

# RISK TO LIFE POLICY – SHELTER OR FLEE? A CASE STUDY IN PITTWATER COUNCIL

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## Abstract

Pittwater Council is located 45 minutes north of the Sydney CBD. Pittwater Local Government Area's 125sq km landform is unique, featuring a diverse range of terrain confined within a land mass located entirely on a peninsula. With its area characterised by many, small, steep catchments, Pittwater is highly susceptible to flash flooding, with very little warning time.

Pittwater Council recently identified a gap in its knowledge and policies with regards to identifying the acceptable, tolerable and unacceptable levels of risk to life on its flood prone lands. Working with Cardno, Council undertook a study to classify the risk to life from flooding throughout the entire LGA, and develop an appropriate policy for emergency response for development that incorporates this risk.

The study analysed a broad range of relevant guidelines, papers and risk to life policies from other NSW Councils in order to formulate the methodological approach applied to the risk assessment. The study also analysed the emergency response issues associated with Pittwater LGA's unique topography and flash flood catchments. The draft policy developed provides recommendations on shelter-in-place versus evacuation and the appropriateness of these different responses.

The paper draws upon the lessons learnt and outlines the key outputs including the risk assessment, mapping life hazard categories, the implications for land use planning within the Pittwater LGA and the assumptions used to define the risk to life assessment.

## Introduction

This paper explores the evacuation versus shelter-in-place issue that is created in floodplains that are subject to flash flooding. The following draws on the issues faced by Pittwater Council in developing a policy and development control, in order to reduce the risk to life posed by the many flash flood catchments within the Pittwater LGA to either a tolerable or an acceptable level.

This paper will take you through the steps undertaken by Cardno and Pittwater Council, when developing Pittwater Council's Risk to Life Policy, as well as the key questions that should be asked:

- What is the floodplain behaviour?
- Is evacuation possible? If not what is an acceptable shelter in place option?
- What is the level of risk to life – how do you identify the risk?
- To what design event should the risk to life policy draw on?
- How do you map risk to life?
- How do you assess the risk to be acceptable, tolerable or unacceptable?
- What information needs to be asked of the developer/owner when building on flood prone land?
- What are the shelter-in-place requirements?

## **Background**

There are over 2300 properties within the Pittwater LGA affected by mainstream flooding, and approximately 2000 additional properties affected by Overland Flow based off the 1% AEP flood event.

Council's existing Flood Policy (Appendix 8 of the Pittwater 21 DCP – Flood Risk Management Policy for Development in Pittwater) focuses on risk of property damage caused by flooding. However, for Council to ensure the flood risk is adequately addressed, the other key component of risk, risk to life, needs to be considered. Council identified that there was a need to have an adopted policy and associated DCP control on flood emergency response planning of development on flood prone land through an additional policy to minimise this risk.

A draft interim risk to life policy was peer reviewed by Molino Stewart and Cardno was subsequently engaged to undertake the Pittwater LGA Flood Risk to Life Classification Study.

The outputs of the Pittwater LGA Flood Risk to Life Classification Study was the creation of the Flood Emergency Response Planning for Development in Pittwater Policy and the associated DCP control. The policy and control have been created based on industry best practice.

The policy follows the SES evacuation requirements of evacuation as a first response. However, due to Pittwater flash flood catchments shelter-in-place is also considered – but only as a secondary response to evacuation.

Many of the provisions placed in the policy and subsequent development control, relate to the shelter-in-place position and if this option is an acceptable, tolerable or an unacceptable risk.

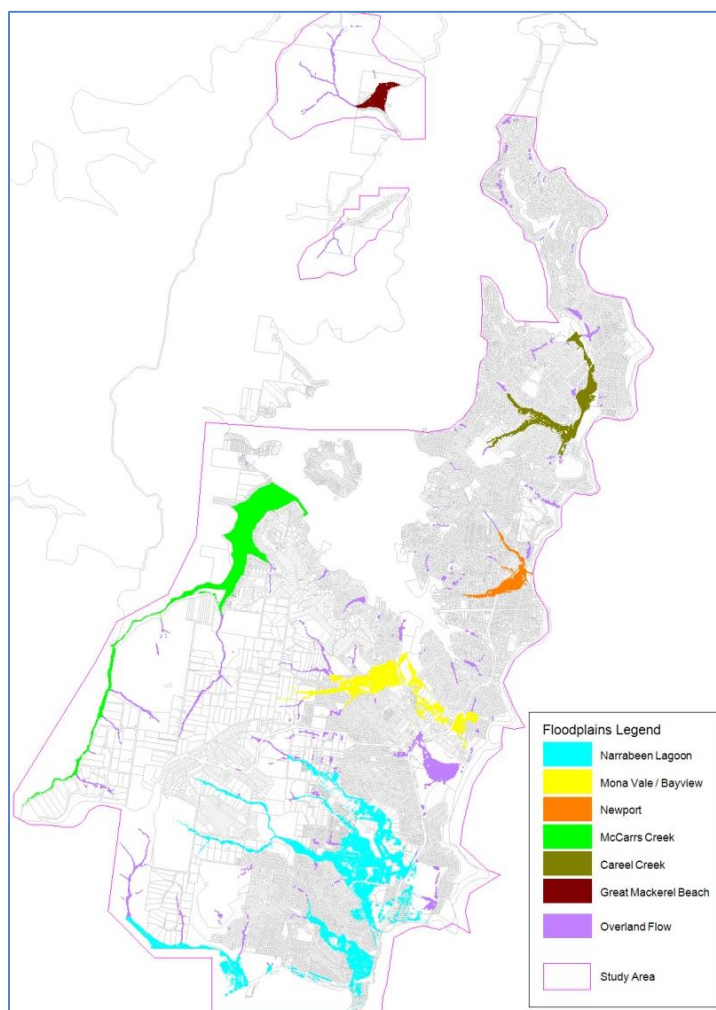
It should be noted that the policy and associated control will not apply to land release areas within the Pittwater LGA. This is due to the specific requirements (which cover flood evacuation and design levels for development) set out in the Water Management Specification document for the land release area which needs to be adhered to.

## **Pittwater Floodplains**

There are six mainstream floodplain within the Pittwater Local government Area (LGA). These floodplains (Figure 1) are:

- Narrabeen Lagoon,
- Mona Vale/Bayview;
- Newport;
- McCarrs Creek;
- Careel Creek; and
- Great Mackerel

In addition to the above mainstream floodplain there are significant areas of overland flow affectation within the Pittwater LGA. With the LGA characterised by many, small, steep catchments, Pittwater is highly susceptible to flash flooding from overland flows, with very little warning time.



**Figure 1 Pittwater LGA Study Area and Floodplain Summary**

### ***Floodplain Behaviour***

The Australasian Fire and Emergency Service Authorities Council (AFAC) (2013) define flash flooding as:

Flash flooding may be defined as flooding that occurs within 6 hours or less of the flood-producing rainfall within the affected catchment. Flash flood environments are characterized by the rapid onset of flooding from when rainfall begins (often within tens of minutes to a few hours) and by rapid rates of rise and by high flow velocity.

The majority of catchments within the Pittwater LGA are small, with steep upstream areas. This results in the majority of locations within the LGA having very fast catchment response times where flash flooding is predominant.

The exception to the above is Narrabeen Lagoon, which has a relatively large catchment with longer response times by comparison to the rest of the LGA. Though it is expected that Narrabeen Lagoon flooding would not be considered flash flooding, portions of the floodplain lie within Pittwater LGA are also subjected to flash flooding from the more localised sub-catchments of Narrabeen Lagoon such as Nareen Creek, Narrabeen Creek, and Mullet Creek. This means that while the flooding from the

Lagoon may allow for slightly longer response times, a local catchment flood for some of these areas can be significantly shorter.

Therefore, for the purposes of considering response to flooding in Pittwater it was concluded that the rate of rise for all floodplains within Pittwater LGA can be classed as flash flooding.

Flash flooding poses flood risk with regards to responding to flooding. The available response time is likely to be in the scale of hours, or in many cases sub-hourly, placing more significance on the ability to evacuate compared to shelter-in-place.

## **Emergency Response – Evacuation potential**

AFAC (2013) provides the following comment relating to duration of isolation for flash flooding:

The duration of flash flooding is often relatively short by comparison to riverine floods. However, safety of isolation is subjective and there is no evidence-based method for determining the tolerable duration of isolation that might result from floods, that is, the question of what is a safe period of isolation is not resolved.

As mentioned in the AFAC (2013) guideline for emergency planning in flash flooding events, evacuation too late may be worse than not evacuating at all because of the dangers inherent in moving through flood waters. The timescale at which flash floods occur may limit the feasibility of evacuation as a response measure. Nevertheless the guideline states that where the available warning time and resources permit, evacuation should be the primary response.

Therefore the evacuation potential of Pittwater LGA has been assessed based on evacuation timelines and available resources.

Generally for NSW, flood evacuation potential for an area may be defined by the categories outlined in the Flood Emergency Response Planning Classification of Communities guideline (NSW Government, 2007). These categories account for the suitability of evacuation based on the following:

- The suitability of the evacuation route, and/or
- The suitability of the shelter location.

One of the key advantages of flood evacuation is intended to be the removal of flood isolation. Flood isolation can be considered in a number of ways:

- Isolation from medical services: in the event of a medical emergency; a pre-existing condition, injury, or sudden onset event such as heart attack, medical services may be accessed;
- Isolation from supplies: isolation from drinking water, food, amenities, and communication lines.

It was assumed that isolation from medical services poses a greater risk to life for the short durations of isolation likely to be experienced in Pittwater LGA. Therefore if flood free land does not have access through public land to an emergency centre, then the land may effectively be considered isolated, and therefore a high flood island.

Assessment of flood free land up to the PMF event in Pittwater LGA was undertaken to determine which areas have road access to a medical emergency centre. Medical emergency centres have been defined as hospitals and ambulance stations.

Within the Pittwater LGA the SES will not have sufficient response time in the event of flash flooding to establish additional emergency centres, and that medical services will

only be available at existing medical emergency centres such as hospitals. It should be noted that there are no SES local headquarters located within the Pittwater LGA.

Based on access to medical emergency centres, the majority of Pittwater LGA can be considered a High Flood Island. The implications of this outcome are that even if evacuation to flood free land is available, in most instances the evacuation destination will also be 'isolated', limiting the effectiveness of evacuation as an emergency response strategy. This may be improved if formal education centres (such as schools) were established throughout the Pittwater LGA with medical facilities. However, the flash flood nature of many of the catchments in Pittwater still results in many properties having not enough time to evacuate to these centres.

## **Evacuation versus Shelter-in-Place**

Unlike property damage assessments of flood risk, such as the methodology outlined within the *Managing Flood Risk through Planning Opportunities Guideline* (HNFMSC, 2006), when determining the flood risk to life the flood hazard for an area does not directly imply the danger posed to people in the floodplain. This is due to the capacity for people to respond and react to flooding, ensuring they do not enter floodwaters.

To help minimise the flood risk to occupants, it is important that developments have provisions to facilitate flood emergency response. There are two main forms of flood emergency response that may be adopted by people within the floodplain:

- Evacuation: the movement of occupants out of the floodplain before the property becomes flood affected; and,
- Shelter-in-place: the movement of occupants to a building that provides vertical refuge on the site or near the site before their property becomes flood affected.

The evacuation potential of Pittwater LGA in the event of flooding is considered to be limited due to the following:

- The flash flooding nature of the catchments within the LGA. Based on the SES evacuation timeline approach, there is insufficient time to co-ordinate a regional evacuation process, however there is potential for localised evacuation of sites near the edge of the floodplain; and,
- Due to the wide-spread nature of flooding in the Pittwater LGA, access to medical services for the majority of the Pittwater LGA is not available in the event of flooding, therefore most evacuation centres located within the LGA would be considered a High Flood Island.

Therefore, it was concluded that safe evacuation is not possible for the majority of floodplains in Pittwater LGA. In instances where localised evacuation is feasible, it is considered the preferred primary emergency response, however shelter-in-place is considered an acceptable alternative.

This conclusion is in accordance with the following relevant sources:

- The AFAC (2013) guideline states that evacuation is the most effective strategy, provided that evacuation can be safely implemented, however it may be worse than not evacuating at all. It suggests determination of whether there are barriers to evacuation posed by available warning time, availability of safe routes, and resources available, with evacuation potential found to be minimal.
- Tweed Shire Council Flood Risk Management Policy (2007) states that evacuation is the preferred risk management approach for developments, however shelter-in-place is considered an acceptable alternative when designed to meet specific development controls.

- Newcastle City Council Flood Policy (2003) states that as flood waters have the potential to rise within half an hour, there will generally be insufficient warning time to allow safe evacuation across flood-affected land. Consequently on-site refuge will normally be required to satisfy the acceptable risk to life criteria. The policy requires on-site refuge for all high hazard developments that are greater than 40 metres from the perimeter of the PMF extent which is the majority of the floodplain.
- Review of flood fatalities in Australia has found that the vast majority (75.7%) of fatalities occurred outside when people have entered flood waters in a vehicle or on foot, with only 12.4% of fatalities occurring in a house (Haynes et al, 2009). Conversely, it should also be noted that flooding in the Lockyer Valley showed the hazard associated with shelter-in-place, with 13 of the 19 fatalities being people sheltering in buildings that were either completely inundated or collapsed under the force of the flood flows (Rogencamp and Barton, 2012)

## **Determining the Risk to Life**

The Risk to Life Policy for Pittwater draws on numerous guidelines and papers relating to flash flooding and risk guidelines:

- National Emergency Risk Assessment Guidelines (Commonwealth Government, 2010),
- Managing Flood Risk through Planning Opportunities (HNFMSC, 2006),
- Flood Emergency Response Planning Classification of Community Guideline (NSW Government, 2007),
- Developing a Framework for Holistic Risk Based Floodplain Planning (Molino. S *et. al*, 2012),
- Updating National Guidance on Best Practice Flood Risk Management (McLuckie, D *et. al*, 2014),
- Technical Guideline for SES Timeline Evacuation Model (Molino. S *et. al*, 2013),
- Guideline on Emergency Planning and Response to Protect Life in Flash Flood Events (AFEC, 2013),
- Flood Risk to Life Policies of Other Council's (Newcastle City Council, 2012 and Tweed Shire Council, 2007).

The level of flood risk to life is proportional to the flood hazard for the area, that is to say; as the flood hazard increases, the cumulative risk to life also increases. Therefore there is a need to establish mapping of 'flood life hazard' categories which represent the risk to life caused by flood hazard.

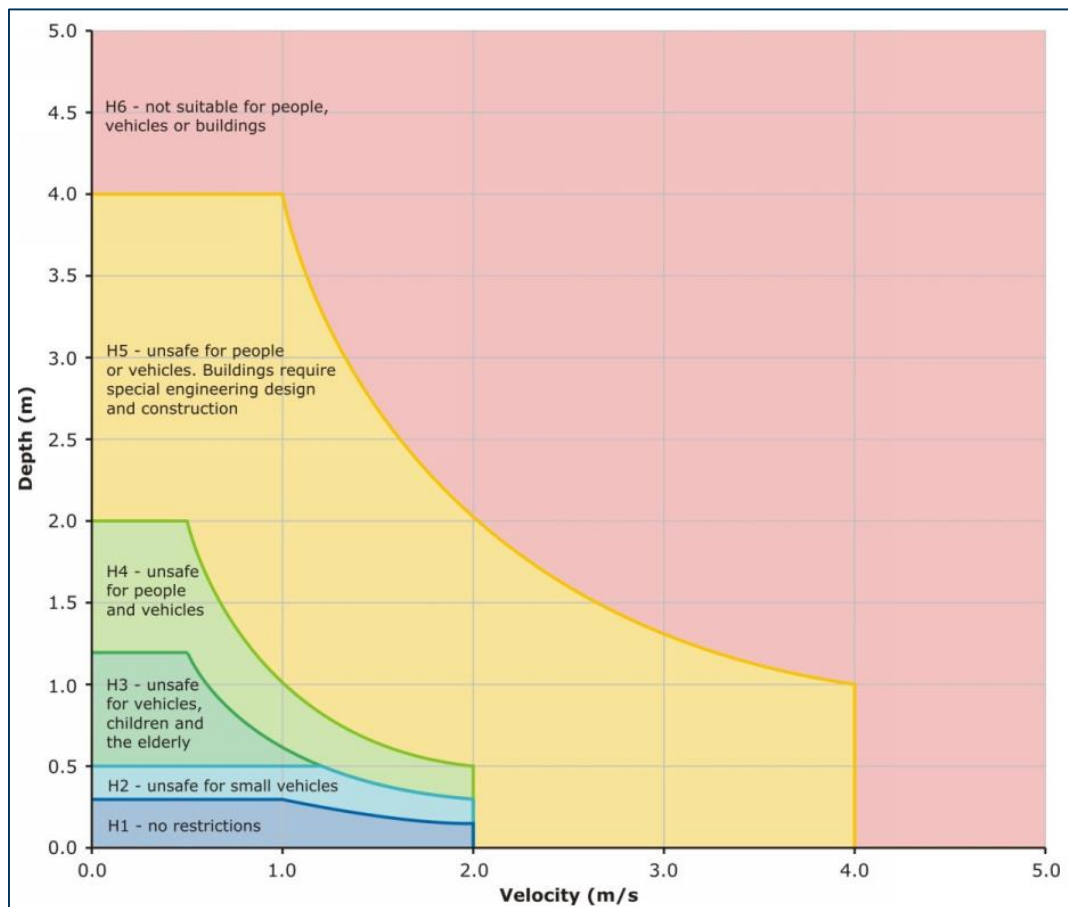
The determination of flood life hazard categories within the Pittwater LGA is based on consideration of the following factors:

- Flood hazard curves to identify the degree of flooding which poses a risk to life for demographics of the population.
- The design flood event to be adopted as the basis of the life hazard categories

### **Life Hazard**

The hazard thresholds presented within the paper "Updating National Guidance on Best Practice Flood Risk Management (McLuckie D *et al*, 2014)" have been used as the basis for flood life hazard categories within the Pittwater LGA.

The combined flood hazard curves are shown in Figure 2. The associated vulnerability thresholds are shown in Table 1.



**Figure 2 Combined Flood Hazard Curves**  
Source: McLuckie et al, 2014

**Table 1 Combined Hazard Thresholds**

Hazard Classification	Description
H1 – H2	Relatively benign flow conditions. Unsafe for small vehicles.
H3 – H4	Unsafe for all pedestrians and all vehicles.
H5	Unsafe for all pedestrians and all vehicles. Buildings require special engineering design and construction.
H6	Unconditionally dangerous. Not suitable for any type of development or evacuation access. All building types considered vulnerable to failure.

The increase in cumulative flood risk for occupants within the Pittwater LGA floodplains is not expected to be significantly impacted by the potential de-stabilisation of small vehicles, as pedestrian stability for all demographics is not compromised at this hazard level. Therefore for the purposes of Pittwater LGA's flood risk to life - hazard thresholds H1 and H2 have been grouped into the lowest possible risk category.

Similarly, there are assumed to be minimal increases in the cumulative flood risk to the population between H3 and H4 thresholds. The difference between the two hazard thresholds is that adult pedestrians are considered to be stable in H3 and not in H4, however as a significant portion of pedestrians (children and the elderly) will be unstable, the level of risk is similar. Therefore the two hazard groups were grouped.

## ***Adopted Design Event***

The NSW Government's Floodplain Development Manual (2005) states the following:

“Response planning for the consequences of the PMF provides for effective management of smaller events, particularly those rarer than the flood event selected as the basis of the Flood Planning Level (FPL). For example, where 1% AEP flood is used as the basis for minimum floor levels or protection from a levee, a 0.5% AEP flood event will probably overwhelm these measures. This event, whilst smaller, but significantly more likely than the PMF, will have major consequences to people, property, and infrastructure and needs to be accounted for in emergency response planning.”

“It is critical that relevant information on evacuation is provided on events up to the PMF”.

The guidelines examined within the literature review have the following comments on design flood events when considering flood risk to life and emergency response:

- Discussion within Chapter 11 of the *Managing Flood Risk through Planning Opportunities – Guidance on Land Use Planning in Flood Prone Areas* (HNFMSC, 2006) stresses the importance of considering flood emergency response for all events up to the PMF;
- The Flood Emergency Response Planning guideline (NSW Government, 2007) also states that categories should be considered for the PMF event (as well as the 20 year ARI and 100 year ARI events);
- The AFAC (2013) guidelines state that ideally shelter-in-place buildings should have habitable floors that will be flood free in a PMF event; and,
- The paper *Updating National Guidance on Best Practice Flood Risk Management* (McLuckie *et al.*, 2014) recommends the national adoption of PMF as the design event for emergency response classifications similar to those presented in the NSW Flood Emergency Response Planning guidelines (NSW Government, 2007).

Therefore, in consideration of flood risk to life, the Probable Maximum Flood (PMF) has been adopted as the design event for Pittwater LGA. The adoption of the PMF event represents a level of risk aversion that reflects the severity of potential loss of life of occupants.

Overland flow flood life hazard are however based on the 100 year ARI event. The majority of these overland flow affected lands within Pittwater LGA are steep, narrow flowpaths, with flowpath widths often not exceeding the width of most properties, meaning there is flood free land on most overland flow affected properties.

Mapping to identify Flood Life Hazard Category used the latest information relating to best practice flood risk management.





**Figure 3 Life Hazard Category mapping example**

### ***Likelihood of Loss of Life***

To provide background on flood risk to life using principles established in the National Emergency Risk Assessment Guideline (NERAG) (Commonwealth Government, 2010), for flood risk to life there is only one consequence, which is the loss of life as a result of flooding. As the consequence is not a variable, the analysis of risk relates only to the analysis of the probability. That is, if the likelihood of loss of life is rare enough, then risk is considered acceptable.

The following likelihood ratings are presented in the NERAG (Commonwealth Government, 2010):

- Almost Incredible;
- Very Rare;
- Rare;
- Unlikely;
- Possible;
- Likely; and,
- Almost Certain

The life hazard categories detailed previously have been assigned a loss of life likelihood rating based on the risk to life posed to all potential demographics within the floodplain for Pittwater LGA (Table 2).

Both flood emergency response measures; evacuation and shelter-in-place, are considered effective in reducing flood risk to life through avoiding exposure of occupants to flood hazard. Therefore the only developments within the Pittwater LGA that could result in certain loss of life are those where neither of the flood emergency responses may feasibly be implemented. This is defined as areas where:

- Evacuation is not possible as there is insufficient time available or capacity of the evacuation route to evacuate all occupants; and,
- Shelter-in-place buildings cannot be guaranteed to be stable, which is flood risk category H6.

**Table 2 Life Hazard Categories – Likelihood of Loss of Life Rating**

Life Hazard Category	Hazard Description	Likelihood of Loss of Life Rating	Discussion
H1 – H2	Relatively benign flow conditions. Unsafe for small vehicles.	Unlikely	Risk to life within the floodplain is not expected to be significantly impacted by the potential de-stabilisation of small vehicles as pedestrian stability for all demographics is not compromised at this hazard level. Therefore loss of life in these regions is unlikely
H3 - H4	Unsafe for all pedestrians and all vehicles.	Possible	All pedestrians and vehicles are unstable, posing a risk to a significant portion of the population, meaning loss of life is possible.
H5	Unsafe for all pedestrians and all vehicles. Buildings require special engineering design and construction.	Likely	All pedestrians and vehicles are unstable, buildings that are not specially designed are at risk, posing a risk to a significant portion of the population, meaning loss of life is likely.
H6 – Evacuation Possible	Unconditionally dangerous. Not suitable for any type of development or evacuation access.	Likely	All pedestrians, vehicles, and buildings are unstable, however as there is still an opportunity to evacuate, loss of life is likely (but not almost certain).
H6 – Evacuation Not Possible	All building types considered vulnerable to failure.	Almost Certain	All pedestrians, vehicles, and buildings are unstable, as people cannot evacuate, shelter-in-place is the only response option. As the stability of refuge buildings is compromised, loss of life is almost certain.

## Risk to Life Policy

The following outlines the key aspects contained within Pittwater Council’s Risk to Life Policy, including:

- What are the risk assessment categories?
- What type of flood emergency response is feasible?

## Risk Assessment Categories

There are three subjective risk assessment categories:

- Acceptable risk: Flood risk to life is considered negligible and the flood emergency response planning policy does not apply;
- Tolerable risk: Flood risk to life is significant and the flood emergency response planning policy applies for all developments;
- Unacceptable risk: Flood risk to life is severe, developments should not be permitted on a flood risk to life basis.

A graphical representation of the risk categories as they relate to flood life hazard categories is shown in **Table 3**.

**Table 3 Flood Risk Assessment Outcomes Summary**

Adopted Emergency Response	Flood Life Hazard Category			
	H1 - H2	H3 – H4	H5	H6
Evacuation				
Shelter-in-Place				

Where,

- Green = Acceptable risk, flood risk to life policy does not apply;
- Yellow = Tolerable risk, flood risk to life policy applies for all development; and,
- Orange = Unacceptable risk, no development should be permitted in these areas due to severe flood risk.

### ***Evacuation Feasibility contained within Pittwater’s Risk to Life Policy***

The main consideration of risk to life of occupants for evacuation is whether there is sufficient time to evacuate before flooding, if occupants can evacuate before flooding occurs then the risk to life may be considered acceptable.

The assessment of evacuation feasibility for a development needs to also account for the Flood Emergency Response Planning classification of the site, with evacuation via rising road access preferred.

### ***Flood Risk Emergency Assessment***

For evacuation to be considered an acceptable emergency response within the Pittwater LGA new development as well as alterations and additions to existing development should demonstrate all occupants may evacuate safely through a Flood Risk Emergency Assessment that considers:

- Proposed evacuation route and mode of transport, and the flood hazard along the route in the PMF. Note that:
  - Evacuation routes must not be through private property that is not a part of the subject site;
  - Preferable evacuation routes are rising road access
- Evacuation timeline including time required vs time available based on principles established in the NSW SES Evacuation Timeline Model and adapted for local evacuation ;
- Intended evacuation destination, the flood hazard at the destination, the level of service provided by evacuation destination (medical, food, water, communication lines), and duration of isolation of the destination in the PMF event from any of these services;
- Consideration of vulnerability of likely occupants, and their ability to evacuate;
- Consideration of the number of occupants, ensuring sufficient capacity of evacuation route, and evacuation destination to facilitate all occupants;

- Intended flood warning mechanism, potentially outlining concept design of warning systems taking into account flooding at all times of the day;
- Identification of the depth of floodwater along the evacuation route in the 1% AEP and PMF events;
- Intended flood evacuation awareness, if no obvious evacuation route is available then signage should assist occupants, particularly for business and commercial land uses; and
- Identification of any buildings on site that are appropriate for shelter-in-place as an alternative emergency response.

The combination of all these factors contribute to the acceptability of evacuation as an emergency response. Council's assessment of evacuation strategies will involve a merits based assessment based on the factors listed above.

### *Shelter-in-Place Requirements*

The following sections outline the shelter-in-place requirements and to which development types the controls are relevant.

**Flood Risk Emergency Assessment** - For shelter-in-place to be considered an acceptable emergency response, a development should demonstrate that the development controls summarised in the following sections have been addressed through a Flood Risk Emergency Assessment report.

**Minimum Floor Level for Shelter in Place** - The adopted requirements for shelter in place minimum floor levels are equal to the PMF flood event. These requirements apply to all tolerable life hazard categories, H3-H4 and H5 categories.

**Floor Space** - The adopted requirements for shelter in place minimum floor space are:

- A floor space of the shelter-in-place area 2 m<sup>2</sup> per person is required for all long duration flooding unless it can be shown the development lies within this region but is only inundated for a "short duration" (less than 6 hours in the PMF); or,
- A floor space of the shelter-in-place area 1 m<sup>2</sup> per person is required for development located in short duration flooding (less than 6 hours in the PMF).

These requirements apply to all tolerable flood life hazard categories, H3-H4 and H5 categories, and all development types.

The definition of sufficient capacity is defined as floor space of 1 m<sup>2</sup> per person for short duration (less than 6 hours), and 2 m<sup>2</sup> per person for long duration (greater than 6 hours).

**Accessibility** - The adopted requirements for shelter in place for all developments are:

- Shelter-in-place refuge must be intrinsically accessible to all people on the site, plainly evident, and self-directing, with sufficient capacity of access routes for all occupants.
- There must be sufficient time for all occupants to access shelter-in-place refuges, with fail safe access provided with no reliance on elevators. Flood warning systems should be considered where the number of occupants is significant.

**Building Stability** - For all shelter-in-place refuge buildings proposed within flood risk to life category H3-H4:

- Structural stability of the refuge building is to be verified by a suitably qualified structural engineer considering lateral flood flow, buoyancy, suction effects, and debris load impact of 1% AEP design flood depths and velocities; and
- Refuge must comply with Building Code of Australia requirements, with external components rated appropriately for storm, wind, and moisture.

This requirement is relevant for all land-use types within the flood risk to life category H3-H4.

For all shelter-in-place refuge buildings proposed within flood risk to life category H5:

- Structural stability of the refuge building is to be verified by a suitably qualified structural engineer considering lateral flood flow, buoyancy, suction effects, and debris load impact of PMF design flood depths and velocities; and
- Refuge must comply with Building Code of Australia requirements, with external components rated appropriately for storm, wind, and moisture.

This requirement is relevant for all land-use types within the flood risk to life category H5.

Serviceability - The following serviceability requirements only apply to long duration flooding unless it can be shown the development lies within this region but is only inundated for a “short duration” (less than 6 hours in the PMF). The serviceability requirements apply for all land-uses with the exception of subdivision:

- Sufficient clean water; and
- First Aid Kit; and
- Portable radio with spare batteries; and
- Torch with spare batteries.

In addition, land-use groups listed under Critical and Vulnerable Uses must also provide:

- a practical means of medical evacuation; and
- Emergency power.

## **So to Shelter or to Flee?**

To help minimise the flood risk to occupants, it is important that developments have provisions to facilitate flood emergency response. There are two main forms of flood emergency response that may be adopted by people within the floodplain:

- Evacuation: The movement of occupants out of the floodplain before the property becomes flood affected; and,
- Shelter-in-place: The movement of occupants to a building that provides vertical refuge on the site or near the site before their property becomes flood affected.

By establishing minimum requirements for evacuation and shelter-in-place strategies for new developments, as well as additions and alterations to existing developments, Pittwater Council ensures that:

- Flood risk associated with development is clearly identified; and,
- Flood risk to life for development is appropriately managed.

In assigning what is an acceptable emergency response measure for a development, Pittwater Council has taken into consideration:

- Flood Life Hazard Category: Life hazard accounts for the potential hazard relating to the flood behaviour throughout the Local Government Area (LGA). If the floodplain were occupied at the time of flooding then the flood life hazard

categories indicate the hazard occupants would be exposed to. Flood life hazard categories have been mapped for the entire Pittwater LGA (and available through Council's Flood Information Request service);

- Land-use: The land-uses within the floodplain provide an indication of the occupation of the floodplain which will influence the number and demographic of people exposed to flood risk. Therefore emergency response requirements should be tailored to each land-use; and,
- Proposed emergency response: Consideration of emergency response measures relates to the likelihood of occupants within the floodplain being directly exposed to flood hazard. The emergency response requirements are dependent on if evacuation or shelter-in-place is the adopted emergency response.

By adjusting emergency response requirements for each development based on these considerations, the flood risk to life may be addressed in a targeted way while not being needlessly onerous on the developer / land owner.

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