be experienced:

- Do not enclose underneath. Major forces during a storm tide are transferred from fixed wall structures into the structural frame and should be avoided. Where possible design for flow-through water movement.
- Consider openable enclosures. For security of vehicles and valuables consider the use of vertically rolling, sliding or stacking garage doors that can be enclosed in day-to-day use but fully retracted in response to a storm surge or flooding alert.
- Reinforce any lower level enclosure. Where there are enclosed spaces at the lower level, they should be built strong and compactly. Small laundry or workshop areas should be strong and fully lockable and as compact as possible for minimum resistance.

Figure 16 Highset house construction with raised lower floor level

[16] (Queensland Reconstruction Authority)

- Use minimal profile bracing systems. Use steel or timber bracing sets rather than shear walls for lower floor bracing. Consider transverse portal framing for wide column free openings.
- Consider impact resistance to tall columns. Storm surges and flood waters may propel vegetation, boulders or vehicles against the structure. Consider the impact resistance of tall columns and bracing sets. Consider more substantial column cross-sections than are required for wind-forces alone, and consider additional bracing sets to provide a degree of structural redundancy to cover for impact damage

Highset construction in flood prone areas should only permit low intensity uses, such as car parking, temporary storage and other non-habitable uses at ground level, preserving the upper floor levels for habitable purposes.

Flood retreat area

It may also be possible to add a flood retreat area as an upper level or extension to an existing property. If considering a flood retreat area ensure there is adequate access to the retreat zone to allow for readily moveable valuable items to be relocated quickly and efficiently. Wider doorways, stair cases and hallways should be considered in the design to allow the easy movement of furniture or equipment.

In locations where short duration flash flooding is a threat it may be preferable to plan for the relocation of people to flood free second storey levels of a structurally sound building rather than facing additional risks of trying to relocate occupants to locations of higher ground surface.

House raising is just one method of protecting existing housing. Local architectural issues relating to potentially undesirable impacts on the streetscape, visual impacts, privacy impacts and over shadowing may also need to be considered.

Please refer to the Sunshine Coast Planning Scheme 2014 for further details on requirements for your local area'

https://www.sunshinecoast.qld.gov.au/planningscheme/

Figure 17 Slab on ground lower level with second storey flood retreat area

Figure 18 Suspended timber lower habitable floor level and second storey flood retreat area

Slab on ground construction

Traditional slab on ground construction is very resilient to immersion and floatation however, the top of a slab will generally only be slightly higher than the surrounding ground surface and hence may still be prone to over floor inundation, even from local drainage flooding.

For ground floor extensions to buildings, with existing slab on ground construction, an elevated concrete slab will reduce the potential for water to enter the building over the floor height when the ground surface surrounding the building is inundated. (Refer to

Figure 22) This technique may require a step and ramp (or steps and ramp) to access from ground level. This option may be particularly relevant in wide flat floodplains where peak flood levels do not vary significantly in height and a relatively modest amount of addition elevation for an adjoining slab may be sufficient to offer a more tolerable level of exposure.

Flood scour

Moving flood water has the potential to scour and erode soils. Flood waters will also generally move faster when constricted between and around buildings. To prevent buildings and walls from being undermined deeper footings or piers may be needed in areas where moving flood waters may cause erosion.

Figure 19 Varying lowering floor levels of neighbouring properties

Figure 20 Eroded building footings from moving flood waters

Figure **21** illustrates the results of an assessment that determined an overall economic benefit achieved from having a flood free storey where the reduction in flood damages incurred for fixtures and contents exceeds the additional capital costs of the second storey.

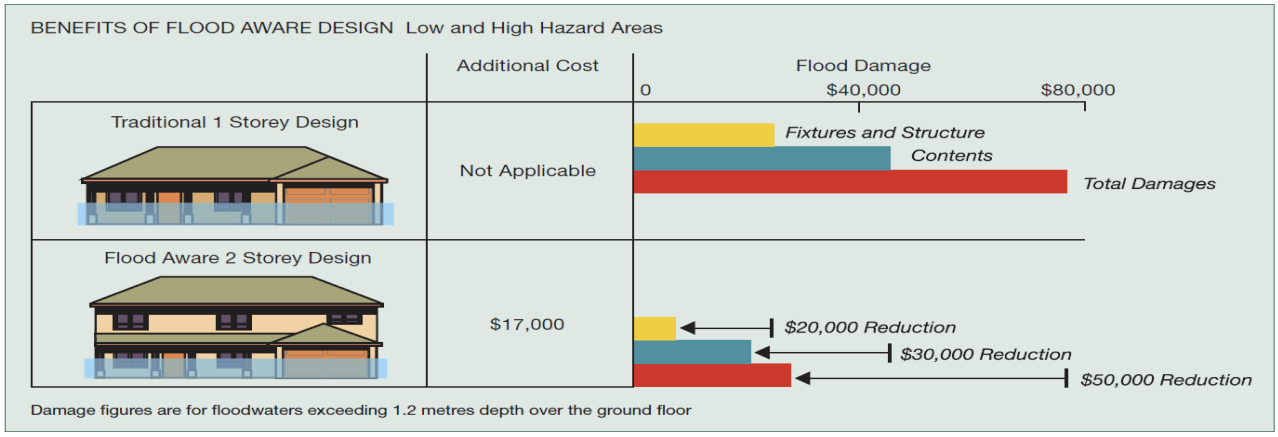


Figure 21 Reduction in overall food damage due to additional house storey[17]

Raising the slab 500-800mm on waffle pods (right) is very effective in reducing the possibility of the house being innundated in situations of overland flooding and where there is greater risk of the drainage infrastructure being overwhlemed by intensive localised flooding and blockages.

Figure 22 Elevated slab on ground illustration[18]

[17] Managing Flood Risk Through Planning Opportunites (Figure 52) Hawkesbury-Nepean Floodplain Management Steering Committee, Parramatta, June 2006

[18] Reducing Vulnerability Of Buildings To Flood Damage Hawkesbury-Nepean Floodplain Management Steering Committee, Parramatta, June 2006

Onsite perimeter barrier

Where it is not practical to consider raising the habitable floor area, an alternate method to dry proof a building may be to erect a perimeter barrier around the building or property to prevent flood waters from coming into contact with the building.

A perimeter barrier may be a masonry, or concrete, wall or a compacted earth bund. Barriers to prevent the ingress of flood waters are only likely to be suitable for locations where the target flood depth is less than 1 metre.

Partially filling your site to keep flood waters out may require a development approval for filling. Check Council's planning scheme provisions for filling or consult with an authorised building certifier.

Common issues that require thought when considering a perimeter barrier include the:

- potential impact on neighbouring properties due to the impediment of flow caused by the barrier;
- potential impact of the displacement of the equivalent volume of flood waters that would have otherwise occupied the bunded area;
- reliability of any mechanisms or actions required to be engaged to seal access openings in the perimeter barrier at the time of a flood; and
- time and resources required to implement.

It is not permissible for any flood resilience building works to adversely impact upon other properties.

Temporary and demountable flood barriers

Temporary and demountable flood barriers are designed to be erected immediately prior to a flood and then removed after the threat of flooding has passed.

Temporary and demountable barriers may be useful where permanent structural measures to prevent flooding are not economically or structurally possible.

Temporary barriers may include soft flexible systems that inflate or fill with water as it rises or they may be rigid structural items that may be self-supporting once erected or fit within an existing structural feature, such as a doorway, gateway or driveway.

Important considerations for temporary barriers include having an understanding of:

- what the trigger or threshold is for erecting/installing the barrier;
- who can erect it;
- where will the temporary barrier be stored when not in use;
- special storage requirements to protect the barrier from damage or deterioration;
- ongoing maintenance requirements;
- how will people pass through or over the temporary barrier when it is erect; and
- what are the consequences of it failing?

The following images are examples of a proprietary flexible temporary flood barrier system.[19]

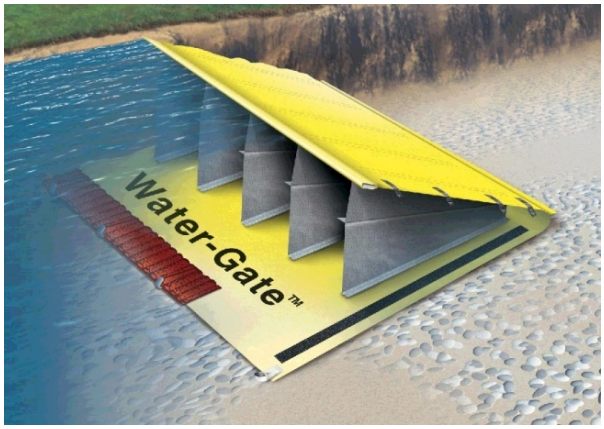


Figure 23 Temporary flexible flood barrier- Water-Gate (www.hydroresponse.com)

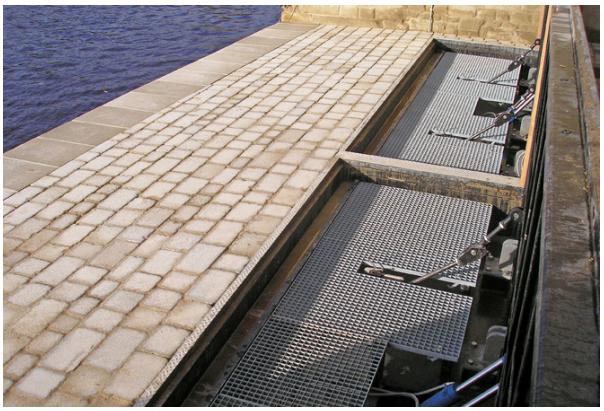
Figure 24 Temporary flexible flood barrier (www.hydroresponse.com)

Figure 25 Temporary rigid flood barrier (www.hydroresponse.com)

[19] The inclusion of these images in this guideline is not to be interpreted as an endorsement of this product by the Sunshine Coast Council. These images are provided for demonstration purposes only. To view other flood barrier systems, enter flood barriers into your favourite search engine.

Activated flood barriers

Activated flood barriers are a form of temporary flood barrier that are permanently in place and deployed via an electrical/mechanical system. Activated flood barriers may be automatically triggered to self-erect in the event of flood waters reaching a set threshold or they may be manually initiated following a procedure to check for obstructions or potential access issues.



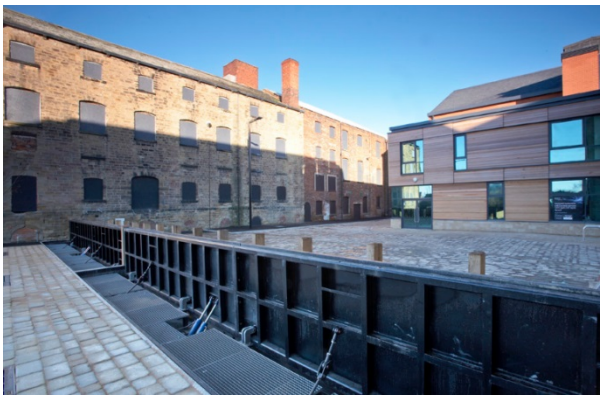


Figure 26 Flip-Up activated flood barrier example (www.aquobex.com/products/flip-upbarrier)

Figure 27 Flip-Up activated flood barrier example (www.architects24.com)

Figure 28 Flip-Up activated flood barrier for basement carpark entrance example (www.floodingsolutions.com.au)

Passive flood barrier systems

Passive flood barrier systems do not require people or electricity to engage/erect the system. Passive flood barrier systems are structurally rigid and designed to self-erect based on floatation and buoyancy principles linked to the water levels of the flooding source.

Passive flood barrier systems are well suited to protecting underground carparks from inundation overtopping the driveway access and flooding the basement carparks.

Figure 29 Large scale passive flood barrier system – panel installation A (www.globalfloodds.com)

Figure 30 Large scale passive flood barrier system – panel installation B (www.globalfloodds.com)

Figure 31 Flow Defence passive flood barrier systems based here on the Sunshine Coast (http://www.flowdefence.com/)

Figure 32 Large scale passive flood barrier system – panel engaged (www.globalfloodds.com)

Figure 33 Passive flood barrier system – basement carpark entrance (www.flood-barriers.com)

Permanent flood protection barriers

Permanent flood protection barriers offer a reliable means of preventing flood waters from entering a property or a community.

Glass flood protection panels, are becoming more common in public locations seeking to preserve a visual connection with the natural waterway or water body whilst providing flood protection.

Figure 34 Permanent flood wall providing community protection (www.coolgeography.co.uk/)

Figure 35 Permanent flood wall providing community protection, Binghamton New York

Figure 36 Permanent glass flood protection panels – public flood defence system application (www.floodcontrolinternational.com)

Figure 37 Glass flood protection panels (www.careyglass.com)

Dry flood proofing a building

Walls

A single storey brick veneer house built to current standards, together with its contents, is the most vulnerable type of housing to suffer flood damage. (Queensland Reconstruction Authority)

Pre-fabricated or tilt-up concrete panels of full brick/block construction offer a lower susceptibility to damage from flooding than brick veneer and stud framed dwellings.

Concrete Walls (including concrete panels, blockwork and poured in-situ concrete) are the most resilient to damage from contact, immersion and the velocity of flood waters. These structures are readily cleaned and add mass to a building to reduce the potential for floatation and movement.

Buildings with external brick veneer walls and framed internal walls are generally not suitable for dry proofing. External brick veneer walls are not designed for the water pressures imposed on dry proofed buildings. Water pressure associated with the build up of water only on the external face of a brick veneer wall may cause the wall to deform and ultimately collapse.

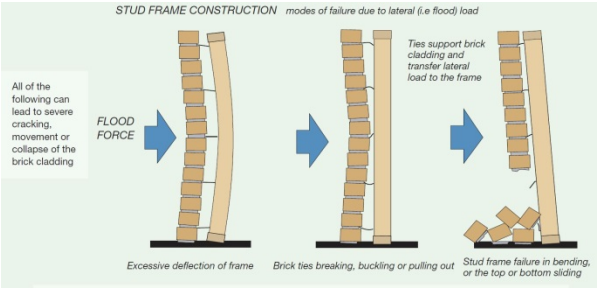


Figure 38 Typical brick veneer wall failure from flood forces (Hawkesbury-Nepean Floodplain Management Steering Committee, 2006)

Traditionally constructed brick veneer houses are particularly vulnerable where velocities greater than 0.8 metres / second will occur. As such, alternative building types are suggested for locations where such velocities could occur in floods up to and including the defined flood event or largest historical flood on record.

Buildings with external brick veneer or cavity brick walls will normally include ventilation slots between the outer wall and the internal face or cavity. To dry flood proof a brick building will require these ventilation slots to be temporarily sealed during the flood event. Unsealed brick and mortar walls are still porous and will absorb moisture from flood waters whilst they are immersed.

It may take weeks or even months for masonry to completely dry out after being immersed in flood waters.

Sealing doorways and access points

Adequate sealing of doorways and access points is critical to dry flood proofing a building.

Doorways and access points can be sealed using a variety of proprietary flood doors and gates. Permanently installed flood doors and flood gates also offer the convenience of rapid deployment in response to flash flood conditions and the containment of chemical spills.

Flood doors and gates require little or no long term maintenance.

Flood doors

Specifically designed flood doors are a good option for retrofitting to existing buildings. Flood doors built with water tight compression seals are in place ready for use without the need for deployment arrangements. Flood doors offer good floor to ceiling flood depth protection and should be designed for easy single person engagement. Flood doors offer additional general security to access points and can be left fully engaged whenever the building or site is unattended, even for long periods of time.

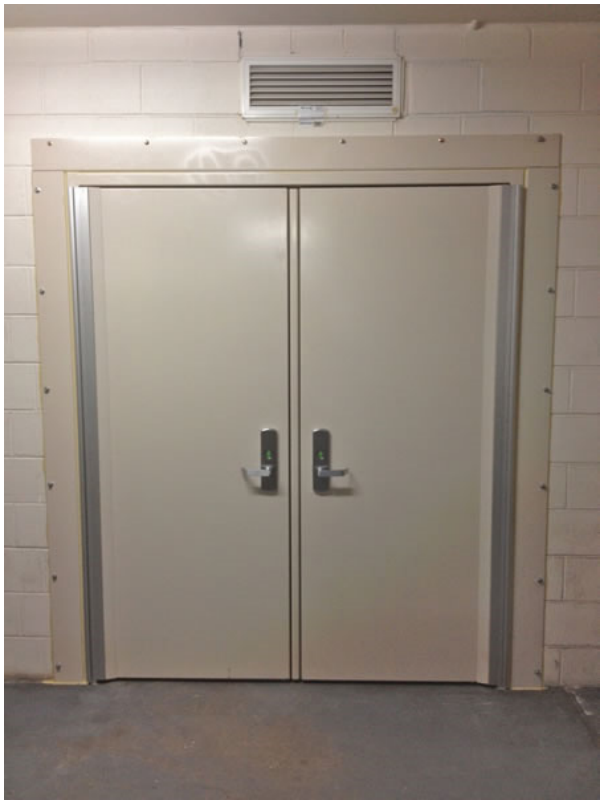


Figure 39 Utility application of a flood door (www.hochwasserschutz-rs.de/en/flutschutz-turen-fst-s-2)

Figure 40 Commercial/Industrial flood door application (www.floodingsolutions.com.au)

Permanent flood gates

Flood gates function in a similar manner to flood doors however, are often installed to only protect up to a partial height of the full access height clearance. As per flood doors, flood gates offer the convenience of always being in place and ready for deployment. There are a number of options for the installation and operation of flood gates.

Flood gates typically operate from either a simple swing hinge which positions the gate against a step or edge beam or for locations requiring a level access surface with no steps or beams, a lift and swing hinge can be used. The lift and swing hinge allows the door to be raised slightly above the ground surface level and then lowered into place flush to the ground surface. A lift and swing gate will usually include a compression seal along the base of the gate to ensure water tightness.

Wide span openings can also be covered by pairing flood gates to close across the opening.

Figure 41 Domestic flood door application (www.doorfactory.co.uk)

Side vertical pivoting flood gates are suitable in locations where side room, head room, and storage room are not available and placement of flood barriers needs to be accomplished by minimal staff. Pivoting flood gates can be manually lowered mechanically or by cable and winch.

Figure 42 Swing hinged flood gate - domestic (www.thefpa.org.uk)

Figure 43 Lift and swing hinged flood gate - industrial (www.psdoors.com)

Figure 44 Lift and swing hinged flood gate (www.floodcontroltechnology.com.au)

In locations where sufficient vertical height is available, flood gates may be stored in a raised position above the access point and lowered vertically into position when required.

Figure 45 Side vertical pivoting flood gate (www.floodcontroltechnology.com.au)

Figure 46 Vertical lift and drop flood gates (www.floodingsolutions.com.au)

Temporary and demountable flood panels

Temporary and demountable flood panels are totally removable and designed to offer the same degree of flood protection as permanently installed flood gates.

Temporary and demountable flood panels may be appropriate where physical limitations or building aesthetics preclude the installation of a permanently installed gate.

Temporary and demountable flood panels may impede access to and from a building whilst they are in place if there are no other accesses available at that level.

Temporary and demountable flood panels may be used for domestic or commercial applications and may also be deployed for public flood defence systems such as access points through flood levees and other forms of flood barriers.

Temporary and demountable flood panels require storage of the gate elements and may require training of staff to correctly erect the gate system. Temporary flood panels may be comprised of a series of lightweight planks which seal or interlock to ensure water tightness or may consist of a single panel. Temporary and demountable flood panels will usually require fixing points to be permanently installed to ensure the gates are located in the appropriate position and are provided with a structurally reliable brace and seal.

Figure 48 Temporary demountable flood gate (www.floodingsolutions.com.au)

Figure 47 Temporary demountable flood gate (www.floodpanel.com)

Figure 49 On-site flood panel storage box (www.floodcontrolinternational.com)

Glass flood protection panels

Glass flood protection panels, also referred to a flood resistant glazing, are more commonly used in commercial shop fronts and in locations seeking to preserve a visual connection with the natural waterway or water body whilst providing flood protection.

Figure 50 Glass flood protection panels – commercial application (www.floodcontrolinternational.com)

Figure 51 Flood resistant glazing (www.floodingsolutions.com.au/flood-windows)

Protection from high velocity flood waters

High flood water velocities are generally found nearer to the main waterways or where flow paths and floodplains narrow.

Even in relatively low flood velocity areas, high and possibly destructive localised water velocities can be experienced around buildings and structures where these structures offer a constriction to the wider floodplain flow paths.

Dry flood proofing barrier systems may constrict the normal flow path of flood waters causing a localised increase in flood flow velocity. Hence, any flood barrier system should be design to not only offer watertight flood protection to a building or property but also to resist the hydrodynamic forces of a flood.

Wet Flood Proofing Building Techniques

Flood resilient houses (also called Wet Flood-proofing) make use of materials that are undamaged by minor inundation during significant flood events.

The first instinct is to keep floodwater out, but at times there are advantages in allowing floodwater into the house.

Typically, the longer floodwaters linger, the more resilient house construction materials need to be and the more post-flood clean up work and cosmetic repair is necessary.

Accepting the passage of water allows for a changed relationship to water and flooding events, and a lessening of the anxiety associated with them.[20]

Wet flood proofing includes measures applied to a building that prevent or reduce damage from flooding while allowing floodwaters to enter and leave the building.

Wet flood proofing aims to make a building 'flood resilient', allowing water to enter a building via vents and openings that aims to minimise hydrostatic pressure and structural damage.

Wet proofing a building from flood allows water to enter the building without creating unbalanced water pressure on the walls which may lead to failure and collapse.

Floors

Low level floors of flood prone buildings need to be resilient to immersion and capable of being readily cleaned and dried following inundation.

Absorbent floor coverings should be avoided.

Timber floors

Timber floor components are more prone to damage from flood waters and may need replacing or repairing after each inundation event. Timber flooring may swell and cup following inundation and may also lose some structural integrity.

Timber floors of flood prone buildings should be well ventilated to ensure drying and to prevent the long term decay of timber components.

Suspended timber floors may allow flood waters to pass beneath the building and are more adaptable to facilitate further raising of the floor level over time. If the timber elements of the flooring do become inundated then they may lose some of their structural integrity. They may also retain moisture and swell. Buildings with timber floors are significantly lighter and hence may be more prone to movement and uplift from flood waters if they reach levels above the floor height. An alternative to timber flooring may be for a tile floor on a fibre cement floor sheeting substrate, or a floating timber floor over a marine grade ply substrate.

Concrete slab on ground construction

More than nine out of ten houses now built in Australia have a concrete slab ground floor.

Traditional slab on ground construction is very resilient to immersion and floatation however, will generally only be slightly higher than the surrounding ground surface and hence may still be prone to over floor inundation, even from local drainage flooding.

For flood prone floor levels, consider using polished concrete floors or ceramic tiles with sunken door sill details for easy washing out of flood waters and silt after an event.

Quality floor covering such as high quality tiles, water proof adhesive and quality moisture resistant backing should resist a flood of moderate duration (less than 24 hours). Floods of longer periods are likely to result in deterioration of the backing. However, tile lifting could occur in short floods if any of the components are of marginal quality. If only isolated tiles are lifting it may be possible to replace these tiles.[21]

Slab and foundation scour

Flowing water can also have a significant scouring effect on the foundation soil, so this needs to be protected against erosion. Deeper footings may be needed in areas where moving flood waters may cause

[20] (DAVIDSON, 2013)

[21] (CSIRO)

erosion. Build deep perimeter footings to prevent undermining of slabs and walls.

Walls

The successful wet proofing of a building is dependent upon the resilience of the building material used and the ability to equalise the water pressures by balancing the external and internal water levels.

If the openings for flood water to enter the building are too small or too few, then the rate at which the flood water rises may result in an uneven pressure across the wall potentially causing a failure.

Typical options for creating an opening to allow flood waters to enter (and exist) from a building include:

- Vents in external brickwork and internal walls;
- Additional weepholes;
- Hinged “pet doors”

Typically, the longer floodwaters linger, the more resilient house construction materials need to be and the more post-flood clean up work and cosmetic repair is necessary.

Concrete panels

Pre-fabricated or tilt-up concrete panels or full brick/block construction offer a lower susceptibility to damage from flooding than brick veneer and stud framed dwellings. These structures are readily cleaned and add mass to a building to reduce the potential for floatation and movement.

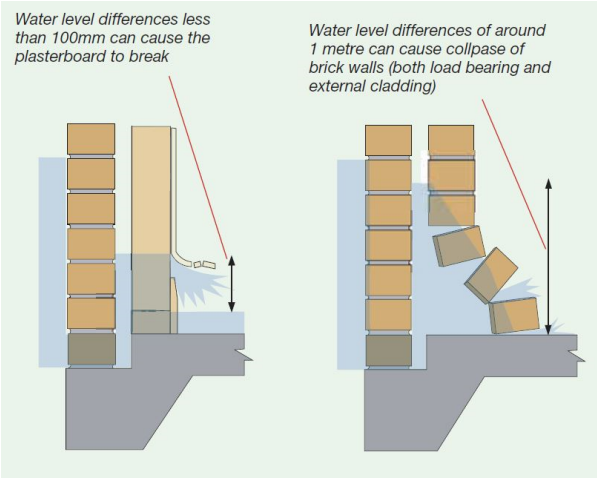


Figure 52 Internal plaster and cavity brick failure due to uneven water pressure (H-N FMSC 2006a)

Concrete block

Core filled concrete block walls are a flood resilient, structurally sound building wall material. Flood resilient render can be added to improve and customise the aesthetic appearance of the block work. The absence of any cavities prevents these wall types from trapping moisture and silt. They are easily cleaned and offer a high degree of flood resilience. Wall cavities can be difficult to clean and also difficult to dry.

To meet current NCC requirements for energy efficiency, these types of single skin walls may not be acceptable. An insulation layer may be required as an internal wall lining and insulation. This can still be flood resilient if the wall lining was to be Fibre Cement and non fibre insulation used.

Brick veneer

Brick veneer walls are the most common form of residential wall construction. Brick veneer walls typically consists of a single outer brick wall tied to an internal timber or steel frame. Plasterboard is fastened to the internal frame to seal the cavity and to create the internal wall surfaces. Insulation is often applied in the cavity between the brick wall and the frame.

Timber frames

According to the US Federal Emergency Management Agency (FEMA), structural damage to buildings caused by natural hazards – such as strong wind, waves, flooding and earthquakes – are usually not initiated by the timber members breaking under the higher loadings. Structural failure often begins with the connection between the individual timber members as this is normally the weakest point. In many cases, replacing conventional nailing with a sheet metal connector produces a connection over 10 times stronger[22].

Galvanised steel strap bracing is recommended for timber frames as it does not lose its structural strength even after long periods of immersion. Where hard sheeting is still used for bracing a timber frame, additional nails are recommended to secure the hardwood to the frame. Timber bracing should only be considered in locations where immersion times are understood to be short. i.e flash flooding conditions.

Steel frames

Steel frames are a good alternative to timber frames for flood prone buildings. Steel frames do not lose their structural integrity if immersed for long periods. It is recommended that holes be drilled at a regular spacing along the side of a steel frame base plate to allow easy cleaning and to avoid silt and water from accumulating within the frame recess.

Plasterboard

Plasterboard that has been inundated will generally lose its structural strength. Plasterboard will absorb water and is likely to sag due to the increased weight.

Fibre Cement Wall Sheeting

For flood prone areas substitute plasterboard for Fibre Cement wall sheeting. It is recommended to leave at least 30mm above bottom wall plate or cut notches to allow entry of water, ventilation and silt removal. Use deeper skirting boards to cover openings at the base of the lining. Ensure that the bottom edge of the Fibre Cement sheeting is supported by vertical nogging that will allow water and silt to drain.

Wall insulation

It is recommended that you choose wall insulation with minimal absorption characteristics. Consider additional ventilation (above standard requirements) for wall cavities of external walls in flood prone locations to assist with drying out cavities and reducing the potential for mould and decay.

Stairs

Design stairs to allow for the easy movement of furniture or stock to higher flood free floor levels during a flood event. Ensure stairway widths are sufficient to allow valuable items to relocated before a flood.

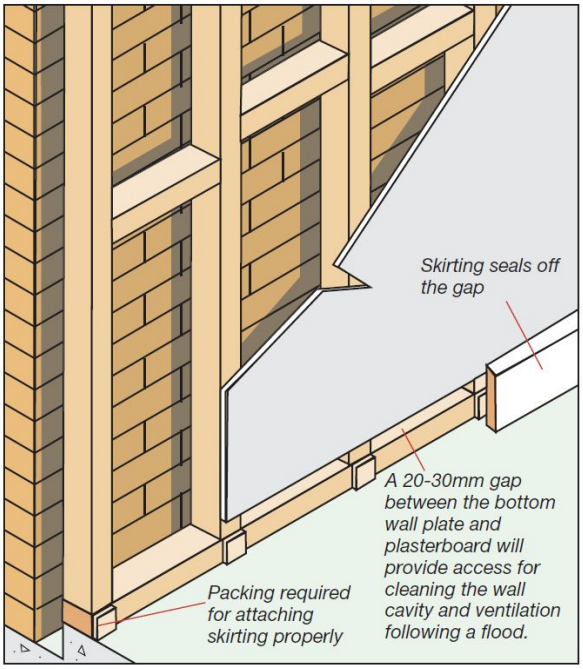


Figure 53 Recommend substituting plasterboard for fibre cement sheeting. Leave a gap at the base of fibre cement sheeting for drainage and ventilation. (H-N FMSC 2006a)

[22] (Hawkesbury-Nepean Floodplain Management Steering Committee, 2006)

Ceilings

Air pressure can build up as water levels rise and trapped air cannot escape. Vents placed in the ceiling can allow air to pass through the ceiling without causing damage.

Inside the home or business

An important objective for a flood resilient house is to provide the potential for continued occupation during a flood event, when services may be cut for several days.

A resilient house that is inundated requires any low-level, built-in wardrobes, kitchen cupboards, bathroom vanities, linen presses and laundry stores to be made of resilient materials. Where possible, cupboards should be suspended from walls, not on a plinth, so there is a gap between floor and cupboard bases. Cabnets should be steel framed with marine ply carcass.

More-robust alternatives for cupboards are reconstituted stone or masonry vertical supports or polished concrete bench tops with painted fibre cement shelving. Plinths for these cupboards can be formed concrete.

Joinery on lower flood prone levels should be constructed of marine grade ply.

Houses with internal masonry walls on slab floors can be built without skirting boards, or architraves on windows and doors. The omission of these items simplifies cleaning and makes for a more resilient finish.

Electrical systems

Power is often required to be disconnected in floods and cyclones for safety reasons to ensure that people do not sustain electricity associated injuries.

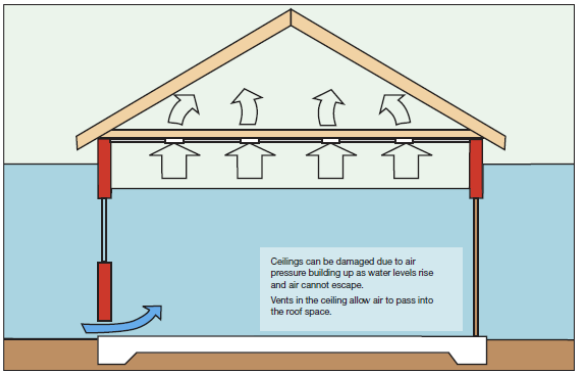


Figure 54 Use ceiling vents to reduce air pressure in a wet flood proofed building

This is done for the benefit and safety of everyone. The electricity network will sustain less damage during a flood or cyclone event when the power is pre-emptively disconnected.

Unplug and do not use any electrical appliances affected by water and have them inspected by a licensed electrical contractor before use.

If you are in any doubt about the switchboard's safety, stay clear and call your licensed electrical contractor.

Licensed electricians and plumbers must do electrical and plumbing installations respectively. They should be consulted when renovating or extending houses in flood-prone areas. The electrical system, including meter, power outlets and light switches can be short-circuited or damaged by floodwater exposure.

Installing electrical systems as high as possible minimises these problems. All internal wiring, power outlets and switches should, where possible, be set above the worstcase flood height. Positioning power outlets about a metre above the floor is unusual, but convenient for everyday use. Where lower power connections are unavoidable they should incorporate an above-flood isolation switch.

In existing buildings, investigate how electrical equipment can also be raised – at the very least raise the low voltage switchboard above the defined flood level to allow connection to a generator.

At a minimum ensure there is an emergency connection power point above the Defined Flood Level. This will provide power supply during the clean up operation when the available supply is safe to use. This is a simple and low cost solution to supply power so that you do not need to use a generator to run electrical tools in the cleanup process.

The elevated switchboard or meter box must be in a position that allows sufficient access for electricity distributors and/or qualified electricians.

You may wish to separate the meter from the switchboard so that the meter can be read easily by the meter reader but the switchboard remains elevated.

It is important to understand that elevating the electrical equipment will not mean that you won't lose power, but it will assist you in sustaining less damage to the electrical equipment in your house, which will mean that you will be reconnected to the power supply sooner.

Connecting generators

It is critical that there is a connection for generators available and that this connection is easily accessible. Building owners and operators will then be able to organise temporary power supply through the use of a generator.

Do not use generators in an enclosed place as this can lead to carbon monoxide poisoning which can be fatal.

Do not modify and plug generators directly into powerpoints in the home or into any part of the distribution network. This will send electricity through the switchboard and into the powerlines, which is a significant safety risk.

Plumbing

For plumbing installations, sewage backflow during a flood is a possibility. Backflow can be prevented by the installation of a reflux valve in the sewer line. Backflow prevention valves are a performance requirement of the QDC MP 3.5.

Protecting items outside of your home or business building

For properties within a flood prone area, any unsecured items or structures located above ground level may be at risk of being damaged by immersion or at risk from being swept away by flood waters. Large items may present a further risk to buildings and other structures from collision.

Protecting vehicles and equipment

Avoid keeping high value items such as cars, machinery, stock, sporting equipment and white goods in locations vulnerable to floods.

Large valuables like vehicles, boats, caravans and trailers should be evacuated when emergency warnings are announced. You should develop a practical plan to move these items to a pre-determined location on higher ground. Your plan to move these items should ensure it is done early enough so you do not put yourself or your staff or family at risk.

Be sure to discuss this plan with your staff or family and periodically review it to ensure it reflects the items that may require moving.

Car Parking

The collective value of parked vehicles and stored items is considerable. Basement parking should ideally be fully flood protected minimising the reliance on mechanical devices. To avoid early inundation, they should be designed with elevated entry ramps, ventilation entry points and pedestrian exits.

The hazardous nature of underground car parks emphasises the need for full public awareness to ensure prompt and early evacuation of cars from the car park before the evacuation routes become impassable and before the car park becomes flooded.

To assist in evacuation of vehicles, car park exits should direct drivers to a continuously rising evacuation routes. Signage advising of flood levels and clearly marked exits to evacuation routes would assist in maintaining public awareness.

Fencing

Standard wire or paling property fencing may catch debris and other floating material in flood waters. If the debris causes a significant impediment to the flow of water through the fence then water pressure will build up against the debris. In most cases, standard property fencing is not designed for these types of unbalanced forces and may cause the fencing to collapse or be torn away from support posts. Dislodged fencing is a significant hazard to people and nearby structures.

Wire fencing can be designed and installed to lift away from the support posts and to pivot around a fixed horizontal support allowing the base of the wire fencing to lift as water passes beneath.

A deceptively thin line of debris laden fencing can offer a significant localised impediment to flood waters, increasing flood levels immediately upstream. This localised increase in upstream flood levels can also be accompanied by a sudden surge of flood waters immediately downstream when the fencing collapses.

Water Tanks

External water tanks are once again a common feature in residential and commercial developments. Plastic and metal water tanks are generally not fastened to the ground or to the building. Water tanks are capable of being dislodged and carried away by moving flood waters and may present a significant hazard to other structures. Whilst most water tanks would be expected to be full due to the rainfall contributing to the flooding it is still possible that some air gap remains which may cause the tank to become buoyant. Partially full water tanks, where rainfall has ceased and consumption has reduced the stored volume of water prior to the arrival of floodwaters are even more likely to be dislodged.

In flood prone locations, above ground water tanks should be securely fixed to a structural footing. Reinforced concrete tanks should be considered for locations where high flood water velocities are expected to resist flowing water forces.

Special attention should be given to underground water tanks to prevent them from becoming buoyant and lifting out of the ground. If flood waters have submerged the site of an underground water tank, or exceeded the inlet height of an external water tank, then the captured water will be polluted and should not be consumed. In these circumstances, the tanks should be drained and cleaned before use.

Storage and shipping containers

Storage and shipping containers that are not secured to the ground or other immovable object have the potential to be dislodged by flood waters and to become a significant threat to downstream properties.

All containers stored within a known floodplain or flow path should be secured to prevent floatation and movement. If containers cannot be adequately secured they should either be elevated above the anticipated flood height or relocated to a flood free site.

Owners of containers that cause damage to other properties may be liable for the cost of repairs.

Figure 55 A unsecured shipping container deposited against the Country Life Hotel at Kin Kin during flash floods.

Flood Insurance

The Insurance Council of Australia (ICA) is the representative body of the general insurance industry in Australia.

The ICA supplies to the Commonwealth Treasury each quarter as part of an insurance industry undertaking to help the Federal Government monitor consumer choices concerning the purchase of residential flood insurance policies. The data[23] demonstrates that flood insurance is available to all Australian property owners in a variety of policy formats designed to suit individual circumstances. About 7 per cent of (insurance) consumers have some exposure to flood risks. Consumers can choose to purchase products with flood cover as a standard inclusion, products that allow the consumer to opt out of the flood component, or products that exclude flood from the policy.

What is a 'flood?'

In 2011, the Australian Government announced the introduction of a standard definition of 'flood' for certain insurance policies. The announcement was part of the Government's response to the recommendations in the Natural Disaster Insurance Review report.

The standard definition applies when an insurer offers flood cover for a home building, home contents, small business or strata title insurance policy.

The standard definition for 'flood' is :

Flood means the covering of normally dry land by water that has escaped or been released from the normal confines of:

(a) any lake, or any river, creek or other natural watercourse, whether or not altered or modified;

or

(b) any reservoir, canal, or dam.'

The above definition specifically refers to flooding from natural watercourses and in doing so may exclude local drainage flooding which generally occurs from an intense burst

[23] www.insurancecouncil.com.au/industry-statistics-data/flood-cover

of rainfall over a short period of time over a local stormwater drainage catchment.

Whilst this standard definition reduces uncertainties related to defining a flood it is a matter for each insurer to decide if and how they will cover loss associated with a flood.

When choosing a policy

When choosing an insurance policy for your home, contents or business; consumers should first seek to understand:

1. the property's level of exposure to flooding;
2. the likely nature and source of the flooding; and
3. the likely consequences of the flooding.

Consumers should then read the product disclosure statements for policies being considered, and then satisfy themselves that the policy does not exclude any factor contributing to a loss due to flooding. If you are uncertain, seek professional advice from a Registered Professional Engineer of Queensland (RPEQ) to clarify your potential flood exposure and/or a registered insurance agent to identify an appropriate policy and insurer.

ICA notes that a property should be designed so that it is resilient to the hazards present in the environment, both today and into the future to the end of the expected life-span of the building. Property owners and developers should ensure that appropriate materials and design are employed to ensure that the property will survive the predicted intensity of natural hazards in their region into the future.

ICA also notes that minimum building standards in Australia do not cater for property protection, only safety, allowing occupants time to egress before a building constructed to a minimum standard becomes untenable.

Australian Resilience Taskforce

The Australian Resilience Taskforce (ART) is an initiative of the ICA. It is intended as a platform for collaboration, and alignment across government, industry and non-government organisations to enable increased resilience in Australian communities.

The Taskforce is a forum to house and progress practical project driven activities, focussed on encouraging intelligent buildings that through design and material choice are resilient to local hazards.

Building Resilience Rating Tool

Through the ART the ICA is funding the development of a Building Resilience Rating Tool (BRRT). The tool aims to stimulate best-practice resilience in residential buildings across Australia.

The Building Resilience Rating Tool (BRRT)[24] is intended to rate the resilience of your home to common extreme weather hazards. A rating from the BRRT will provide you with information concerning which parts of your home are most at risk. You will be able to explore alternative building elements to see how you can increase your resilience.

The BRRT is supported by a database of building materials and the ICA anticipates that this initiative will also drive the production of more resilient building materials.

The ICA has been working on increasing the resilience of the built environment for a number of years and has been developing the BRRT since 2010. The BRRT Development Team has engaged with over 120 stakeholders; extensively researched the resilience and durability of building materials; and developed calculations and formulations to form the basis of the BRRT. The methodology of the BRRT has been supported and informed by an Expert Advisory Group.

After a flood event

Making early contact with your insurer and knowing what to do while you are waiting for your insurance assessment can make a big difference to your peace of mind. The Insurance Council of Australia provides assistance to anyone experiencing problems in resolving insurance issues. See www.insurancecouncil.com.au for further information.

[24] BRRT 2.0 has been released for beta testing by relevant experts and stakeholders. Check www.buildingresilience.org.au/brrt for more details.

During a flood event

Improving flood resilience also requires appropriate actions to be undertaken during a flood event.

During a flood event it is recommended[25] that you:

- Stay tuned to local media for flood warnings - know where to look or listen for flood warnings. Check with RACQ for safe driving routes. Don't ignore flood warnings
- Follow instructions from authorities – adhere to road closure signs, detours and other instructions regarding movement, limit nonessential movements. Don't drive in flood waters unless instructed to do so by authorities. Driving through flood water is the number one cause of flood deaths. Remember" If its Flooded Forget It!"
- Don't enter flood waters or drains. Keep children away from flood water.
- Ensure children do not play in or near storm water drains. Suction and entrapment may occur suddenly and unexpectedly.
- Locate children in a safe place if you need to leave them alone to attend to a flooding situation.
- Prepare to evacuate if necessary. Allow time to assist dependents. Deal with pets and animals as per your flood emergency plan.
- Don't use electrical or gas appliances during floods. Don't drink flood water or eat contaminated food.
- Don't delay your actions or panic if situations worsen.
- Where possible communicate with friends, family, colleagues or neighbours to inform them of your situation and your intentions.
- Never walk or wade through flood waters. As little as 15cm of moving water can knock you off your feet.
- Stay clear of fallen power lines. Electricity passes easily through water.
- Wash your hands and feet with soap if you do come into contact with flood water. Sewage or chemicals can be found in flood water.
- Tread carefully. Slippery surfaces can cause falls and injuries.
- Contact the SES on 131 500 if you need assistance.
- In a life threatening emergency contact 000.

[25] FEMA www.ready.gov/floods

After a flood event

After a flood event your road to recovery and improved resilience begins. A flood can cause physical hazards and emotional stress. You need to look after yourself and your family as you focus on cleanup and repair.

Immediately after a flood event

Be aware that although flood waters may have receded there may still be many dangers present within or around your property and community.

- Stay away from damaged areas unless your assistance has been specifically requested by police, fire, or relief organization.
- Emergency workers will be assisting people in flooded areas. You can help them by staying off the roads and out of the way.
- If you have left your home or business only return when authorities indicate that it is safe to do so.
- If you must enter areas that have been flooded, stay on firm ground. Avoid standing water as it may be electrically charged from underground or downed power lines.
- Stay away from creek or river banks as they may be unstable.
- Be aware that where flood waters have receded from a roadway the roadway may have weakened and may subside due to the weight of a vehicle.
- Roads that have been closed may require a formal inspection from an authorised person before they can be opened.
- Stay out of any building if it is surrounded by floodwaters.
- Use extreme caution when entering buildings; there may be hidden damage, and dangers.
- Listen for news reports to learn whether your local water supply is safe to drink.

When returning to your property

When returning to your property consideration of the following items[26] will reduce your exposure to hazards and keep you healthy whilst you recover.

- Avoid contact with floodwater. Never drive, ride, walk or play in floodwater!
- Ensure the structural stability of your property before entering. Check for damage to windows, walls and the roof and be especially cautious of potential contaminants including asbestos.
- Turn off the electricity at the main breaker or fuse box, even if the power is off in your community. That way, you can decide when your home is dry enough to turn it back on. before going inside. Use a torch to carry out inspections inside buildings.
- If power points, electrical equipment, appliances or electrical hot water systems have been exposed to floodwater or are water damaged in any way, they must be inspected by a qualified electrician before use.
- Gas appliances and gas bottles that have been exposed to floodwater should be inspected for safety before use.
- Wear suitable protective clothing, including boots, gloves and eye protection when cleaning up. Asthmatics or anyone cleaning mould may want to protect themselves with a dust mask.
- Be aware of any slip, trip or fall hazards.
- Never eat food which has been in contact with floodwater. Throughout any food that may have been damaged or spoiled. If in doubt, throw it out. Unfortunately, this also applies to home-grown garden fruits and vegetables that may have come into contact with flood waters.
- Only use clean utensils and personal items.
- Have a supply of fresh drinking water and drink plenty of water to avoid dehydration. Only drink water that you know is safe, such as bottled water or water that has been boiled. Normal water supplies may be contaminated
- Do not drink or use the town water supply until the local authorities confirm it is safe.
- Once the local authority confirms the safety of the water supply, take the following steps if floodwater has submerged the taps in your home:
    - Run taps for a few minutes to eliminate any contaminants
    - Remove any screens, flow regulators and aerators and thoroughly clean the tap and all parts with hot water and detergent
    - Apply a mild disinfectant to the tap and its parts.
    - Rinse, reassemble the tap and run it for a few minutes before use
    - For cleaning purposes, use water from taps that have not been submerged or contaminated
- Contact your insurance agent to discuss claims. If possible, document the damage with photos and video.
- Listen to your radio for information on assistance that may be provided by the local, state or federal government or other organisations. Disaster Recovery Centres may be established following some disasters. Recovery centres may provide a range of welfare services including financial assistance, personal support, organising temporary accommodation and providing information and referrals.
- Many insects, especially mosquitoes, thrive in wet environments. Protect yourself and your family, especially in the weeks following the flood.
    - Wear an insect repellent that contains DEET.
    - Wear light-coloured clothing and, as often as possible, long sleeves and pants.
    - Avoid going outside at dawn and dusk, when mosquitoes are most active.

[26] www.ses.nsw.gov.au/news/2012/Advicetoresidentsreringtofloodedhomes

Getting Started

The full rectification process may take months. However, to minimise repairs, it is important to start work as soon as the rain has stopped and the water receded.

The CSIRO have prepared an online information tool called Flood Damage Advisor[27] which provides guidance on the identification of possible flood damage for a residential property.

Further to this CSIRO has also prepared guidance on Repairing flood damaged buildings.[28] These guidelines recommend the following tasks be done as quickly as possible:

- Clear up, drain and start drying out the house as soon as the flood waters recede.
- Take out everything that is wet and that can be moved – floor coverings, furniture, bedding and clothing.
- On dry days, keep all doors and windows open; on wet days, leave windows ajar.
- Drain away water under the house, and try to increase the airflow to assist drying.
- Check for trapped water and mud in wall cavities, as well as under such things as shower trays, baths, benches and bottom shelves.

Everything that is wet and that can be moved – floor coverings, furniture, bedding, clothing, etc. – should be taken outside for cleaning and drying whenever the weather permits. Leave nothing that can trap moisture and prevent the structure from drying.

Drying times for building materials immersed in flood waters will be dependent upon the duration of the inundation and the local weather conditions to facilitate the drying. Drying times for building materials is generally measured in months, not weeks or days.

[27] www.csiro.au/flood-damage-advisor/fdadvisor.html

[28] www.csiro.au/Outcomes/Environment/Australian-Landscapes/Repairing-Flood-Damage.aspx

Recovering keepsakes

For badly damaged locations the recovery of important personal items and keepsakes by residents and business owners may alleviate some of the distress of the event.

The salvage of personal items and keepsakes is best undertaken within the 48 hours of inundation.

The following advice is provided by Purdue University in its online publication *First Steps to Flood Recovery*[29].

Photographs

- Remove photos from plastic or paper enclosures and frames.
- Carefully rinse the photos with cool, clean water as necessary.
- Do not touch or blot surfaces.
- Air-dry wet photos. Hang them with clips attached to the edges, or lay them flat on absorbent paper.
- Don't allow photos to touch each other.
- If there are too many photos for immediate attention, keep the photos in a container of clean water. This will preserve your photos for 48 hours. If you need more time, you can freeze them. If possible, insert freezer or waxed paper between each photo before freezing.

Books

- If rinsing is necessary, hold the book closed.
- For partially wet or damp books, stand them on their top or bottom edge with covers opened at a 90-degree angle, and allow them to air-dry.
- For very wet books, lay them on a flat clean surface. Insert paper towels, or other absorbent material, throughout the book. But don't insert so much that you stretch the binding.
- If there are too many books to air-dry in 48 hours, wrap each book in freezer or waxed paper, pack them spine down in sturdy containers, and then freeze them.

[29] www.extension.purdue.edu/floodpub/index.html

Recovering electrical appliances

Appliances submerged in floodwater are often not repairable, and even those that are repaired will have a shortened life expectancy. It's generally not economical to repair such small appliances as microwaves, televisions, and stereos.

Carpets and Floors

It's best to have professional cleaners work on carpets and floors, but if that isn't possible, there are some steps you can take. Remember to clean and dry the floor thoroughly before attempting any repairs.

In general, carpets are not designed to survive floods but because carpets are of complex construction and manufactured from a broad range of materials, it is not possible to provide advice applicable to every type and situation.

If a carpet has been contaminated by sewage, advice is needed on which cleaning method, if any, will ensure full sterilisation.

In the absence of specific manufacturer's instructions, the following procedures are recommended[30] and should be done as soon as possible:

- Pull up saturated carpets and rugs and hang them outside.
- Hose items down if muddy.
- Dry it as quickly as possible to minimise degradation of the jute and cotton backings. To minimise shrinking, drying in flowing air without artificial heating is recommended.
- While the carpet is drying try to retain its original dimensions by careful stretching and tensioning.
- After it has dried an assessment should be made of its condition, noting such points as:
    - shrinkage and distortion
    - degradation of backing materials and adhesives
    - degradation of the pile fibre (synthetic piles should be unaffected but wool may show some degradation if left damp for some weeks)
    - colour, pattern and texture retention. Extractives from the jute backing may stain the pile fibre but this is readily removable for all fibres except wool. In certain carpets the yarn used for the pile may have been 'set' for special effects and this set may have been lost.
- If the carpet is considered suitable for re-use it should be professionally cleaned. Original carpet sizes should be supplied to the cleaners and fungicide treatment specified.
- Discard the carpet underlay.
- Disinfect the slab or subfloor, and allow it to dry completely. (This may take several months.)

Mould

Floods are usually associated with excess moisture, long periods of heat and humidity, and pooling of water. These factors all help to create an environment that is favourable to the growth of moulds. People can be exposed to moulds through inhalation, skin contact or ingestion. For some individuals, such as asthmatics or those with sensitivities or allergies, exposure to moulds may induce an adverse reaction or cause them to develop health problems. By reducing mould growth and by taking precautions when removing mould, you can help reduce the risk of mould-related health problems.

When returning to a flood-affected house or building:

- Dry it out as quickly as possible by opening all the doors and windows.
- If possible use fans to speed up the process.
- Porous items that can't be easily cleaned and have been wet should be discarded. This includes items such as mattresses, carpet, food, leather goods, soft toys and ceiling insulation.

[30] www.csiro.au/Outcomes/Environment/Australian-Landscapes/Repairing-Flood-Damage/Repairing-flood-damaged-floors.aspx

Cleaning walls, ceilings and doors

The following advice is an extract of advice provided by CSIRO in their online guideline *Repairing flood damaged buildings*.[31]

Walls

Clean mud and dirt off brickwork and concrete blocks with water, detergent, and a stiff nylon or bristle brush. Using acid instead of detergent may cause staining.

A white salt growth (efflorescence) is likely to appear on bricks and concrete blocks during drying out. This is not serious, and should stop when the wall is fully dried. It can often be removed with a bristle broom.

Timber weatherboards should be cleaned with water, detergent and a cloth or soft bristle brush. Make sure all the detergent is rinsed off.

If the flood level was higher than the floor, water can be trapped in the external wall cavity. Drain the cavity by wedging out the bottom two or three weatherboards, or by removing a bottom row brick or veneer block every metre. In both cases, this should be done around the entire house. Hose out any mud or silt in the cavity, and let it dry out. Please note that this method of cleaning and repairing veneer is usually best tackled by a tradesman.

Plaster sheet is very weak when wet but may recover its strength when dry, especially if it is reinforced with glass fibre. If it is not obviously damaged, remove any loads from it and let dry.

Bulk thermal insulation in wall cavities can act like a sponge, soaking up water to the full height of the walls. The inside wall linings on the outside walls may therefore have to be completely removed. Apart from having lost most of its insulation value, wet insulating material may hold moisture for months, causing dampness and mould to appear after redecorating has finished.

Water can also be trapped in the internal wall cavities, behind the wall lining. Remove the skirting boards, and cut out all damaged or wet linings up to the first horizontal piece of timber above the water mark. Hose out any mud or silt, and leave the cavity open so that it can dry. Remember that with timber frames there may be noggings in the frame half-way up which could also hold mud.

Ceilings

Firstly, if flood waters have reached ceiling levels consideration must be given to potential structural issues. This should be evaluated by an appropriately qualified building inspector or engineer.

While plasterboard wall linings can be recovered if they are looked after while wet, ceilings will deflect and retain the deflection on drying and will require replacement if they have been submerged.

If water has entered the roof, take out the wet ceiling insulation material as soon as possible. The extra weight of wet insulation may damage the ceiling and its presence will slow drying of the structure.

Cellulose fibre insulation (a loose fill material made from newspaper pulp) should be discarded and replaced with new insulation, as water affects added fire retardants and reduces its resistance to fire spread.

Doors

Hollow core doors will most likely be ruined by water damage, and so could be removed to help drying. Solid wooden doors need to be dried slowly and evenly. Don't be tempted to hurry the drying by placing a heater close to or facing a door as this may cause warping or cracking of the wood. Note – some residential buildings (e.g. apartments) may have specialised “Fire Doors” at their entry. These should be inspected by a fire protection specialist before returning to service.

Oil all locks and hinges immediately to prevent rust.

Don't rush into repairing or refitting doors until the timber has had a chance to dry. A door may have swollen and jammed while it is still wet. Don't trim it off while wet. Wait until it is dry – it will probably fit again then. It may help to take off the architraves to help drying.

[31] www.csiro.au/Outcomes/Environment/Australian-Landscapes/Repairing-Flood-Damage/Walls-ceilings-and-doors.aspx

Redecorating

Redecorating should be left for at least another three months after repairs have been finished. Painting or papering too soon may result in mould, blistering and peeling. Laying vinyl too soon may trap moisture.

The one exception to this is carpet. Provided there is not rubber underlay or backing, carpet allows moisture from the floor to evaporate, so it can be laid earlier.

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End of Guideline

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