



Planning for a stronger, more resilient North Queensland



Part 1

Rebuilding in storm tide prone areas: Tully Heads and Hull Heads

Foreword



Message from the Premier of Queensland and Minister for Reconstruction

Storms and cyclones are part of life in Queensland, but the summer of 2010/2011 reminded every Queenslanders that we can never take nature for granted.

Our State was devastated by cyclones and floods that not only took lives but also tore apart communities and left behind a \$6.8 billion damage bill.

Facing a rebuilding program of post-war proportions, I established the Queensland Reconstruction Authority to oversee the task. The Authority is charged with ensuring we built it back better and smarter to create a stronger, more resilient Queensland.

This guideline *Rebuilding in storm tide prone areas: Tully Heads and Hull Heads* is the first in a series of four guides that will help us achieve that aim.

Rebuilding in storm tide prone areas: Tully Heads and Hull Heads contains practical recommendations for people who are rebuilding, as well as advice on cyclone safety and storm tide measures.

Although it is aimed at residents of Far North Queensland, the guide also recognises that many of our coastal communities are cyclone-prone and could experience severe storms, and therefore it has relevance for communities from the tip of the Cape to the Sunshine Coast.

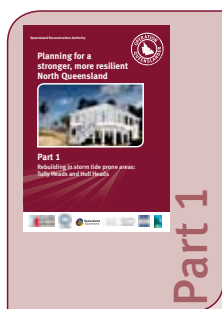
This past summer also reminded us that cyclones do not only affect our coast. The effects of Cyclone Yasi were felt on the coast, where it devastated local communities, and 1500 kilometres west in Mount Isa.

Therefore, the guide has benefit for communities around Australia and anywhere in the world where serious storms like typhoons and hurricanes are prevalent.

This guide is an Australian first. It has been developed in a unique partnership between the Queensland Reconstruction Authority and leading cyclone and architecture experts at James Cook University's Cyclone Testing Station, CSIRO, Australian Institute of Architects, GHD and Cassowary Coast Regional Council.

By sharing our experiences and our expertise, together we can rebuild, and prepare for the future, with greater resilience.

Anna Bligh MP
Premier of Queensland and Minister for Reconstruction



Part 1

Part 2 - wind resistant housing

Part 3 - Preparing for a cyclone

Part 4 - Rebuilding in low lying coastal areas

Planning for a stronger, more resilient North Queensland

Part 1 - Rebuilding in storm tide prone areas: Tully Heads and Hull Heads

Part 2 - Wind resistant housing (Draft July 2011)

Part 3 - Preparing for a cyclone (Draft September 2011)

Part 4 - Building in low lying coastal areas (Draft November 2011)

Introduction

We enjoy a wonderful climate and lifestyle in Queensland, however, natural disaster events such as tropical cyclones, severe storms and flooding are an inevitable part of our Queensland lifestyle. Queenslanders cannot afford to be complacent about the dangers natural disasters present.

This Guideline, is the first in a series to help you and other North Queensland residents rebuild and repair your homes following severe Tropical Cyclone Yasi (Cyclone Yasi). This guideline is **not mandatory however it is recommended that all building designers / architects / contractors consider the issues raised in this guideline**. The principles outlined in this guideline are of relevance to other low lying coastal areas where cyclones pose a threat.

This Guideline Part 1 - *Rebuilding in storm tide prone areas: Tully Heads and Hull Heads*, provides recommendations on what you should consider when rebuilding or repairing your home after Cyclone Yasi incorporating both cyclone safety measures and storm tide events associated with cyclones. The Guideline focuses on ensuring that your property is better prepared for future storm tide events given that a large portion of damage was as a result of the storm tide event associated with Cyclone Yasi.

Subsequent guidelines will focus on cyclone preparedness and the importance of maintaining your property to ensure you are ready for the next cyclone season.

This guideline does not replace the need to evacuate prior to a storm tide event. During a flood or storm surge event, your personal safety and that of your family is paramount. You need to take steps before, during and after any disaster to help reduce potential loss of life and property damage. Timely evacuation, based on the advice of emergency services personnel is paramount to saving lives during a severe natural disaster event. If you live in a storm tide prone area it is important that you are prepared in case you need to evacuate. For further assistance relating to disaster preparation and evacuation planning including a checklist to prepare your own evacuation plan visit www.emergency.qld.gov.au/emq/css/beprepared.asp

About this guideline

This guideline has been developed to support a better rebuild of homes, especially in the areas of Tully Heads and Hull Heads, as a result of damage caused by Cyclone Yasi, which crossed the Queensland coastline on 3 February 2011. This guideline is intended to:

- Advise you as a home owner of key issues associated with rebuilding in a storm tide prone area
- Provide guidance to assist in the design of dwellings to improve their resilience in the event of a storm tide inundation
- Provide guidance to assist in ensuring design outcomes are compatible with the tropical climate, the character of the local area and the needs of the residents
- Outline the approvals process including building certification.

This guideline does not replace the need to evacuate prior to a storm tide event.

Objectives

The main objectives of the Guideline are to:

- Improve the resilience of residential dwellings to the impact of a storm tide event predominantly caused by a tropical cyclone
- Assist in safeguarding property in a storm tide
- Improve the broader long term sustainability of dwellings and their local context.

Existing design standards for housing

In Australia we have extensive building standards to resist wind loads. This work has evolved over many years and has resulted in a very good understanding of effective house design to resist severe wind loads associated with storm events such as a tropical cyclone. During Cyclone Yasi, homes built to the current wind load standard performed well. **In contrast to wind events, there are no Australian housing design standards for resisting storm tides.**

This Guideline has been prepared to encourage design considerations for improved storm tide resilience, to complement existing Australian standards for wind loads. You should ensure that your contractors are aware of these Guidelines. It remains important that as part of the rebuilding process you ensure that your building designers / architects / contractors are fully aware of the existing standards for wind loads, which will be assessed as part of the building certification process.



Source: Google maps

This guideline was released as a draft at a community meeting in Tully Heads on 20 April 2011. Comments were sought from members of the community, state agencies and industry bodies. These comments were considered and have informed the finalisation of this guideline.

A “meet the experts” session was held on 7 May 2011 where residents were able to discuss the guideline recommendations with architects, engineers and builders.

1 Understanding storm surges and storm tide

When commencing the rebuilding process in a storm tide area there are a number of matters you should consider and properly understand.

What is a Storm Surge?

A storm surge is a rise above the normal water level along a shoreline as a result of strong onshore winds and/or reduced atmospheric pressure. Storm surges accompany a tropical cyclone as it comes ashore. They may also be formed by intense low-pressure systems in non-tropical areas.

What is a Storm Tide?

Storm Surge + Normal Tide = Storm Tide

The combination of storm surge and normal (astronomical) tide is known as a 'storm tide'. The worst impacts to property will occur if the storm surge arrives on top of a high tide. When this happens, the storm tide can reach areas that might otherwise have been safe. On top of this storm tide are pounding waves generated by powerful winds. In the event of a tropical cyclone, the extent of sea water flooding as a result of a storm tide may extend along the coast for more than 100 kilometres, with water encroaching several kilometres inland if the land is low lying. The combined effects of the storm tide and waves can damage or destroy buildings, wash away roads and run ships aground. Being caught in your home or in a car when a significant storm tide arrives is a life threatening situation.

The storm surge during Cyclone Yasi raised the ocean level to more than five metres above the normal tide at Cardwell and up to three metres higher than normal at Clump Point. As some houses in Tully Heads and Hull Heads are built on lower-lying areas than Cardwell, the storm tide flooded some of these houses to a depth of more than one metre with a storm tide of 3.5 metres above normal tide. The storm tide was responsible for the majority of housing damage experienced in Tully Heads and Hull Heads.

The Cyclone Yasi storm tide – can it happen again?

Based on the surveyed estimates of the storm tide water levels experienced at Tully Heads and Hull Heads, the probability of a similar event happening again is relatively low.

However, the height of the storm tide experienced in Cyclone Yasi can happen again.

Accordingly, if residents act to ensure that their properties are more resilient to a storm tide (based on the Cyclone Yasi event), then the level of protection attained will be broadly consistent with the protection attained for wind resistance when designed in accordance with the Australian building standard for housing wind resistance.

Building above the storm tide height experienced in Cyclone Yasi will provide protection from storm tides that may be seen on average once in 50 years (2% Annual Exceedence Probability (AEP)). Building even higher will mean that the floor level is at a height above a storm tide that may only be seen once in 500 years (0.2% AEP).

By way of comparison, new houses are built to withstand wind speeds from cyclones that are predicted to be experienced once in 500 years (0.2% AEP). Therefore it makes sense to raise houses to a level that takes into account a once in 500 year storm tide event.

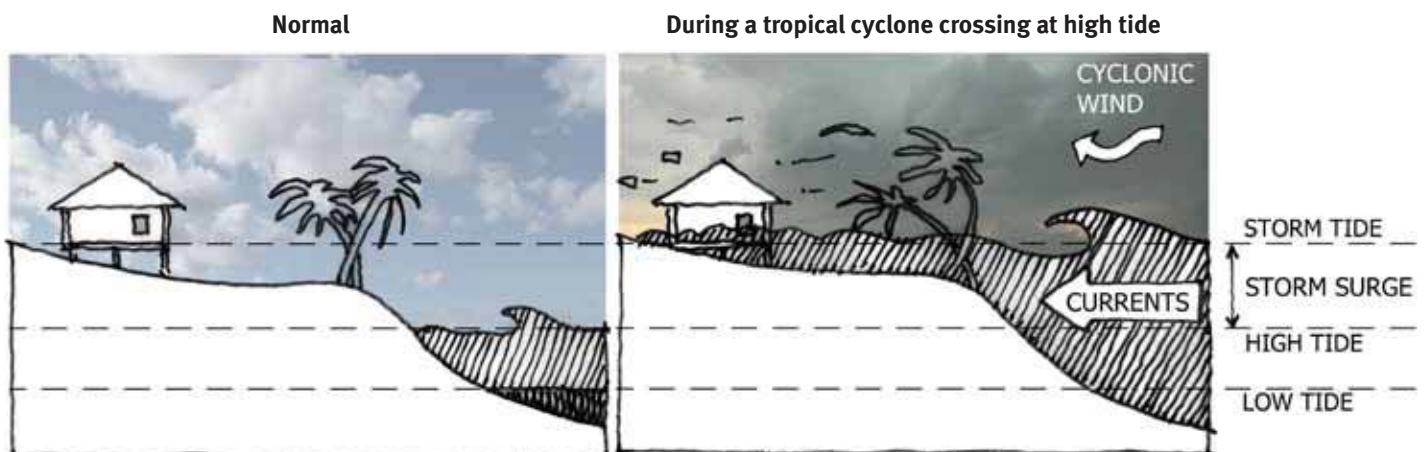
Existing storm tide risk studies in the area affected by Cyclone Yasi

Tropical cyclone storm tide studies previously completed for Cassowary Coast Regional Council cover the region affected by Cyclone Yasi and provide estimates of the expected risk of storm tide inundation in present and future climate scenarios.

These studies indicate that the risks increase southwards, mainly as a result of the varying exposure relative to the Great Barrier Reef and the large bays such as Rockingham Bay at Cardwell, which tends to concentrate the storm surge. These studies, completed over the past few years, have successfully reproduced the impacts from other tropical cyclones in the region, including tropical Cyclone Larry in 2006.

For further information on these studies please contact Cassowary Coast Regional Council.

Storm Surge + Normal Tide = Storm Tide



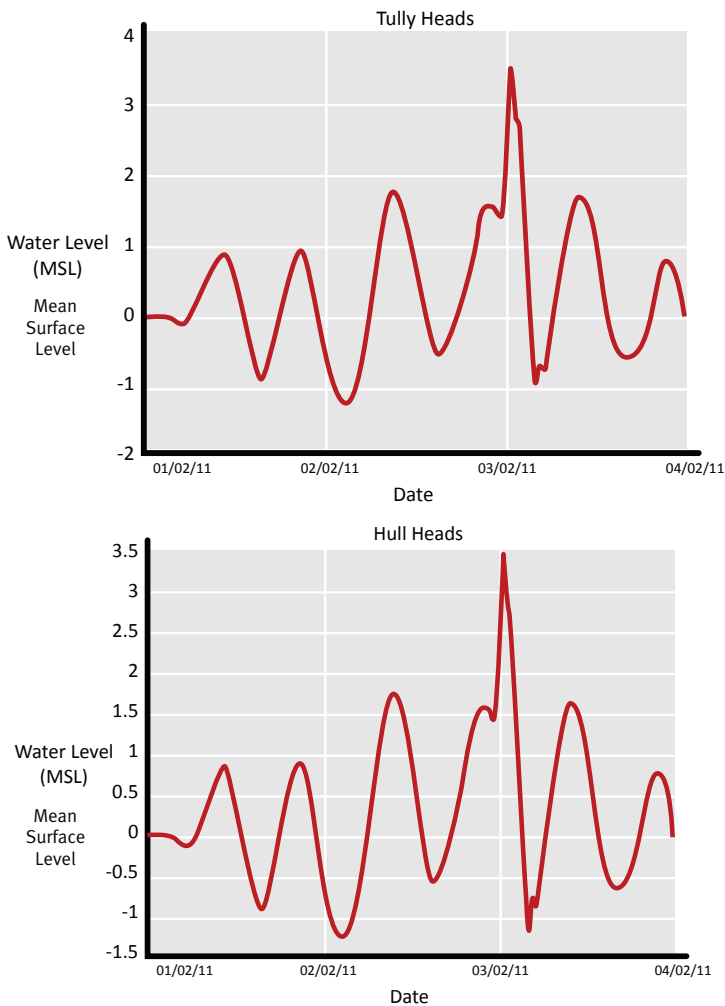
Source: Bureau of Meteorology - www.bom.gov.au/cyclone/about/

Returning after the event

Residents returning after Cyclone Yasi would have found varying degrees of damage to buildings depending on the location of the home, the type of building and the materials used in its construction. Events of this nature will invariably involve some form of damage depending on size/scale of the tropical cyclone.

The purpose of these guidelines is to raise awareness in rebuilding to improve resilience for future events.

Storm tide levels for Tully Heads and Hull Heads during Cyclone Yasi.



Source: Department of Environment and Resource Management

This Guideline has been prepared to encourage design considerations for improved storm tide resilience

'Risk-Based' design

It is very difficult, if not impossible, to design houses that are capable of resisting all possible extreme events. For example, houses are designed to be fire-resistant but not fire-proof and houses are not designed to resist vehicle or aircraft impacts. To allow for every possible threat to housing would be uneconomic and wasteful of resources.

Therefore, the Building Code of Australia adopts an 'implied level of risk' and includes standards for events such as wind resistance and many other functional, health and safety considerations.

The preferred method of long term defence against storm tide impacts on new communities, especially with the threat of rising sea levels due to climate change, is avoidance of the risks through the use of responsible long term land use planning.

Where communities have already been established and where a storm tide threat exists, it is recognised that residents may wish to live in these locations despite the risk. The intention of this Guideline is to enable residents to adopt a level of protection against storm tide impacts for their homes and properties, which is broadly equivalent to the level of risks adopted for wind damage from tropical cyclones.

Climate change considerations

Climate change research* suggests that tropical cyclones may gradually increase in intensity, therefore higher storm surges (and higher wind speeds) may be possible. Conversely there is also an expectation that tropical cyclones may decrease in number.

Climate change projections further indicate that sea levels are likely to continue to rise. The Queensland Government now requires that land use planning schemes allow for a sea level rise due to climate change of 0.8 m by the year 2100. The regional storm tide studies have assessed the risks due to climate change and the results indicate that the effect of sea level rise will be the dominant influence. As a result, sea level rise, combined with more intense cyclones will mean that low lying coastal areas are more likely to experience storm tide impacts.

You should therefore consider the value of making additional allowance for sea level rise in addressing the impacts to housing over the long term.

* United Nations' Intergovernmental Panel on Climate Change (IPCC) 2007.

There is no such thing as a cyclone-proof house

The following photos show damage to homes relative to the level of water through the property.

House type

Block 

Timber 

Damage scale

Water height above ground

If less than 200mm, only minimal structural damage but possible water damage to flooring and plasterwalls



Block 

Minimal structural damage if floor heights are above level of water inundation

Storm tide level (approx)



Timber 

Approximately 600mm and minimal structural damage to reinforced concrete block construction, but still significant damage to the interior fixtures and fittings



Block 

If more than 1m, significant damage to interior of house, fixtures and fittings



Block 

Greater than 1m and significant damage to unreinforced masonry



Block 

Photos courtesy of the Cyclone Testing Station.

3 Building in the storm tide zone

Storm tide waves are extremely powerful, capable of destroying houses and sweeping away heavy items such as cars, caravans, trees and large boulders at high speed causing damage to anything in their path. Whilst the impacts of storm surge can be severe, building outside of storm surge zones is not always possible. If you choose to accept this risk then the careful consideration of your house design and location can reduce the extent of damage to your property and those around you.

The impact of storm tide will be affected by the distance of your property from the shoreline, the height of waves travelling across your property and the shape of the land and roads around it. During a storm tide the most damage will be experienced where a property is directly exposed to incoming ocean waves. This will typically be within 100 to 200m of the open shoreline and in such conditions, it can be expected that the first line of houses will always experience the greatest impact.

Whether a particular property will be wave-affected, and to what extent, should be assessed by a qualified professional coastal engineer. Councils are required to adopt a minimum planning level for storm tide in accordance with the guidelines outlined by Department of Environment and Resource Management. To determine the level you need to adopt, contact the Cassowary Coast Regional Council.

Site planning - Locating your house, landscaping and other structures on the site.

The initial destructive forces of storm tide come from the open waterfront and in most cases travel at 'right-angles' to the beach. The impact of surge waves may be affected by the height of foreshore dunes and surge resistant vegetation, although these effects may be minor at times of severe exposure as was seen at Tully Heads and Hull Heads.

Any structures above the ground will be at severe risk of being swept away and cause further damage to your house or your neighbours. Care should be taken to avoid building structures such as boulder walls, fences and garden sheds or if necessary to then locate and build these to minimise their exposure to wave forces.

Fences can catch debris, be torn out and then swept against houses. Plastic or metal water tanks may similarly be swept by waves or the ebbing water as it returns to the sea. Consideration should be given to reinforced concrete tanks with footings or supports to resist wave forces.

Mature and healthy coastal tree species such as coconut palms and Calophyllums (Coastal Touriga) may reinforce soft dunes against storm erosion although their condition and maintenance is important if they are not to become dangerous debris in a Cyclone.

Damage to buildings in the storm tide inundation zone

The effects of the waves are dependent on the height of the storm tide. Houses experiencing storm tide impacts will generally suffer damage caused by:

- Seawater inundation
- Water currents that break through walls and move whole buildings off their foundations
- Water currents and high winds that drive debris into the building
- Breaking waves

In addition to the damage caused by the storm tide waves as they wash ashore, the sea water will cause further damage as the storm tide subsides and the water recedes back into the ocean. The flow of this 'ebbing' water is guided by the shape of the land, the roadways, houses and other structures in its path. As a result, the direction of water flow may be quite different to that of the initial storm tide as it erodes new channels and applies different forces to houses and buildings.

The inundation zone covers all water-front properties below the defined storm tide height and can extend hundreds of metres inland in low lying areas.

Building resistance to storm tide

Under the Building Code of Australia, a building or structure must perform adequately under all reasonably expected design actions and withstand extreme or frequently repeated design actions. In a storm tide prone area this may include scour, seawater currents and wave forces. The consideration of these design actions may necessitate building techniques such as using reinforced concrete construction.

If housing is on the ground then it must be made capable of withstanding the considerable seawater current and wave forces, which necessitates use of reinforced concrete construction. If the building is a two storey construction sufficient strength must be available to support the upper level. This might involve allowance for the breakaway of some non-load-bearing ground level walls to reduce the sea water forces or generous window and door openings to permit the flowthrough of the expected currents.

A range of specific considerations is provided on pages 10 – 12.



Fences, sheds and water tanks may be swept away and may become a risk to your house and your neighbour's house.

4 Building design recommendations

Avoiding waves and water

Building outside of storm tide zones is not always possible. If a house or building is to be located in the inundation zone then strategies should be considered to minimise the damage caused by the storm tide.

The best protection for property involves building above the defined storm tide planning level in an elevated (high-set or low-set) house, similar to a traditional Queenslander. Ideally all valuables should be secured above storm tide height.

Large valuables like vehicles, boats, caravans and trailers should be evacuated when emergency warnings are announced. Not only are they at risk of being damaged in the storm tide, but they may also cause severe damage to your home and other homes if they are moved by the seawater. You should develop a 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 family evacuation plan at risk.

'Flow-through' design

Where living areas are built above the storm waves it is also important that the ground level is designed to allow for the flow-through of water and waves whilst supporting the house above. Lower-level enclosure should be avoided as partition walls, battens or roller doors etc can be torn off and become dangerous projectiles.

Lower level walls should be avoided or, if absolutely necessary, be designed to withstand the forces of waves and allow for reasonably easy repair afterwards. If solid walls on the ground floor are essential to the structure they should be aligned perpendicular to the coastline so that they offer the least possible resistance to the progress of the storm tide.

The ground level walls and supports must be braced extensively to withstand both cyclonic winds and storm surge. Building methods such as small bracing walls, cantilevered columns or stumps and open portal frames (rather than long solid walls that obstruct the flow of water) should be used.

Reinforced and fully core-filled concrete block walls or cast concrete panels may be the only common building materials that can resist these forces.

Consideration should also be given to the potential damage from the storm surge on important services such as electricity, permanent fixtures and plumbing. They should be elevated or protected from the impact of waves.

Repairs after the storm tide

As well as surviving the impact of storm tide, a well designed house will allow for a reasonably easy clean up and repair after inundation from a storm tide. Materials resistant to wave damage and immersion should be chosen for any construction below the storm tide level (as outlined in the building materials section below). Solid walls have the advantage that debris and mud cannot become lodged in them, however you should be aware that solid material such as masonry and concrete will take considerable time to fully dry out and so you should delay repainting such walls until they are fully dry. Cavity construction is not recommended, however if used then the cavity must be fully cleaned of mud and debris after inundation from a storm tide. This can be facilitated by use of an extra large skirting board which when removed post inundation, provides easy access to the cavity. If hollow cell insulation is used and has been wetted (e.g. batts) it will need to be removed and replaced. Closed cell insulation should survive a short immersion. Mud may also be trapped in other places around the home – under hidden bottoms in cupboards, vanities etc and these also should be cleaned out. Electrical wiring and plumbing should be checked by a qualified tradesperson.

In general, carpets and linings will need to be replaced after being inundated. Solid timber floors should survive if they have not been physically damaged, however timber boards may have cupped due to immersion in water. A key message is to ensure that all surfaces are dry before re-decorating.

Building materials used below storm tide

There are two primary building material requirements that should be considered when building in a storm tide prone area. Wherever possible, building materials used below the storm tide level should be:

- resistant to impact damage arising from the storm surge waves and debris
- resistant to moisture damage and able to hold their strength when wet

As noted earlier, solid materials (reinforced and fully core-filled concrete masonry walls or cast concrete panels) are more likely to be resistant to waves and debris impacts than cavity construction (brick veneer or double brick) or studwork (steel or timber).

If framed construction is used, timber cladding is recommended over fibre cement. Inside the home (for furnishings and doors), solid timber will withstand greater impact and moisture damage than hollow core or particle board. Durable internal linings should be selected such as timber panelling in place of particle board.

Appendix A shows the susceptibility of common building materials to water damage and should be considered when homes are being designed in high risk storm tide areas.

Building materials in storm tide prone areas should be resistant to impact and moisture damage

Building design recommendations

When reconsidering rebuilding or repairing your home the following considerations should be taken into account for your ultimate building design.

It is generally recommended that the building floor level needs to be located sufficiently above the design storm tide level such that it is clear of the tops of the waves extending across the coastline. Wave heights will be of primary concern to the most seaward row of buildings and progressively less important with distance inland. Wave crests can be expected to reach at least a height of about 1.5 times the local seawater depth.

Breakaway walls on the structure below the floor level need to be incorporated into the design so as to reduce the load on the structure from the increase in water level and associated flows.

Given the need to provide a clear passage for the storm tide and the storm debris in the water, standard types of cross bracing will need to be replaced by upgraded connections between the foundation piers, end walls, piles and the floor to maintain the lateral strength of the building.

All foundations need to be designed with an allowance for scour and erosion caused by currents generated by the storm tide inundation and, where applicable, wave action.

The principal defence against storm tide is to elevate housing above the adopted level of storm tide inundation risk

Where living areas are built above the storm tide it is also important that the ground level is designed to allow for the flow-through of water and waves whilst supporting the house above



Storm tide waves are extremely powerful and are capable of sweeping heavy items such as vehicles, caravans, trees and boulders inland at high speed causing damage to anything in their path

High-set houses on stumps

In high risk locations, usually in areas closest to the coast, high-set construction is always recommended. High-set housing may make universal access requirements very difficult to satisfy, but it provides the best safeguard against property damage during a storm tide.

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.

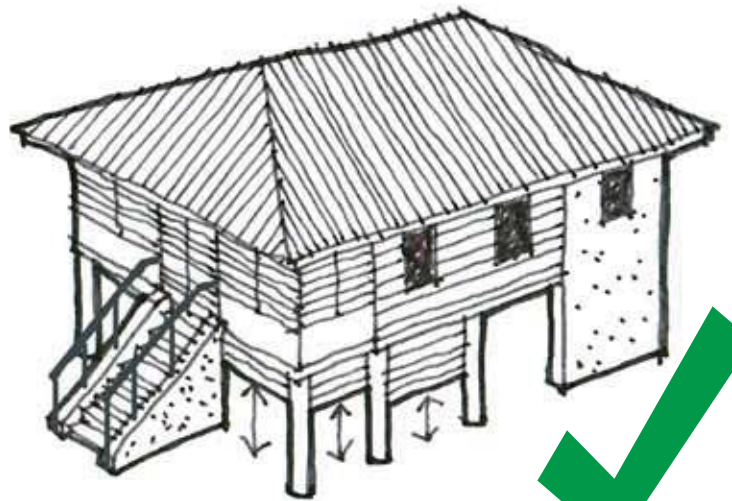
Consider openable enclosure. For security of vehicles and valuables consider the use of vertically rolling, sliding or stacking garage doors that can be enclosed in day-to-day use but fully retracted in storm surge alert.

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.

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.

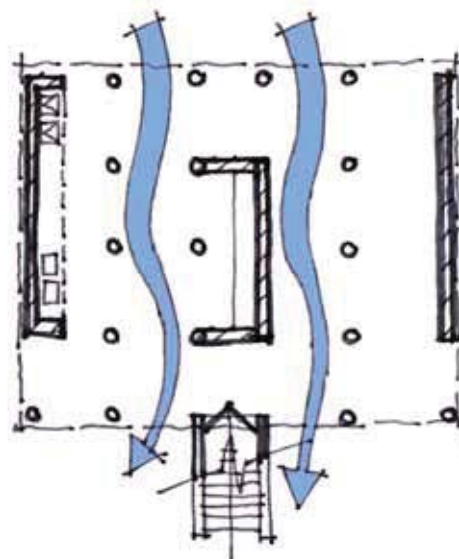
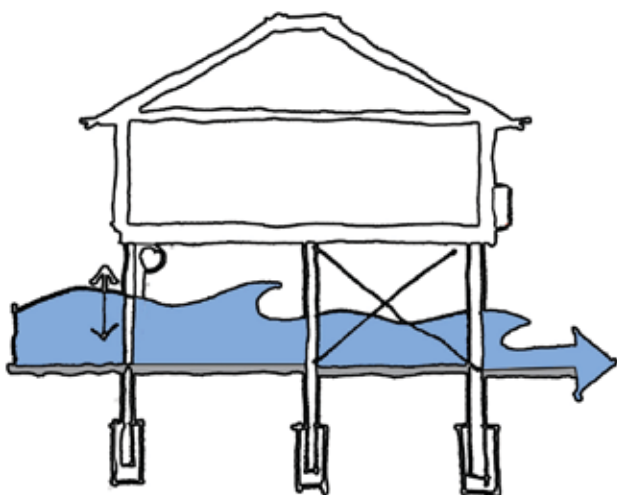
Consider impact resistance to tall columns. Storm surges may propel vegetation, boulders or vehicles against the structure. Consider the impact resistance of tall columns and bracing sets. Consider more substantial column cross-sections than are required for wind-forces alone, and consider additional bracing sets to provide a degree of structural redundancy to cover for impact damage.

Ensure house is designed in accordance with Australian Standards for wind loads



RECOMMENDED

IN HIGHER RISK AREAS



- 1 Design for flow-through water movement.
- 2 Reinforce any lower level structures.
- 3 Construct lower level structures such that they do not impede water movement.
- 4 Use steel cross bracing instead of sheer walls that would impede water flow.
5. Meter box above storm tide level.

Low-set houses on stumps

In many cases a low-set designed house will be the preferred housing type where an individual or family desires universal access. Where ramped access or minimal steps to the house are required, it is still recommended that the principal floor level is raised as high as possible to reduce the risk of storm tide damage. Low-set houses on stumps are also acceptable away from high-risk locations.

Raise the floor level as high as practicable. Because of the unpredictability of storm tide occurrence and possible heights, the higher the floor the better.

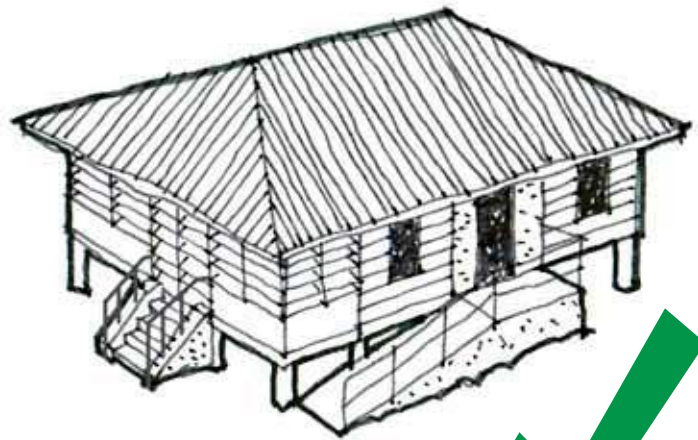
Use robust and impact resistant construction. For framed construction, timber or thick plywood cladding can provide greater protection than thin fibre-cement or metal sheeting. Maintain and use storm shutters on external windows.

Consider carefully the location and orientation of stairs and ramps. Where possible, orient these elements with the smallest dimension perpendicular to the beach frontage to minimise impact forces. Where using ramps to provide universal access, utilise landscaped path ramping as much as possible to reduce the size of built elements.

Minimise impact resistance of subfloor structures. Use cantilevered bracing columns or steel or timber crossing sets in preference to subfloor walls or bracing panels for bracing. Do not enclose the subfloor area with lightweight battening as this too can become dangerous debris.

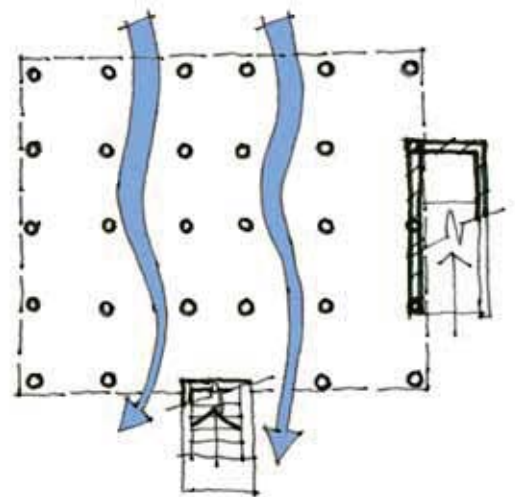
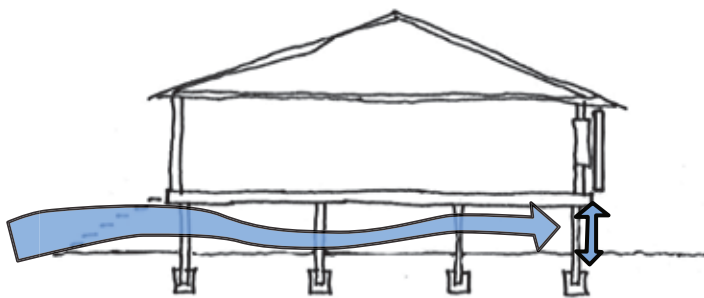
Additional lightweight walled sheds, garages and structures are not recommended.

Ensure house is designed in accordance with Australian Standards for wind loads.



RECOMMENDED

IN LOWER RISK AREAS



- 1 Raise the floor level as high as practicable.
- 2 Carefully locate stairs and ramps to not impede water flow.
- 3 Do not battern or enclose the area beneath the house.
- 4 Use Robust and Impact resistant columns and cladding.

Slab-on-ground construction

Lower storey of two storey construction

Where the floor of the lower storey of two storey construction is below the storm tide design level, then only building materials that can cope with inundation should be used for all internal and external walls. There are two strategies for the design of the lower storey:

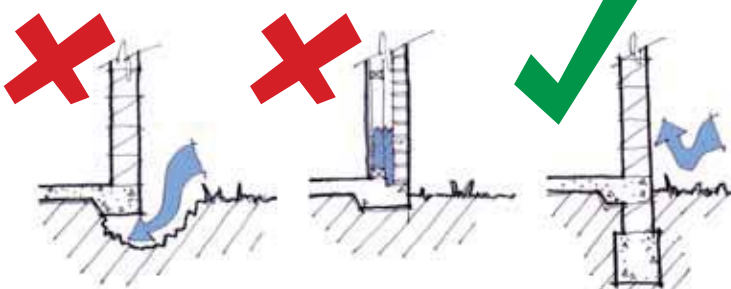
- In the wave zone, or where inundation is expected to be greater than 1 metre above the floor level, the lower floor should incorporate large windows, and an open design to allow surge water and debris to flow through the lower storey with as little resistance as possible. In the event of a storm tide event, all possessions can be stored in the second storey.
- Outside of the wave zone and where inundation is expected to be less than 1 metre, the lower storey should be designed to force the water to flow around the building. In this case strong walls and small windows well protected with heavy storm shutters, may absorb wave and debris impact. While the lower floor will still be inundated, it should be protected from waves and currents.

In either of these cases, the following guidance will minimise repair costs:

- Keep all electrical wiring and installations as high as possible.
- Have a means of quickly raising all furniture and valuables to the second storey.
- Take extra precautions for footings to minimise undermining by storm surge or ebb flow.
- Avoid the use of cavity walls in construction of the lower storey.
- Ensure that the house is designed in accordance with Australian Standards for wind loads.

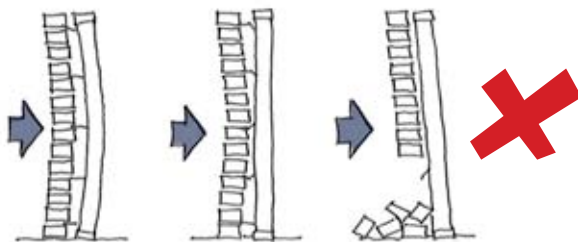
Single storey slab on ground

This construction is not recommended for sites in which the storm tide level will be above the floor slab level. However, if this type of construction cannot be avoided, the guidance on lower storey of two storey construction above should be followed. In addition, it must be recognised that the contents of the building are likely to be inundated in the event of a design storm tide. Plans should be made to evacuate all of the contents in the event of a storm tide alert.

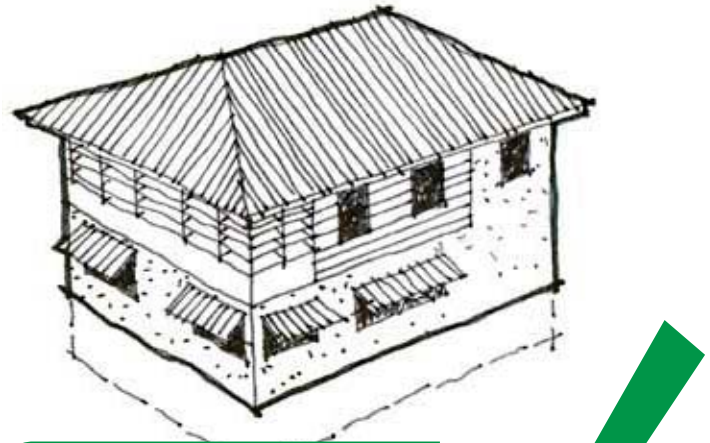


Standard footings can be undermined by the storm surge.

Building deep footings and utilising bored piers reduces the likelihood of undermining.

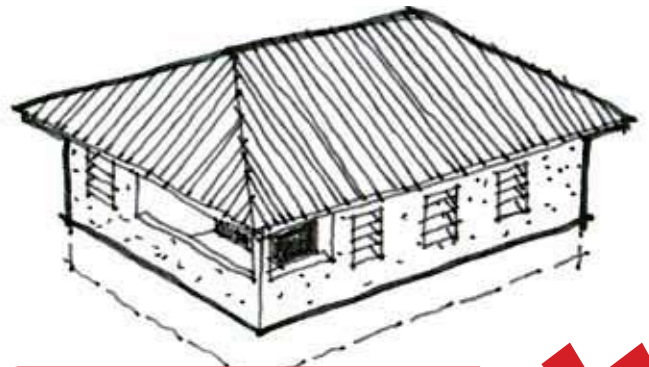
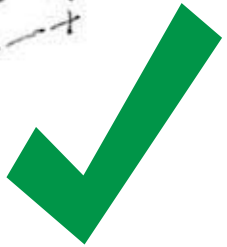


Walls with cavities can buckle and collapse under flood loads and should be avoided in storm surge prone areas. Cavities are also difficult to repair after inundation.



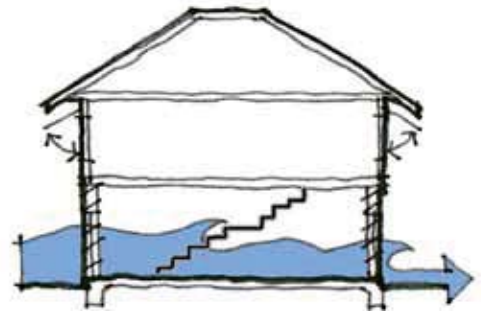
RECOMMENDED

IN LOWER RISK AREAS

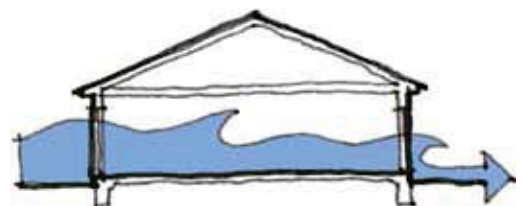


NOT RECOMMENDED

IN HIGHER RISK AREAS



- 1 Design stairs to allow easy furniture movements upstairs.
- 2 Use strong impermeable construction materials on the lower level.
- 3 Design for inundation – avoid plasterboard and other materials that degrade when wet.



- 1 Use strong construction methods and avoid cavities in walls – core filled concrete masonry or concrete panel construction is recommended.
- 2 Provide for reinforced storm shutters.
- 3 Build deep perimeter footings to prevent undermining.

5 Approvals

Queensland Coastal Plan

The Queensland Government has approved the Queensland Coastal Plan which will commence in August 2011.

The Coastal Plan recognise circumstances in which the policies do not apply including where:

- Building work is only assessable against the Building Act 1975
- The gross floor area is less than 1000 square metres
- Building work is landward of existing built structures not on State coastal land
- There is a development commitment (subject to achieving policy outcomes to the maximum extent possible)

This means that you can replace like with like in terms of the existing use. For example you can replace a single dwelling house with another single dwelling house. The new single dwelling house may be of a different design but will need to keep within the **relevant planning guidelines and building regulations that apply.**

Building Approval Process

The normal building approval process will apply when seeking approval to commence construction. A building approval will need to be granted by a building certifier and/or Council. The certifier will need to confirm that the proposed building complies with relevant building codes before any construction begins. Building certifiers are required to inspect that the work is being constructed to the relevant codes and standards.

Buildings in the storm tide zone are recommended to be designed in accordance with this guideline. However, it is important to note that in some individual circumstances this document could conflict with provisions under the *Building Act 1975*, such as siting requirements. In these cases, the requirements of the *Building Act 1975* will prevail over this guideline. It is recommended that homeowners and builders check with their building certifier or Local Government for clarification of the requirements for their individual circumstances.

Further information regarding the type of approval required should be sought from Cassowary Coast Regional Council on (07) 4030 2222.

It is recommended that all building designers / architects / contractors consider the issues raised in this guideline.

Other useful contacts include:

Building Codes Queensland, freecall 1800 534 972
www.dlqp.qld.gov.au/our-services/building-codes-queensland-2.html

For Professional Engineering advice:

Consult Australia – www.consultaustralia.com.au
Engineers Australia – www.engineersaustralia.org.au/nccoe
Board of Professional Engineers Qld – www.bpeg.qld.gov.au

STORM TIDE HISTORY



Historically the worst storm tide to impact the east-coast of Queensland was that caused by Cyclone Mahina in 1899 in Princess Charlotte Bay on Cape York Peninsular. The estimated highest water level (including wave run up) was reported to be in the order of 14m above mean sea level and extended inland approximately five kilometres, sinking more than 100 vessels and taking more than 400 lives. The most serious storm surges to impact the Queensland coast in the last 100 years occurred in 1918 approximately seven weeks apart and both were reported to have peaked around high tide. The first, affecting Mackay in January 1918, with a storm surge estimated at between 3.5metres and 5.5 metres. Only a few weeks later, Innisfail was hit by a powerful cyclone which at Mission Beach produced a storm surge, which, in combination with the tide resulted in a storm tide of approximately 3.5 metres and sweeping hundreds of metres inland. These three cyclones are reported to have produced the most severe storm surge damage on the east coast of Queensland since European settlement. Since 1918 and there have been several severe cyclones to cross the Queensland coast recording peak storm surge heights of between two and three metres which could have resulted in major damage had the Cyclones crossed the coast at high tide.

Be aware

To meet building, electrical and plumbing standards use only licensed tradespeople to repair or rebuild your home. To check that tradespeople approaching you for repairs are licensed for the work that they intended to undertake, refer to:

Queensland Building Services Authority
www.bsa.qld.gov.au

Electrical Safety Office
www.electricalsafety.qld.gov.au

Plumbing Industry Council
www.dip.qld.gov.au/plumbing/plumbing-industry-council.html

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Appendix A – Performance of buildings materials below storm tide level

COMPONENT	SUITABLE*	MILD EFFECTS*	MARKED EFFECTS*	SEVERE EFFECTS*
Floor, Sub-Floor Structure	- slab-on-ground - suspended concrete	- timber T&G (with ends only epoxy sealed and provision of side clearance for board swelling) or plywood	- standard grade plywood	- particleboard flooring close to the ground
Walls Support Structure	- reinforced or mass concrete - large windows low to the ground	- full brick/block masonry	- brick/block veneer with venting (stud frame) cavity brick	- inaccessible openings
Wall and Ceiling Linings	- fibre cement sheet - face brick or blockwork - cement render - ceramic wall tiles - galvanised steel sheet - glass and glass blocks - stone, solid or veneer - plastic sheeting or tiles with waterproof adhesive	- common bricks - solid wood, fully sealed - exterior grade plywood fully sealed - non ferrous metals	- exterior grade particleboard hardboard - solid wood with allowance for swelling - exterior grade plywood	- particleboard fibreboard or strawboard - wallpaper - cloth wall coverings - standard plywood - gypsum plaster plasterboard
Doors	- solid panel with waterproof adhesive - flush marine ply with closed cell foam - aluminium or galvanised steel frame	- flush or single panel marine ply with waterproof adhesive - painted metal construction timber frame, full epoxy sealed before assembly	- standard timber frame	- standard flush hollow core with PVA adhesives and honeycomb paper core Note: lowest cost and generally inexpensive to replace
Window frames	- aluminium frame with stainless steel or brass rollers	- timber frame, full epoxy sealed before assembly with stainless steel or brass fittings		- timber with PVA glues - mild steel fittings
Insulation	- plastic/polystyrene boards - closed cell solid insulation	- reflective foil perforated with holes to drain water if used under timber floors		- materials which store water and delay drying open celled insulation (batts etc)
bolts, hinges, nails, fittings and connections	- brass, nylon/stainless steel, removable pin hinges	- galvanised steel, aluminium		- mild steel
floor covering	- clay/concrete tiles - epoxy or cementitious floor toppings on concrete - rubber sheets (chemically set adhesives) - vinyl sheet (chemically set adhesive)	- terrazzo - rubber tiles (chemically set adhesives) - polished floor and loose rugs - ceramic tiles	- loose fit nylon or acrylic carpet (closed cell rubber underlay)	- wall to wall carpet - wall to wall seagrass matting - cork - linoleum

Adapted from CSIRO

- These materials or products are relatively unaffected by submersion and flood exposure and are the best available for the particular application.
- These materials or products suffer only mild effects from flooding and are the next best choice if the most suitable materials or products are too expensive or unavailable.
- These materials or products are more liable to damage under flood than the above category.
- These materials or products are seriously affected by floodwaters and have to be replaced if inundated.

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- Consult Australia
- Engineers Australia

