2.0 RECOMMENDATION

1. That the statutory process to amend Pittwater 21 Development Control Plan be commenced.

2. That the proposed changes to Pittwater 21 Development Control Plan (**Attachment 1, 2 and 3**) be placed on public exhibition for 28 days with submissions invited from the public and notified in accordance with Council's Community Engagement Policies.

3. That following the period of public exhibition and consideration of any submissions received, the draft Pittwater 21 Development Control Plan be reported back to Council for further consideration.

3.0 BACKGROUND

3.1 PURPOSE

To seek approval to commence the statutory process to update the Pittwater 21 DCP as it relates to the incorporation of:

- Flood Emergency Response Planning for Development in Pittwater Policy,
- Flood Life Hazard Mapping, and
- Flood Emergency Response Planning DCP control.

3.2 BACKGROUND

There are 2335 properties within the Pittwater LGA affected by mainstream flooding, and an additional 2090 properties affected by Overland Flow based on 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 to property damaged caused by flooding. However, for Council to ensure the flood risk is adequately addressed the need for Council to have an adopted policy and associated DCP control on flood emergency response planning of development on flood prone land through an additional policy is required.

On the 5 March 2012 Council deferred its recommendation with regards to Managing Flood Emergency Response Planning of Development in the Lower Narrabeen Lagoon Floodplain until further information could be provided in relation to the adequacy of Council's 'sheltering-in-place' procedures (see Confidential Report on this Agenda which attaches the Council report, consultant and legal advice, and determination from *Smith v Pittwater Council* [2013] NSW LEC 1145).

Since the Council meeting on the 5 March 2012, the Narrabeen Lagoon Flood Study, Pittwater Overland Flow Flood Study and the Careel Creek Catchment Flood Study have been completed and adopted by Council.

A draft Interim Risk to Life Policy has been peer reviewed by Molino Stewart and Cardno was engaged to undertake the Pittwater LGA Flood Risk to Life Classification Study.

The outputs of the Pittwater LGA Flood Risk to Life Classification Study (**Attachment 4**), was the creation of the Flood Emergency Response Planning for Development in Pittwater Policy (**Attachment 1**), and the associated DCP control (**Attachment 2**). The policy and control have been created based on the information and industry best practice as outlined in the classification study by Cardno.

The Flood Emergency Reponses Planning for Development in Pittwater Policy draws on numerous guidelines and papers relating to flash flooding and risk guidelines:

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

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

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.

3.3 POLICY IMPLICATIONS

- This is a new policy to be introduced to Councils Pittwater 21 DCP.

3.4 RELATED LEGISLATION

Environmental Planning & Assessment Act 1979
NSW Government Flood Prone Land Policy and Floodplain Development Manual (2005)
Local Government Act 1993

3.5 FINANCIAL ISSUES

3.5.1 Budget

- Not Applicable

3.5.2 Resources Implications

- Not Applicable

4.0 KEY ISSUES

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, including additions and alterations to existing developments, the:

> Flood risk associated with development can be identified; and,
> Flood risk to life for development can be appropriately managed.

In assigning what is an acceptable emergency response measure for a development, 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 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.

It is recognised in the draft policy that the policy and development controls are not intended to apply to development/subdivision of a sector, buffer area or development site in a Release area. This is due to the need for a more complex assessment to be undertaken to manage future flood risk of Land Release areas.

5.0 ATTACHMENTS / TABLED DOCUMENTS

- **Attachment One**: Flood Emergency Response Planning for Development in Pittwater Policy
- **Attachment Two**: Flood Emergency Response Planning DCP Control
- **Attachment Three**: Flood Life Hazard Map
- **Attachment Four**: Reference Document – Pittwater LGA Flood Risk to Life Classification Study

6.0 SUSTAINABILITY ASSESSMENT

6.1 GOVERNANCE & RISK

6.1.1 Community Engagement

- A public notice will be placed in the Manly Daily
- Proposed amendments to Pittwater 21 DCP will be placed on statutory public exhibition for a minimum of 28 days

6.1.2 Risk Management

- The proposed DCP policy and associated development control enables a risk management approach to determine whether development that occurs on flood prone land can meet an acceptable level of risk.
- Risk matrix has been used in the development of the policy and is outlined in Attachment 1.

6.2 ENVIRONMENT

6.2.1 Environmental Impact

- Nil

6.2.2 Mitigation Measures

- This DCP policy and associated development control will assist in building resilience into dwellings/buildings located in Council's flood prone land through compliance with the proposed DCP control.

6.3 SOCIAL

6.3.1 Address Community Need & Aspirations

- The proposed amendments to the Pittwater 21 DCP will enable the community to be better prepared and informed on the flood risk associated with their property.

6.3.2 Strengthening local community

- The proposed amendment to the Pittwater 21 DCP through the Flood Emergency Response Planning for Development in Pittwater Policy and associated DCP control will assist in building resilience in the community's knowledge and awareness of the risk to flooding poses.

6.4 ECONOMIC

6.4.1 Economic Development

- The proposed amendment to the Pittwater 21 DCP provides the opportunity for flood affected commercial centre areas to manage flood risk by applying flood emergency management design principles within existing zonings.

Report prepared by
Melanie Schwecke, A/Principal Officer – Floodplain Management

Jennifer Pang
MANAGER, CATCHMENT MANAGEMENT & CLIMATE CHANGE

PITTWATER COUNCIL

PITTWATER 21 DEVELOPMENT CONTROL PLAN

Appendix XX

PROPOSED Flood Emergency Response Planning for Development in Pittwater Policy

TABLE OF CONTENTS

1 Flood Emergency Response Planning for Development in Pittwater Policy

1.1 Purpose

In accordance with the Floodplain Development Manual (FDM) (NSW Government, 2005), in flood prone land the responsibility lies with Council to ensure new developments minimise flood risk through the implementation of effective flood emergency response measures.

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, including additions and alterations to existing developments, 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, 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 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.

1.2 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 are shown in Table 1-1. As seen in Table 1-1 this flood emergency response planning policy applies to all land assigned a flood life hazard category of H3-H4 or greater.

Table 1-1 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 emergency response planning policy does not apply;

Yellow = Tolerable risk, flood emergency response planning policy applies for all development; and,

Orange = Unacceptable risk, no development should be permitted in these areas due to severe flood risk.

1.3 Complying Development Certification (CDC)

In accordance with Clause 3.36C of the Exempt and Complying Development Codes SEPP (NSW Government, 2008), flood affected properties may be eligible for a complying development certificate if the development does not lie within a "high risk area".

For developments within the Pittwater LGA, "high risk areas" are defined as areas of flood life hazard category H3-H4 or greater. Therefore areas of flood life hazard category H1-H2 are considered "low risk areas" and Complying Development Certification may still be possible in these areas.

1.4 Developments to Which This Policy Applies

A summary of the land-use groups is included in Error! Reference source not found..

Table 1-2 Land Use Groups

Critical	Vulnerable Uses	Residential
emergency services facility	child care centre	boarding house
hospital	educational establishment	dual occupancy
public administration building	home-based child care	dwelling house
sewerage system	Community health service facility	exhibition home
Telecommunications facility (SP2)	information and education facility	exhibition village
Public Utility Undertaking (SP2)	respite day care centre	hostel
electricity generating works	seniors housing	residential flat building
	caravan park	rural worker's dwelling
	group home	secondary dwelling
	residential care facilities	semi-detached dwelling
	correctional centre	multi dwelling housing
	tourist and visitor accommodation	shop top housing
		attached dwelling

Business & industrial		
boat building and repair facility business premises car park crematorium depot entertainment facility freight transport facility function centre general industry health consulting rooms heavy industrial storage establishment highway service centre industrial retail outlet industrial training facility industries	medical centre mortuary neighbourhood shop office premises Patient Transport facilities passenger transport facility place of public worship port facility recreation facility (indoor) registered club restricted premises retail premises rural industry service station sex services premises storage premises transport depot truck depot turf farming vehicle body repair workshop vehicle repair station veterinary hospital warehouse or distribution centre waste disposal facility	waste or resource management facility management facility waste water disposal system water recreation structure water supply system wharf or boating facilities wholesale supplies animal boarding or training establishment charter and tourism boating facility home business home occupation home occupation (sex services) community facility research station camping ground eco-tourist facilities marina cemetery

Recreational and Environmental	Subdivision	Concessional	No controls
aquaculture	subdivision	development ancillary to residential development	signage
boat shed		occupation/change of use of an existing premises	intensive livestock agriculture
environmental facility			intensive plant agriculture
environmental protection works			open cut mining
extensive agriculture			jetty
extractive industry			mooring
farm building			mooring pen
flood mitigation works			recreation area
forestry			tree and/or bushland removal
horticulture			earthworks
recreation facility (major)			road
recreation facility (outdoor)			boat launching ramp
viticulture			demolition
			development/subdivision of a sector, buffer area or development site in a Release Area

The flood risk to life is considered significant for all developments under Land use categories "Critical and Vulnerable Uses", therefore it is preferred that these development types not be located within the PMF flood extent. Note that any alterations or additions to existing dwellings must consider this flood policy.

1.4.1 Land Release Developments

This Flood Emergency Response Planning for Development in Pittwater policy and the associated development controls does not apply to Development/subdivision of a sector, buffer area or development site in a Release Area. Flood affected land release developments such as those identified in the Warriewood Urban Land Release are expected to have a more significant impact on flood risk to life.

The development controls specified in this policy address flood risk to life accounting for moderate intensification of development within the floodplain. Development/subdivision of a sector, buffer area or development site in a Release Area are more likely to result in previously low density or unoccupied flood affected land having a major increase in occupation and therefore flood risk to life. The controls specified in this policy therefore do not address flood risk to life adequately to account for land release developments.

Development/subdivision of a sector, buffer area or development site in a Release Area should adopt the same emergency response principles within this policy however to a greater extent incorporating a more complex assessment to ensure future flood risk is not increased as a result of Development/subdivision of a sector, buffer area or development site in a Release Area.

1.5 Evacuation Requirements

1.5.1 Evacuation Feasibility

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.

It is recommended that the Pittwater LGA evacuation model (**Attachment A**) be adopted as the basis for assessing evacuation feasibility.

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

1.5.2 Flood Risk Emergency Assessment

For evacuation to be considered an acceptable emergency response development and 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 (see **Section 1.6** for further details).

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.

1.6 Shelter-in-Place Requirements

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

1.6.1 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.

1.6.2 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.

1.6.3 Floor Space

The adopted requirements for shelter in place minimum floor space are:

- A floor space of the shelter-in-place area 2 m^2 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^2 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^2 per person for short duration (less than 6 hours), and 2 m^2 per person for long duration (greater than 6 hours).

1.6.4 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.

1.6.5 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.

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.

1.6.6 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.

2 Attachment A – Evacuation Timeline Model

Evacuation Time line model for the Pittwater LGA

The determination of the timeline model adopted for Pittwater LGA has been based on the *NSW SES Timeline Evacuation Model* as outlined in the paper *Technical Guideline for SES Timeline Evacuation Model* prepared by Molino S. et al in 2013. The *NSW SES Timeline Evacuation Model* relates to the regional evacuation of floodplains through doorknocking by SES volunteers through to the evacuation of all occupants for the region.

At the centre of the timeline methodology is the following concept:

Surplus Time = Time Available – Time Required

If surplus time is positive then evacuation of all occupants is feasible, while a negative value implies evacuation of all occupants is not likely to be able to be achieved.

The calculation of the two variables is as summarised below:

Time Required

The SES timeline approach to assess time required to evacuate is based on a specific sequence of events; SES monitor, and notify occupants of a region to evacuate following initial reluctance. Due to the flash flooding nature of Pittwater LGA it is assumed that evacuation will not be able to occur through co-ordinated SES door-knocking process.

However evacuation may occur at a more localised level through a different sequence of events; occupants visually see flooding in their vicinity and respond instinctively by moving to higher ground.

This sequence relies less on emergency services co-ordination and relies on the common sense of the occupant to respond to observed flooding through evacuation. It is not dissimilar to the expected sequence of events for shelter-in-place with the exception that occupants evacuate to higher ground rather than elevated buildings.

Based on this localised response approach the calculation of time required for Pittwater LGA is as follows:

Time Required = Travel Time (TT) + Travel Safety Factor (TSF)

Where the following values are recommended in the guideline:

> TT = Variable – the number of hours taken for the evacuation of all vehicles based on road capacity. NSW SES recommend a road lane capacity of 600 vehicles per hour, i.e if there are 1200 vehicles to evacuate TT = 2 hours. A similar approach may be applied to pedestrian evacuation routes.
>
> TSF = Variable – added to travel time to account for any delays along the evacuation route for example resulting from accidents, this value is a variable of TT between 1 hour and 3.5 hours.

Time Available

This variable is to be determined on a case by case basis derived from the following:

- Evacuation route geometry;
- Rate of rise of waters.

Localised evacuation is heavily dependent on Rising Road Access availability in accordance with classifications outlined in the Flood Emergency Response Planning classification guidelines (refer to **Attachment B**).

3 Attachment B – Flood Emergency Response Planning Classifications

The definition of Flood Emergency Response Categories has been based on those outlined in the Flood Emergency Response Planning (FERP) Classification of Communities Guideline (NSW Government, 2007).

The categories are focussed on SES requirements and look to classify land based on evacuation and access availability during flood events. The Flood Emergency Response Planning classifications assist emergency managers with identifying the type and scale of information needed for emergency response planning, and assist planners in identifying suitable areas for development.

The guideline provides a number of classifications, which are based on those utilised by the SES. These definitions are outlined below.

- **High Flood Island:** The flood island is higher than the limit of flooding (i.e. above the PMF), no risk to life or property from inundation on the island, will require resupply by boat or air if not evacuated prior to road being cut;
- **Low Flood Island:** The flood island is lower than the limit of flooding (i.e. below the PMF), if floodwater continues to rise after it is isolated, the island will eventually be completely covered, with a risk to life from inundation from people from who are not evacuated;
- **Area with Overland Escape Route:** These are inhabited areas on flood prone ridges jutting into the floodplain or on the valley side, the access road/s cross lower lying flood prone land, evacuation can take place by road only until access roads are closed by floodwater. Escape from rising floodwater will be possible by walking overland to higher ground;
- **Area with Rising Road Access:** These are similar to above, access road/s rise steadily uphill and away from rising floodwaters, people are not trapped unless they delay evacuation;
- **High Trapped Perimeters:** These are inhabited areas above the PMF so there is no risk of inundation of homes by floodwater but the only access road/s are across flood prone land, similar issues to high flood islands, resupply may be necessary;
- **Low Trapped Perimeters:** The inhabited area is lower than the limit of flooding (i.e. below the PMF), if floodwaters continue to rise, then property will be cut-off and eventually inundated, if no evacuation occurs, risk to life from inundation; and,
- **Indirectly Affected:** There will be areas outside the limit of flooding which will not be inundated and will not lose road access, never the less they may be indirectly affected as a result of flood damaged infrastructure, due to the loss of transport links, electricity supply, water supply, sewage or telecommunications services they may require resupply or in the worst case, evacuation.

The Flood Emergency Response Planning classifications need to be considered for the PMF event as a minimum as it is the design event adopted within this Policy.

4 Attachment C – Form 1

FLOOD EMERGENCY RESPONSE PLANNING FOR DEVELOPMENT IN PITTWATER POLICY
FORM NO. 1 – To be submitted with Development Application

Development Application for

_____
(Name of Applicant)

Address of site: _____

Declaration made by hydraulic engineer or engineer specialising in flooding/flood emergency response as part of a Flood Risk Emergency Assessment:

I, _____ on behalf of _____
(Insert Name) (Trading or Business/ Company Name)

on this the _____ certify that I am a hydraulic engineer or engineer
(Date)
specialising in flooding/flood emergency response and I am authorised by the above organisation/ company to issue this document and to certify that the organisation/ company has a current professional indemnity policy of at least $2million.

Flood Risk Emergency Assessment Details:

Report Title:

……

Report Date: ……

Author: ……

Author's Company/Organisation: ……

I: _____
(Insert Name)
Please tick appropriate box (more than one box can be marked)

☐ have prepared the Flood Risk Emergency Assessment referenced on Form 1 in accordance with Council's guidelines and the Flood Emergency Response Planning for Development in Pittwater Policy.

☐ am willing to technically verify that the detailed Flood Risk Emergency Assessment referenced on Form 1 has been prepared in accordance with Council's guidelines and the Flood Emergency Response Planning for Development in Pittwater Policy.

☐ have examined the site and the proposed development in detail and have carried out a risk assessment (which has been attached to this form), and can confirm that:

- ☐ The addition/dwelling/building is located outside of the extents for Flood Life Hazard Categories H3-H4, H5 and H6 and a Flood Risk Emergency Assessment in not required.

☐ confirm that the results of the risk assessment for the proposed development are in compliance with the Flood Risk Management Policy for Development in Pittwater and a detailed risk assessment is not required for the subject site.

☐ have examined the site and the proposed development/alteration/addition in detail and I am of the opinion (after carrying out a risk assessment) that the Development Application does not require a Flood Risk Emergency Assessment and I have attached the risk assessment to this form.

☐ have reviewed (provide details of Report) the Flood Risk Emergency Assessment previously prepared for this property and can confirm it is up to date and is still current.

Documentation which relate to or are relied upon in report preparation:

☐ I am aware that the Flood Risk Emergency Assessment referenced on Form 1, prepared for the abovementioned site is to be submitted in support of a Development Application for this site and will be relied on by Pittwater Council as the basis for ensuring that the Flood Risk Management aspects of the proposed development have been adequately addressed to achieve an "Acceptable or Tolerable Risk" level for the life of the structure, taken as at least 100 years unless otherwise stated and justified in the Report and that reasonable and practical measures have been identified to remove foreseeable risk.

Hydraulic engineer or engineer specialising in flooding/flood emergency response details:

Signature ……

Name ……

Chartered Professional Status……

Membership No. ……

Company……

Number of years specialising in flooding/emergency response……

PROPOSED DCP control

B3.XX Flood Hazard – Flood Emergency Response planning

Land to which this control applies
Land identified on the Flood Life Hazard Category Maps as H3-4, H5 and H6.

Uses to which this control applies
List (refer to Table 1.2 in the policy)

Outcomes
Protection of people. (S)
Protection of the natural environment. (En)
Protection of private and public infrastructure and assets. (S)

Controls
Areas of the Pittwater LGA potentially impacted by flash flooding or overland flow or lagoon flooding or a combination of flooding are to ensure development is undertaken in a way that is reflective of the flood risk.

Form 1 (Attachment C of the Flood Emergency Response Planning for Development in Pittwater Policy) is to be completed and submitted to Council

If safe evacuation can be demonstrated to Council's satisfaction through the submitted Flood risk Emergency Assessment, then the controls for shelter in place are not applicable.

Development Matrix

The following is a summary of the major steps to be followed in applying this part of the DCP:

(a) Determine the Flood Life Hazard within which your site is situated. The Flood Life Hazards are divided into four categories, i.e. H1-2, H3 -H4, H5 & H6;
Note: Where a property is located in more than one Hazard, the assessment must consider the controls relevant to each Hazard.

(b) Determine the *Land Use Group* relevant to your proposal. The various land use or development types have been grouped into *Land Use Groups* (refer table 1 below);

(c) Address each of the prescriptive controls for the relevant land use category in the applicable Hazard.

Table 1 Flood Risk to Life Development Matrix

Adopted Emergency Response	Land-Use Group	Flood Life Hazard Category			
		H1 - H2	H3 – H4	H5	H6
Evacuation	All	No control	1a	1a	1a
Shelter-in-Place	Recreational and environmental	No control	1b, 2, 3, 4, 5a	1b, 2, 3, 4, 5b	Development not permitted
	Concessional	No control	1b, 2, 3, 4, 5a	1b, 2, 3, 4, 5b	Development not permitted
	Residential	No control	1b, 2, 3, 4, 5a, 6a	1b, 2, 3, 4, 5b, 6a	Development not permitted
	Business and Industrial	No control	1b, 2, 3, 4, 5a, 6a	1b, 2, 3, 4, 5b, 6a	Development not permitted

	Vulnerable Uses	No control	1b, 2, 3, 4, 5a, 6b	1b, 2, 3, 4, 5b, 6b	Development not permitted
	Critical	No control	1b, 2, 3, 4, 5a, 6b	1b, 2, 3, 4, 5b, 6b	Development not permitted

Where,

Green = Acceptable risk;

Yellow = Tolerable risk; and,

Orange = Unacceptable risk.

Evacuation

Control 1a – Flood Risk Emergency Assessment

Requires the preparation of a Flood Risk Emergency Assessment report for the evacuation strategy as outlined in the Flood Emergency Response Planning for Development in Pittwater Policy.

Shelter-in-Place

Control 1b - Flood Risk Emergency Assessment

Requires the preparation of a Flood Risk Emergency Assessment report addressing the shelter-in-place requirements as outlined in the Flood Emergency Response Planning for Development in Pittwater Policy.

Control 2 - Minimum Floor Level

Minimum floor level equal to the PMF flood event for shelter-in-place refuge

Control 3 - Floor Space Requirement

Minimum floor space of the shelter-in-place refuge is:

- 2 m^2 per person is required for all long duration flooding in a PMF event unless it can be shown the development lies within an area only inundated for a "short duration" (less than 6 hours in the PMF); or,
- 1 m^2 per person is required for shelter-in-place refuge impacted by short duration flooding in a PMF event.

Control 4 - Accessibility

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.

Control 5a - Building Stability

Structural stability of the building is to be verified by a suitably qualified structural engineer considering lateral flood flow, buoyancy, suction effects, and debris load impact of the 1% AEP design flood depths and velocities.

Control 5b - Building Stability

Structural stability of the 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.

Control 6a – Serviceability

For developments with long duration flooding regions 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) shelter-in-place refuge is to provide:

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

Control 6b – Serviceability

For developments with long duration flooding regions 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) shelter-in-place refuge is to provide:

- Sufficient clean water for all occupants; and
- Portable radio with spare batteries; and
- First Aid Kit; and
- Torch with spare batteries; and
- Emergency power; and
- Practical means of medical evacuation.

Variation to the controls

Where in the opinion of a hydraulic engineer, or an engineer specialising in flooding/flood emergency response that a Flood Risk Emergency Assessment Report is not required and a variation to the controls is requested - This must be justified as a clear professional opinion with the supporting basis on which the opinion was formed submitted to Council. A completed Form 1 (Attachment C of the Flood Emergency Response Planning for Development in Pittwater Policy), must also be submitted with the development application.

Pittwater Council may also waive the requirement for a Flood Risk Emergency Assessment prior to a Development Application being lodged with Council, following a review of the proposed development, land use group and the Flood Life Hazard by Pittwater Council.

Advisory Notes

For additional information, applicants are referred to Appendix X Flood Emergency Response Planning for Development in Pittwater Policy of this DCP.

Obtaining Flood Life Hazard Categories

To apply this control the Flood Life Hazard Categories on the parcel of land/lot must first be established by:

Obtaining the Flood Life Hazard Category Map from Council through the Flood Information Request service;
or
An independent assessment undertaken by a Hydraulic Engineer to determine the flood life hazard categories 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 (refer to Updating National Guidelines on Best Practice Flood Risk Management by McLuckie , D et al, 2014), and

- The design flood event to be adopted as the basis of the life hazard categories as the PMF event

Developer Decision Tree

The decision tree shown in Figure 1 has been prepared to assist developers in determining whether or not flood risk to life development controls apply to their development and assist in the application of the development matrix shown in figure 1.

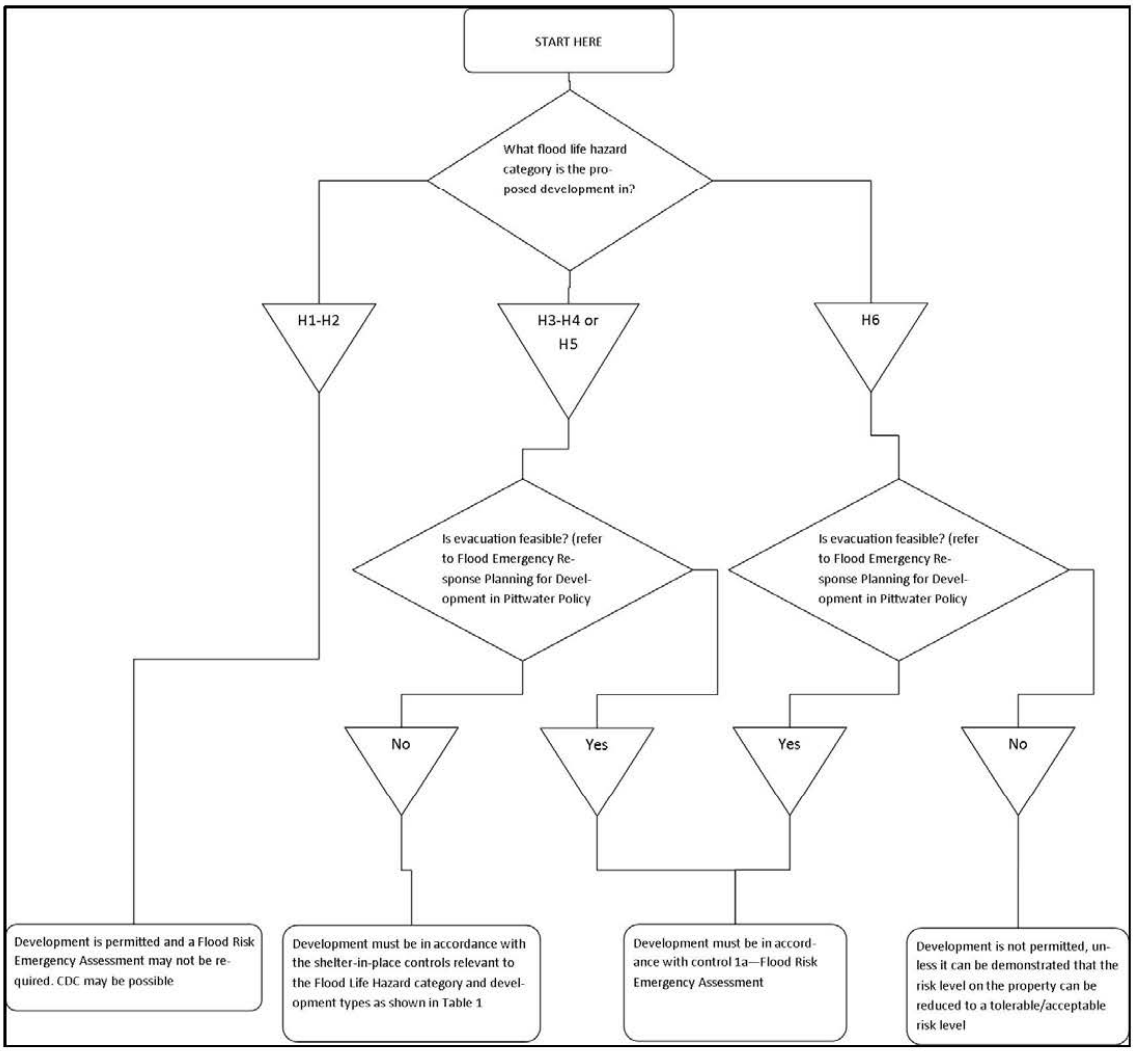
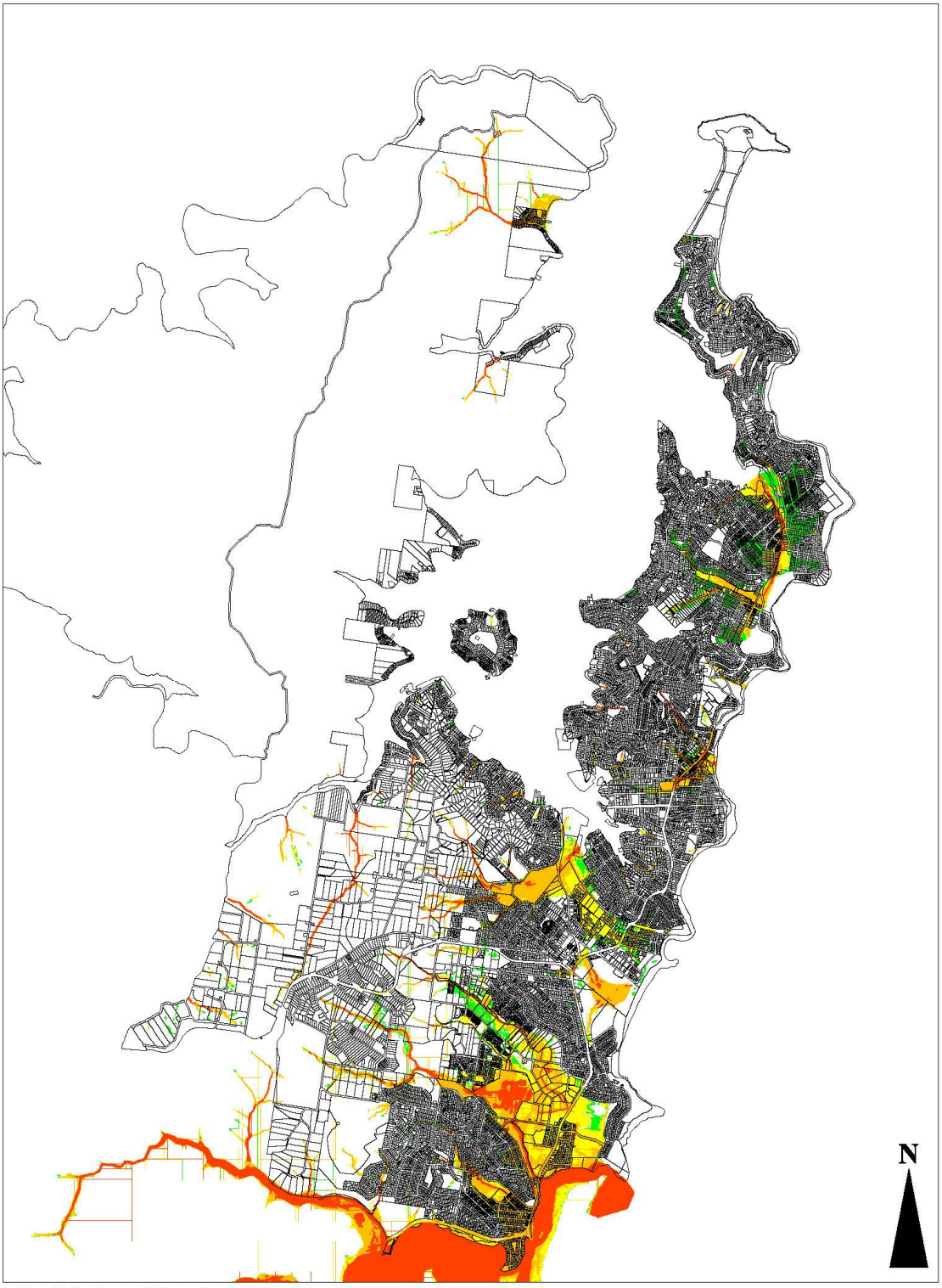


Figure 1 Developer Decision Tree



Flood Life Hazard Categories

H6 H5 H3 - H4 H1 - H2

Map not to Scale

PITTWATER COUNCIL

Reference Document

Pittwater LGA Flood Risk to Life Classification Study

59914130

Prepared for
Pittwater Council

19 January 2015

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Shaping the Future

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1	Final Report	MS		1 December 2014
2	Amended Final Report	MS		10 December 2014
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1 Introduction

The Pittwater Local Government Area (LGA) has a history of flooding. Areas of the Pittwater LGA can be impacted by flash flooding, overland flows, lagoon flooding as well as coastal and estuarine inundation.

Pittwater Council is responsible for floodplain risk management within the Pittwater LGA in accordance with the NSW Government Flood Prone Land Policy. The NSW State Government has prepared the Floodplain Development Manual (FDM) (NSW Government, 2005) to guide local councils to manage flood risk.

The FDM (NSW Government, 2005) defines flood risk as follows:

> *Flood risk is potential danger to personal safety and potential damage to property resulting from flooding. The degree of risk varies with circumstances across the full range of floods.*

The focus of this report is on the personal safety aspect of flooding. At present, Council does not have a robust approach for consideration of personal safety (risk to life) in the relevant policies. The majority of current development controls generally focus on the damage to property aspect of risk, rather than risk to life. In response to this, Council has commissioned the preparation of this study to define the risk to life throughout the LGA from flooding, and create a coherent flood emergency response planning policy for properties that ensures that future development is undertaken in a way that is reflective of the flood risk.

Flood hazard is currently defined for the Pittwater LGA through Flood Studies (FS) and Floodplain Risk Management Studies (FRMS) which have been undertaken throughout the LGA in accordance with the floodplain risk management process outlined in the Floodplain Development Manual (NSW Government, 2005). This information has been utilised to assist in identifying the risk to life as a result of flooding in the LGA.

The key objectives of this study are to:

- Assess the evacuation potential for the Pittwater LGA. Based on the outcomes of this assessment a policy direction in relation to evacuation is to be provided;
- Classify and map regions of 'life hazard' for the Pittwater LGA. This classification and mapping uses flood data sourced from the various FS's and FRMS's for the floodplains within Pittwater LGA;
- Conduct a flood risk assessment to define the following three levels of risk, which incorporate consideration of people at risk:
  - Acceptable: Flood risk is negligible and no consideration of the flood emergency response planning policy is required;
  - Tolerable: Flood risk is significant and consideration of the flood emergency response planning policy is required; and,
  - Unacceptable: Flood risk is severe and no development should be permitted.
- Prepare a *flood emergency response planning policy* which aims to treat flood risk through development controls to be applied to developments, and alterations and additions to existing developments within Pittwater LGA. These controls should focus on addressing flood risk to life through flood emergency response provisions.

2 Context of the Study

An interim flood emergency response planning policy was prepared by Pittwater Council (2012) and a peer review of the document was undertaken (Molino Stewart, 2014). The outcomes of the peer review have provided guidance for the development of this policy (this document). This policy (when adopted) supersedes the interim policy with the majority of the scope and objectives of this study guided by the interim policy and the associated peer review.

An outcome of the classification of flood risk within Pittwater LGA is the opportunity to define high flood risk to assist developers and assessors of flood related exempt and complying development.

The NSW state government has released guidance to Councils relating to the application of flood related development controls to residential developments in "low" flood risk areas. It is important that this policy and the development controls within the policy are in accordance with this guidance.

2.1 Interim Policy

Pittwater Council's existing flood risk management policy and associated development controls are effective in regulating future risk of damage to property. However, following the concerns raised by Council with regards to a number of development proposals in relation to flood emergency response provisions, it became clear that flood risk to life was not appropriately addressed in the existing controls. To address this issue, Council created an interim *Flood Risk Emergency Management Response Policy for Flood Prone Lands in Pittwater* (Pittwater Council, 2012).

The purpose of the interim policy was to provide Council staff and applicants an overview of Council's position on the two main forms of flood emergency response; evacuation and shelter-in-place, and provide an update on subsidiary flood emergency response projects underway at the time.

The policy provided details of Council's position on a number of key points relating to flood risk. The main outcomes of the policy are summarised below:

- Acknowledgement that Council's strategic planning of flood prone areas can influence the efficacy of NSW State Emergency Service (SES) operations and the individual flood emergency responses of flood affected occupants, despite Council only having a secondary role during flood emergency events.
- Council notes that while there is currently no state government policy or direction regarding flood emergency response, the SES has a number of unofficial positions that can significantly limit development potential. These include:
  - Evacuation should be a primary strategy for managing the safety of people in flood environments;
  - "Sheltering-in-place" is not supported by the SES;
  - Flood free access is recommended for flood events up to the PMF event; and,
  - Intensification of development in the floodplain that increases the numbers of people at flood risk is not supported.
- The policy establishes a clear distinction between the two main types of flooding in Pittwater:
  - Short duration, flash flooding, for areas with time of inundation less than 6 hours; and,
  - Long duration flooding resulting from backwater or tailwater dominant flooding from basin / lagoons downstream.

Taking into account all of the considerations listed above, the following interim policy and direction was established:

- The SES edict to have PMF flood free access would be cost prohibitive for Pittwater given the extent of lower lying areas and in particular lower lying main road infrastructure. Instead a minimum design level of the 100 year ARI (with consideration of climate change) with rising level access is recommended for all flood emergency access routes;
- Evacuation is the primary recommended flood emergency response for all developments on flood prone land. However if evacuation is not feasible due to the location of the development, then shelter-in-place

is a potential "last resort" alternative. Shelter-in-place is more likely to be acceptable for developments within short duration flooding areas. To ensure the adequacy of either response in minimising flood risk through a Flood Risk Emergency Response Plan for all developments on flood prone land;

- Intensification of development within flood prone land are deemed permissible only when current zonings are maintained, for example existing shop top housing zones on the basis of a tolerable residual risk. This also takes into consideration social and economic factors; and,
- A flood warning system is to be developed for the northern beaches as part of a current program. In addition, a community flood awareness program is to be developed in an attempt to improve flood emergency response.

The interim policy was peer reviewed by Molino Stewart in January 2014 (Molino Stewart, 2014). The peer review had a number of comments regarding the objectives, structure, and wording of the policy.

In response to the peer review comments; Pittwater Council has commissioned the preparation of this Study and Policy with the following changes to the interim policy scope:

- Develop a flood risk classification approach for the Pittwater LGA that assigns high, medium, low and acceptable, tolerable, and unacceptable risk categories for all land in Pittwater LGA;
- Conduct the risk assessment process in accordance with principles outlined in the National Emergency Risk Assessment Guidelines (NERAG), and Managing Flood Risk through Planning Opportunities guidelines; and,
- Expand scope from being related to flood emergency response to a wider consideration of flood risk to life, with the policy name to reflect this.

The peer review comments provided by Molino Stewart have looked to be addressed within this study.

2.2 High Risk Area Identification for Complying Development SEPP

In accordance with Clause 3.36C of the Exempt and Complying Development Codes SEPP (NSW Government, 2008) flood affected properties may be eligible for a Complying Development Certificate (CDC) if the development does not lie within one of the following:

a) Flood storage area,

b) Floodway area,

c) Flowpath,

d) High hazard area, or

e) High risk area.

Areas a), b), c), and d) are typically defined through the various studies in the floodplain management process outlined within the Floodplain Development Manual (NSW Government, 2005) (refer to **Section 3.1**). In accordance with this, all developed floodplains within the Pittwater LGA have these four categories defined within corresponding flood studies and floodplain risk management studies.

Therefore item e) "high risk area" is the only flood affectation region relevant to complying development that is not clearly identified and mapped for the Pittwater LGA.

The outcomes of this flood emergency response planning policy have been prepared to clearly define high flood risk for Pittwater LGA with the intention to inform hydraulic engineers and assessors involved in complying development certification.

2.3 S117 Directive for Development Controls on Low Flood Risk Areas

In January 2007, the NSW Department of Planning and Department of Natural Resources jointly released a *guideline on development controls for low flood risk areas – floodplain development manual* (NSW Government, 2007). The guideline was issued to provide additional guidance to Councils on matters dealt with in the FDM (NSW Government, 2005).

The guideline refers to areas above the residential Flood Planning Level (FPL) (typically 100 year ARI plus 0.5m freeboard) and below the Probable Maximum Flood (PMF) and states the following:

> *These are areas where no development controls should apply for residential developments but the safety of people and associated emergency response management needs to be considered and may result in:*
>
> - *Restrictions on types of development which are particularly vulnerable to emergency response, for example developments for aged care; and,*
> - *Restrictions on critical emergency response and recovery facilities and infrastructure. These aim to ensure that these facilities and the infrastructure can fulfil their emergency response and recovery functions during and after a flood event. Examples include evacuation centres and routes, hospitals and major utility facilities.*

3 Relevant Guidelines and Papers

3.1 Floodplain Development Manual (2005)

3.1.1 Document Context

The *Floodplain Development Manual* (FDM) (NSW Government, 2005) was prepared to support the NSW Government's *Flood Prone Land Policy* (2005) which had the following objective:

> *"To reduce the impact of flooding and flood liability on individual owners and occupiers of flood prone land, and to reduce public and private losses resulting from floods. At the same time the policy recognises the benefits flowing from the use, occupation and development of the floodplain."*

The manual was prepared to accompany the policy to provide a framework for implementing the policy.

3.1.2 Document Outcomes

The framework for the Manual is centred on the Floodplain Management Process which outlines the steps necessary in the preparation and implementation of a floodplain risk management plan. Running parallel to this is the Flood Planning Process which is more focussed on flood emergency response implementation.

The interaction of the two processes is shown in the **Figure 3-1** below.

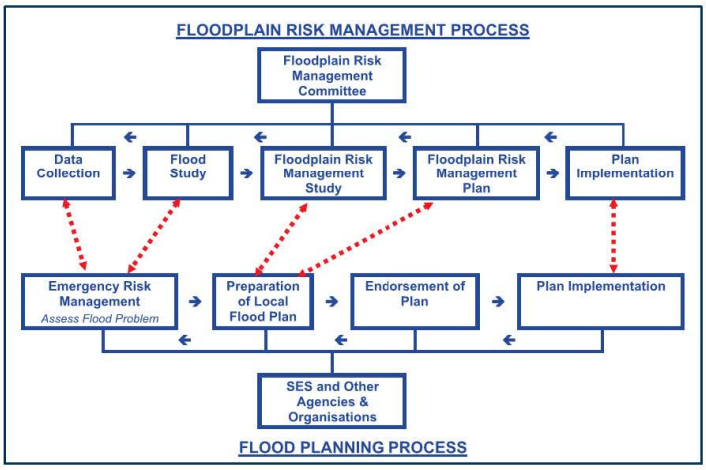

Figure 3-1 Interaction of the Floodplain Risk Management Process and Flood Planning Process

3.1.3 Relevance to this Study

While the preparation of this study does not lie within the Floodplain Risk Management Process, however it does address Council's requirements for flood emergency response planning as outlined in Appendix N of the Manual.

Appendix L of the Floodplain Development Manual states that a comprehensive analysis of flood hazard to establish risk requires consideration of the following:

- Size of flood;
- Effective warning time;
- Rate of rise of floodwaters;
- Depth and velocity of floodwaters;
- Duration of flooding;
- Evacuation problems;

> Effective flood access; and,

> Type of development.

In accordance with the Manual this study considers all of the above factors in determining flood risk.

3.2 National Emergency Risk Assessment Guidelines (2010)

3.2.1 Document Context

The *National Emergency Risk Assessment Guideline* (NERAG) (Commonwealth Government, 2010) was prepared following a review of Australia's approach to dealing with disaster mitigation and relief and recovery arrangements. The review was commissioned by the Council of Australian Governments (COAG) and it found that a new approach to natural disasters was needed.

The NERAG provides a methodology to assess risks from emergency events and are principally concerned with risk assessment that is applicable nationwide.

3.2.2 Document Outcomes

The risk assessment methodology outlined within the NERAG looks to assign a consequence rating and likelihood rating to each risk.

Consequences relate to the severity of potential outcomes of an event occurring. Consequence types are divided into the following categories; people, environment, economy, public administration, social setting, and infrastructure. There are five levels of consequence for each consequence category (in order of increasing severity); insignificant, minor, moderate, major, and catastrophic.

In the NERAG there are seven levels of likelihood, which relates to the probability of an event occurring (in order of increasing probability):

> Almost Incredible: Average Recurrence Interval (ARI) > 300,000 years;

> Very Rare: ARI - 30,000 to 300,000 years;

> Rare: ARI - 3,000 to 30,000 years;

> Unlikely: ARI - 300 to 3,000 years;

> Possible: ARI – 30 to 300 years;

> Likely: ARI – 3 to 30 years; and,

> Almost Certain: ARI < 3 years.

Combining the consequence and likelihood ratings it is possible to determine an overall risk rating using a qualitative risk matrix. The four risk categories are (in order of increasing importance):

> Low;

> Medium;

> High; and,

> Extreme.

Once risks have been appropriately assessed, they may be evaluated to determine whether the risk is acceptable or tolerable, using the "As Low As Reasonably Possible" or ALARP principle.

This approach allows the conversion of risk assessment from objective level of risk (low, medium, high, extreme), to a more subjective analysis that incorporates stakeholder input into the tolerability of certain risks.

3.2.3 Relevance to this Study

As the NERAG is a nationwide guideline for all forms of emergency response, including flooding, the principles outlined in the document are applicable to this study for the Pittwater LGA. As a result the flood risk assessment has been prepared in accordance with the assessment methodology detailed in the NERAG.

3.3 Managing Flood Risk through Planning Opportunities (2006)

3.3.1 Document Context

Managing Flood Risk through Planning Opportunities – Guidance on Land Use Planning in Flood Prone Areas (HNFMSC, 2006) was prepared by the Hawkesbury Nepean Floodplain Management Steering Committee (HNFMSC). The committee consisted of representatives from various NSW state government agencies and local councils within the Hawkesbury Nepean floodplain to oversee the delivery of a floodplain risk management strategy for the catchment.

The document aims to provide local councils, government agencies and professional planners with a regionally consistent approach to developing local policies, plans and development controls which address the hazards associated with the full range of flood events up to the Probable Maximum Flood (PMF).

3.3.2 Document Outcomes

The guideline is divided into four main sections:

- Section 1: Context – Establishes the context of the document by providing an introduction to the guidance on land use planning in flood prone areas, on living with flood risk, and on distinguishing flood hazard and flood risk.
- Section 2: Reducing the Risk to People – This section defines flood affected communities based on the varying degrees of flood hazard and evacuation restriction for less frequent events, before considering the requirements for evacuation including local and regional evacuation routes and allowances for delays in the evacuation process. It goes on to broadly identify what potential implications evacuation considerations may have on future development, and ideas on how evacuation infrastructure may be implemented.
- Section 3: Reducing the Risk to Buildings and Property – This section assesses a number of factors relating to property risk including; significance of property damage, the role of flood insurance, applied freeboard and modelling uncertainties, a methodology for determining flood risk management bands and strategies to manage risk through flood aware development and land use planning.
- Section 4: Towards Achieving Safer, Sustainable Floodplain Communities – This section summarises the roles and responsibilities of all relevant stakeholders in flood risk, and identifies a number of community awareness strategies that could assist local councils.

3.3.3 Relevance to this Study

The Pittwater LGA lies outside the Hawkesbury Nepean floodplain meaning that the guideline is not strictly applicable to this study. However since its release in 2006, the principles set-out in the guideline have been generally adopted by local Councils across NSW looking to manage flood risk.

It should be noted that there are a number of key distinction between the Hawkesbury Nepean guideline and this study for Pittwater LGA:

- The duration of flooding of the two study areas, with Pittwater containing more localised catchments with significantly shorter flooding durations and shorter available response times than the lower Hawkesbury Nepean floodplain. This results in the discussion within the guideline providing greater significance to evacuation and less tolerance of flood isolation than could be expected in Pittwater LGA.
- The Hawkesbury Nepean guideline only considers property damage in its methodology for classifying flood risk, while this assessment is more focussed on risk to life and must incorporate flood emergency response considerations.
- The Hawkesbury Nepean floodplain has a greater "flood range", variation in flood depths between events, particularly for the PMF event (which can be around 7 metres higher than the 100 Year ARI event or more in some locations), therefore greater significance is placed on these very rare events. Conversely the variation in flood depths for the 100 year ARI to PMF for the majority of Pittwater LGA is not as large, placing less significance on this event.

Despite these distinctions, the general methodology for classifying and addressing flood risk outlined within the Hawkesbury Nepean guidelines are still relevant to this study and forms the basis for the adopted approach.

3.4 FERP Classification of Communities Guideline (2007)

3.4.1 Document Context

The *Flood Emergency Response Planning (FERP) Classification of Communities Guideline* (NSW Government, 2007) was prepared by two state government agencies in 2007; the Department of Environment and Climate Change (DECC, now OEH), and State Emergency Service (SES). The guideline provide a basis for the flood emergency response categorisation of floodplain communities.

The categories are focussed on SES requirements and look to classify land based on evacuation and access availability during flood events. The Flood Emergency Response Planning classifications assist emergency managers with identifying the type and scale of information needed for emergency response planning, and assist planners in identifying suitable areas for development.

3.4.2 Document Outcomes

The guideline provides a number of classifications, which are based on those utilised by the SES. These definitions are outlined below.

- **High Flood Island:** The flood island is higher than the limit of flooding (i.e. above the PMF), no risk to life or property from inundation on the island, will require resupply by boat or air if not evacuated prior to road being cut;
- **Low Flood Island:** The flood island is lower than the limit of flooding (i.e. below the PMF), if floodwater continues to rise after it is isolated, the island will eventually be completely covered, with a risk to life from inundation from people from who are not evacuated;
- **Area with Overland Escape Route:** These are inhabited areas on flood prone ridges jutting into the floodplain or on the valley side, the access road/s cross lower lying flood prone land, evacuation can take place by road only until access roads are closed by floodwater. Escape from rising floodwater will be possible by walking overland to higher ground;
- **Area with Rising Road Access:** These are similar to above, access road/s rise steadily uphill and away from rising floodwaters, people are not trapped unless they delay evacuation;
- **High Trapped Perimeters:** These are inhabited areas above the PMF so there is no risk of inundation of homes by floodwater but the only access road/s are across flood prone land, similar issues to high flood islands, resupply may be necessary;
- **Low Trapped Perimeters:** The inhabited area is lower than the limit of flooding (i.e. below the PMF), if floodwaters continue to rise, then property will be cut-off and eventually inundated, if no evacuation occurs, risk to life from inundation; and,
- **Indirectly Affected:** There will be areas outside the limit of flooding which will not be inundated and will not lose road access, never the less they may be indirectly affected as a result of flood damaged infrastructure, due to the loss of transport links, electricity supply, water supply, sewage or telecommunications services they may require resupply or in the worst case, evacuation.

These classifications are independent of the period of isolation, and do not try to distinguish between the level of risk of 1 hour of isolation versus 1 day of isolation for example. The classifications are primarily intended to identify the type of problem, rather than identify the exact measures required to respond to the problem.

The guideline recommends that the classification be undertaken for the 20 year ARI, 100 year ARI and the PMF event. Separate mapping is to be prepared for each event.

However, it is important to note that the classification of High and Low Flood Island, together with High and Low Trapped Perimeter Areas are defined based on the PMF. Therefore, the only variable between the events is the Overland Flow Escape Route, Rising Road Access and Indirectly Affected Areas.

3.4.3 Relevance to this Study

While the Flood Emergency Response Planning Classification of Communities Guidelines provide a good insight into what the key assessment criteria are for the SES in their role in emergency response, it does not assign a level of risk associated with each category. Therefore this study must go an extra step to the guideline and analyse the above categories for the risk to life that is associated with these categories.

3.5 Developing a Framework for Holistic Risk Based Floodplain Planning (2012)

3.5.1 Document Context

This paper, presented at the 2012 Flood Management Authority (FMA) conference, summarises the flood risk assessment methodology adopted for Moreton Bay in Queensland and presents an assessment approach which could have universal application (Molino et al, 2012).

At the time of presentation the approach formulation was in its early stages and the purpose of presenting the paper was to receive feedback on the methodology and opinions on appropriate risk tolerance thresholds.

3.5.2 Document Outcomes

The Moreton Bay study applied a holistic approach to flood risk assessment considering; risk of isolation, risk to road access, risk to life in residential buildings, risk to life in non-residential buildings, risk to residential property, risk to non-residential property, and risk to critical infrastructure.

The approach defines acceptable, tolerable and unacceptable risk for each of the above types based on a combination of hazard level and probability. Determination of hazard is based on a number of factors including:

- Hydraulic hazard, with thresholds as defined in Hydraulic Behaviour Thresholds for Newcastle LGA (BMT WBM, 2008);
- Duration of flooding;
- Vulnerability; and,
- Critical and cumulative consequences.

Probability thresholds were determined based on the acceptability of the various risk types assigned for design storms ranges from 10 year ARI up to the PMF event. As a result, risk matrices for each of the risk types listed above were provided with rows relating to design storm recurrence interval, and columns relating to the various hazard categories.

Using these risk matrices, it was possible to identify suitable risk mitigation options for the combinations of hazard level and design storm probability.

3.5.3 Relevance to this Study

While the risk assessment approach identified within the paper provides a useful basis, there are a number of key distinctions between the aims of the study to the one being conducted for Pittwater LGA:

- The scope of the holistic approach is significantly wider than that required for this study, with only four of the eight risk types addressed in the study relevant to risk to life; risk of isolation, risk to road access, risk to life in residential buildings, and non-residential buildings.
- This approach looks to assign flood risk at a more regional level for not only development, but also regional considerations such as evacuation routes. The study also looks to assess the risk of property damage which is not relevant to flood risk to life.
- The risk assessment has too many variables to be applied easily to the development assessment process as is desired for this study. In accordance with the approach, each development will have a risk level associated with each design storm ARI, isolation duration, and risk type. The objective of this study is to combine all of these variables to produce a cumulative single flood risk classification for each development, as it is difficult to practically apply multiple categories in a planning context.
- The approach identifies risk mitigation options available to Council such as voluntary purchase. As this study is targeted at developers, these mitigation options will likely be replaced by development controls within this study.

While the objectives of the Moreton Bay study varies significantly to that of this Pittwater LGA flood risk classification study, the general methodology and approach to flood risk assessment is still relevant and generally aligns with that adopted within this study.

3.6 Updating National Guidance on Best Practice Flood Risk Management (2014)

3.6.1 Document Context

The National Flood Risk Advisory Group (NFRAG), a reference group of the Australian and New Zealand Emergency Management Committee (ANZEMC), has worked with the Australian Emergency Management (AEM) Institute to update national best practice in flood risk management through the development of *AEM Handbook 7: Managing the floodplain: best practice in flood risk management in Australia* (2014).

To support this national best practice manual, NFRAG is developing a range of technical guidelines and supporting the development of jurisdictional administrative guidance to outline responsibilities across each state and territory. The guidance provides a review of hazard based on a literature review and built on the advice provided in Appendix J of the now superseded Standing Committee for Agriculture and Resource Management (SCARM) *Report 73: Floodplain Management in Australia* (SCARM, 2000)

The paper *Updating National Guidance on Best Practice Flood Risk Management* (McLuckie et al, 2014) was prepared which discusses progress on the development of these guidelines and how the guidelines will work with AEM Handbook 7.

3.6.2 Document Outcomes

A detailed literature review has been conducted to inform the formulation of a proposed set of hazard vulnerability thresholds for the following:

- Small cars, and large cars;
- Pedestrians in the following groups: adults, children and the elderly;
- Light buildings and those not specially engineered; and,
- All buildings.

In addition a detailed review of the Flood Emergency Response Planning (FERP) Classification of Communities guideline (NSW Government, 2007) in anticipation of the adoption of similar guideline at a nationwide level. Some of the issues identified with the adoption of Flood Emergency Response Planning classifications in a national guideline include:

- Improved clarity on the use of the classifications. When the NSW guideline was written pre-2007, it focused heavily on informing emergency management planning, whereas this advice is important for a broader audience.
- Improving the clarity of definitions in consultation with emergency service agencies. This includes using diagrams in describing categories and having a separate classification for communities protected by levees.
- Using the probable maximum flood or equivalent extreme flood as the basis of deciding upon classification. However, if either wasn't available, using the highest available flood to provide some guidance on classification but identifying the limitations and using this with caution. For example, high flood islands for a smaller event may become low flood islands for an extreme flood, which may influence management decisions.
- Consider how to use in overland flooding given its difference in scale.

3.6.3 Relevance to this Study

The paper provides a good indication of the likely hazard thresholds to be adopted in the next NFRAG national guideline.

There are a number of other combined hazard thresholds such as the *Hydraulic Behaviour Thresholds for Newcastle LGA* (BMT WBM, 2008) which was adopted in the *Developing a Framework for Holistic Risk Based Floodplain Planning* paper (Molino et al, 2013).

However, the hazard curves for this study have been developed based on extensive review of a number of different studies and the most recent information. Furthermore, as they are likely to be adopted NFRAG, the expectation is that they will be adopted within the national guidelines in the future.

3.7 Technical Guideline for SES Timeline Evacuation Model (2013)

3.7.1 Document Context

The *NSW SES Timeline Evacuation Model* has been the de facto standard for evacuation calculations in NSW since it was first developed for evacuation planning in the Hawkesbury Nepean Valley. NSW SES recognised the need for the model to be more widely used and consistently applied in the planning of evacuation for existing communities and in the assessment of development.

The purpose of the guideline is to provide the industry a step-by-step guide to the application of the model. Though the guideline has not yet been released, the paper *Technical Guideline for SES Timeline Evacuation Model* was prepared by Molino S. et al in 2013 briefing the industry on the application of the guideline.

3.7.2 Document Outcomes

The timeline assessment of evacuation potential relates to the regional evacuation of floodplains through doorknocking by SES volunteers through to the evacuation of all occupants for the region.

At the centre of the timeline methodology is the following concept:

Surplus Time = Time Available – Time Required

If surplus time is positive then evacuation of all occupants is feasible, while a negative value implies evacuation of all occupants is not likely to be able to be achieved.

The calculation of the two variables is as done below:

Time Required

Time Required = Warning Acceptance Factor (WAF) + Warning Lag Time (WLT) + Travel Time (TT) + Travel Safety Factor (TSF)

Where the following values are recommended in the guideline:

WAF = 1 hour – accounts for the delay between occupants receiving the evacuation warning and acting upon it.

WLT = 1 hour – an allowance for the time taken by occupants to prepare for evacuation.

TT = Variable – the number of hours taken for the evacuation of all vehicles based on road capacity. NSW SES recommend a road lane capacity of 600 vehicles per hour, i.e if there are 1200 vehicles to evacuate TT = 2 hours.

TSF = Variable – added to travel time to account for any delays along the evacuation route for example resulting from accidents, this value is a variable of TT between 1 hour and 3.5 hours.

Note that time required is calculated from the time that SES have mobilised and are ready to begin doorknocking, before this time there is also two additional phases:

- Forecast and actual rainfall monitoring: SES monitors the situation to determine if evacuation is required; and,
- Mobilisation: The time taken for SES to mobilise and travel to residence to commence doorknocking.

Time Available

This variable is dependent on evacuation route geometry, and rate of rise of waters, meaning it varies for each evacuation scenario.

3.7.3 Relevance to this Study

While this study is more focused towards riverine flooding where flood warning times is in the scale of multiple hours due to the slow response time of the catchment, Pittwater LGA is made up of fast response time catchments with warning times typically less than an hour.

This methodology will be used to inform the assessment of evacuation potential for Pittwater LGA which is particularly relevant provided the guideline has been prepared by the relevant state authority for emergency response for NSW, the SES.

3.8 Guideline on Emergency Planning and Response to Protect Life in Flash Flood Events (2013)

3.8.1 Document Context

In 2013, the Australian Fire and Emergency Service Authorities Council (AFAC) released a guideline on emergency planning for flash flood events. The guideline reflects a consensus on best practice for managing flash flooding, focussing on risk to life.

3.8.2 Document Outcomes

The document defines flash flooding as flooding that occurs within 6 hours or less of the flood-producing rainfall within the affected catchment.

The guideline discusses the issues associated with both the pre-incident and the incident phase of flash flood management and provides the following comments to emergency response:

- The safest place to be in a flash flood is well away from the affected area. Accordingly, pre-event planning for flash floods should commence with an assumption that evacuation is the most effective strategy, provided evacuation can be safely implemented.
- 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.
- A structurally suitable building means a building which is strong enough to withstand lateral flood flow, buoyancy, and suction effects and debris impact load.
- In the absence of a more detailed engineering-based code the following observations can be made regarding structural suitability for shelter-in-place buildings:
  - Single storey slab-on-ground dwellings, and relocatable homes and caravans are unlikely to be suitable;
  - Reinforced concrete or steel-framed multi-level buildings are more likely to be suitable; and,
  - Ideally the building should have sufficient area of habitable floor that will be flood free in a Probable Maximum Flood (PMF) event to accommodate the likely number of occupants,
- The pre-incident planning of evacuation must include operational contingency plans for the rescue of individuals who do not evacuate in a timely manner,
- Due to the nature of flash flood catchments, flash flood warning systems based on detection of rainfall or water level generally yield short lead times (less than 30 minutes) and as a result provide limited prospects for using such systems to trigger planned and effective evacuation,
- The dangers to be considered in relation to evacuation include evacuees being overwhelmed by floodwaters, and exposure to adverse weather such as lightning, hail, heavy rain, strong winds, flying debris, or falling trees and power lines,
- The dangers to be considered for shelter-in-place include risks resulting from:
  - Their own decision making (drowning if they change their mind);
  - Their mobility (not being able to reach the highest part of the building);
  - Their personal safety within the building (fire and accident); and,
  - Their health while isolated (pre-existing condition or sudden onset).
- For these reasons, remaining in buildings likely to be affected by flash flooding is not low risk and should never be a default strategy for pre-incident planning. Where the available warning time and resources permit, evacuation should be the primary response strategy.

3.8.3 Relevance to this Study

The guideline provides a useful insight into the position relating to emergency planning for flash flooding events of the emergency services authorities council, of which NSW SES is a member. This makes the guideline directly relevant to this study, therefore the comments made within the guideline have been considered throughout this study.

3.8 Guideline on Emergency Planning and Response to Protect Life in Flash Flood Events (2013)

3.8.1 Document Context

In 2013, the Australian Fire and Emergency Service Authorities Council (AFAC) released a guideline on emergency planning for flash flood events. The guideline reflects a consensus on best practice for managing flash flooding, focussing on risk to life.

3.8.2 Document Outcomes

The document defines flash flooding as flooding that occurs within 6 hours or less of the flood-producing rainfall within the affected catchment.

The guideline discusses the issues associated with both the pre-incident and the incident phase of flash flood management and provides the following comments to emergency response:

- The safest place to be in a flash flood is well away from the affected area. Accordingly, pre-event planning for flash floods should commence with an assumption that evacuation is the most effective strategy, provided evacuation can be safely implemented.
- 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.
- A structurally suitable building means a building which is strong enough to withstand lateral flood flow, buoyancy, and suction effects and debris impact load.
- In the absence of a more detailed engineering-based code the following observations can be made regarding structural suitability for shelter-in-place buildings:
  - Single storey slab-on-ground dwellings, and relocatable homes and caravans are unlikely to be suitable;
  - Reinforced concrete or steel-framed multi-level buildings are more likely to be suitable; and,
  - Ideally the building should have sufficient area of habitable floor that will be flood free in a Probable Maximum Flood (PMF) event to accommodate the likely number of occupants,
- The pre-incident planning of evacuation must include operational contingency plans for the rescue of individuals who do not evacuate in a timely manner,
- Due to the nature of flash flood catchments, flash flood warning systems based on detection of rainfall or water level generally yield short lead times (less than 30 minutes) and as a result provide limited prospects for using such systems to trigger planned and effective evacuation,
- The dangers to be considered in relation to evacuation include evacuees being overwhelmed by floodwaters, and exposure to adverse weather such as lightning, hail, heavy rain, strong winds, flying debris, or falling trees and power lines,
- The dangers to be considered for shelter-in-place include risks resulting from:
  - Their own decision making (drowning if they change their mind);
  - Their mobility (not being able to reach the highest part of the building);
  - Their personal safety within the building (fire and accident); and,
  - Their health while isolated (pre-existing condition or sudden onset).
- For these reasons, remaining in buildings likely to be affected by flash flooding is not low risk and should never be a default strategy for pre-incident planning. Where the available warning time and resources permit, evacuation should be the primary response strategy.

3.8.3 Relevance to this Study

The guideline provides a useful insight into the position relating to emergency planning for flash flooding events of the emergency services authorities council, of which NSW SES is a member. This makes the guideline directly relevant to this study, therefore the comments made within the guideline have been considered throughout this study.

3.9 Flood Risk to Life Policies of Other Council's

3.9.1 Document Context

In addition to the papers and guidelines listed in the sections above, risk to life policies for other Council's have been drawn on for guidance and policy direction. The following Council's policies have been of particular relevance:

- Newcastle City Council: Located within the state of NSW, the City of Newcastle LGA covers the Newcastle metropolitan area and surrounding rural areas to the north-west. There is extensive flooding of both urban and rural areas through both riverine flooding and flash flooding.
- Tweed Shire Council: Located within the state of NSW, the Tweed Shire Council LGA covers the suburbs of Tweed Heads, Banora Point, Kingscliff, and Casuarina. There is extensive flooding of both urban and rural areas through both riverine and flash flooding.

3.9.2 Relevance to this Study

The two policies have been used for the purposes of comparison with the outcomes of this policy including:

- Section 5: Emergency Response: Council's position relating to emergency response;
- Section 6: Flood Life Hazard Categories: Adopted design flood event, and hazard thresholds; and,
- Section **Error! Reference source not found.**: Flood Emergency Response Planning Policy: Flood emergency response planning development controls.

4 Study Area

The Pittwater LGA lies within the northern beaches of the Sydney Metropolitan Area, and covers a total area of 125 square kilometres. The land-use is dominated by large areas of National Park (43%), and residential land (41%), whilst small portions of land are commercial land (9%) and light industrial area (1%). This study focuses on the inhabited areas of the study area, and therefore the National Park portions of the study area have not been included in this assessment. The risk to life in these areas is expected to be negligible.

The study area is shown in **Figure 4-1**.

4.1 Pittwater Floodplains

There are six mainstream floodplains within the Pittwater LGA study area:

- Narrabeen Lagoon floodplain: This floodplain incorporates all flood prone lands that discharge into the Narrabeen Lagoon which is located in the south of the Pittwater LGA. The main flood affected areas in this floodplain include:
  - Narrabeen Creek, Mullet Creek, and Fern Creek as well as the Warriewood wetland which are all contained in the Warriewood Valley;
  - Nareen Creek; and
  - Narrabeen Lagoon foreshore.
- Mona Vale / Bayview floodplain: This floodplain covers the low-lying portion of the suburbs of Mona Vale and Bayview, including:
  - Bayview Golf Club and surrounds;
  - The areas to the west of the golf club, which extend up towards Ingleside and Mona Vale Road;
  - Mona Vale industrial precinct to the west of Barrenjoey Road; and,
  - Residential area to the east of Barrenjoey Road in Mona Vale.
- Newport floodplain: The floodplain covers the majority of the Newport town centre from Newport Park in the south-west, to Newport Beach to the east. It also extends up to some of the steeper flowpaths to the west of the Newport township.
- McCarrs Creek floodplain: A large portion of the McCarrs Creek floodplain is mostly uninhabited National Park however there are a several key areas of flood affectation:
  - McCarrs Creek foreshore area; and,
  - Road crossings of McCarrs Creek for access roads to the western side of Pittwater including Great Mackerel Beach.
- Careel Creek floodplain: This floodplain covers the central low-lying area of the suburb of Avalon, as well as the northern portion of Bilgola Plateau. The floodplain extends from Angophora Reserve to the south-west, through Avalon town centre, as well as Careel Creek and its surrounds to the north.
- Mackerel Beach floodplain: This floodplain consists of the low lying portion of the suburb of Great Mackerel Beach.

In addition to these mainstream floodplains there are significant areas of overland flow affectation within Pittwater LGA. These areas are typically in the steep upper catchments and most discharge into one of the mainstream floodplains mentioned above.

The approximate extents of the various floodplains within Pittwater LGA are shown in **Figure 4-1**.

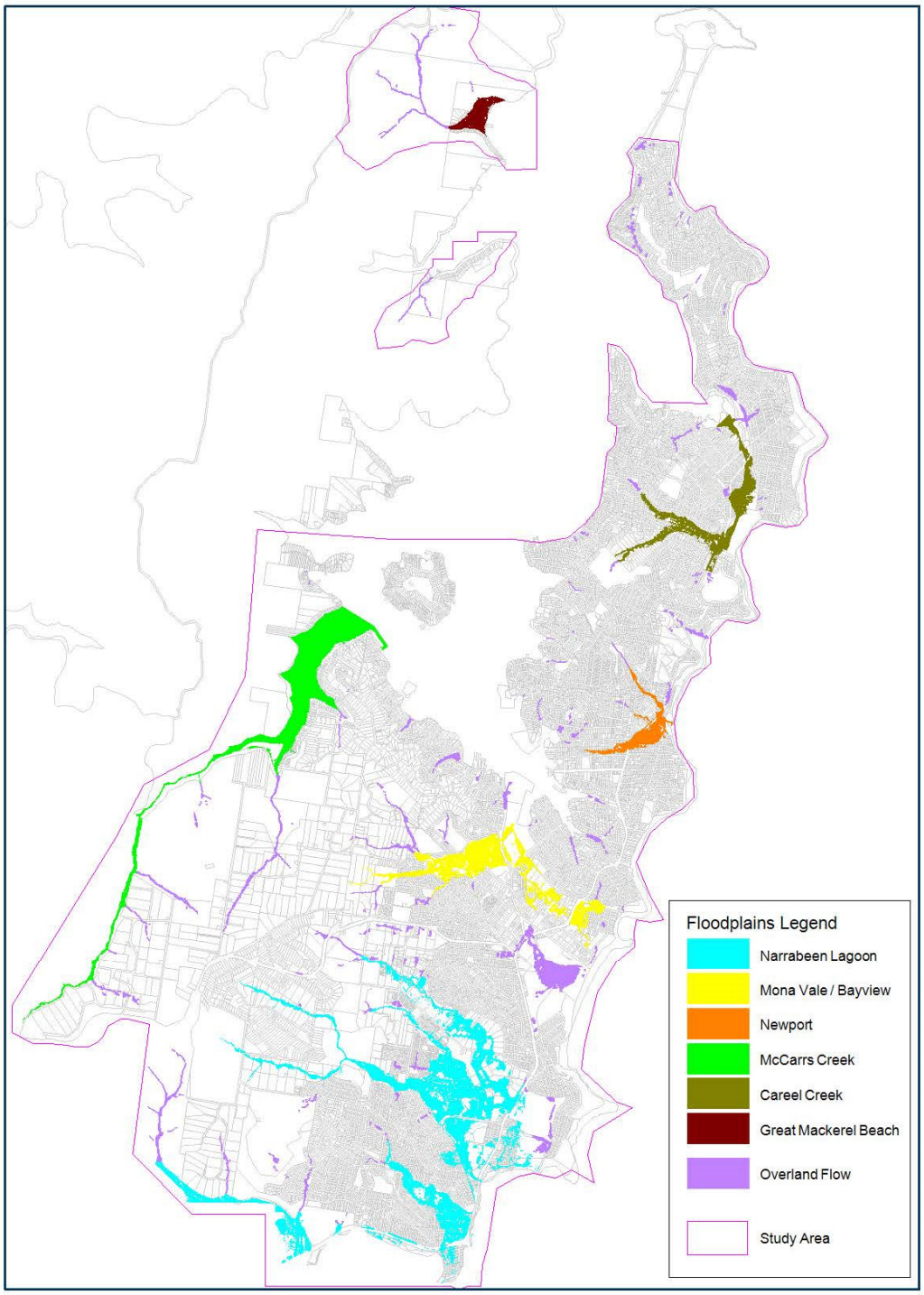

Figure 4-1 Pittwater LGA Study Area and Floodplain Summary
*Figure shows 100yr Flood Extents from Pittwater OLF Study (Cardno, 2013)

4.2 Flood Data

4.2.1 Available Flood Data

The scope of this study is to use available flood data for the Pittwater LGA which has been sourced from previous flood studies and floodplain risk management studies.

A summary of the most recent flood studies and the available data from them for each floodplain has been included in **Table 4-1** below.

Table 4-1 Flood Data Summary for Pittwater Floodplains

Floodplain	Current FS / FRMS	Available Data
Narrabeen Lagoon	Narrabeen Lagoon Flood Study (BMT-WBM, 2013)	Flood extents, depth, velocity, water level, hazard, hydraulic categories
Mona Vale/ Bayview	Mona Vale / Bayview Flood Risk Management Study and Plan (Cardno, 2008)	1D Results at representative cross section locations including: depth, velocity, water level, flow hydrographs, and water level time series
Newport	Newport Beach Floodplain Risk Management Study and Plan (SMEC, 2004)	1D Results at representative cross section locations including: depth, velocity, water level, flow hydrographs, and water level time series
McCarrs Creek	None	
Careel Creek (Including Overland Flow Areas)	Careel Creek Flood Study (WMA Water, 2013)	Flood extents, depth, velocity, water level, hazard, flow hydrographs, and water level time series
Great Mackerel Beach	Great Mackerel Beach Floodplain Risk Management Study and Plan (WMA Water, 2010)	Flood extents, depth, velocity, hazard, hydraulic categories
Overland Flow (Excluding Careel Creek Catchment)	Pittwater LGA Overland Flow Mapping and Flood Study (Cardno, 2013)	Flood extents, depth, velocity, water level, hazard, hydraulic categories, flow hydrographs, and water level time series

4.2.2 Validation of OLF Study Results in Mainstream Areas

There are three mainstream catchments within Pittwater LGA where Pittwater Overland Flow Flood Study results are to be used as the basis for risk to life category mapping:

- Mona Vale / Bayview;
- Newport; and,
- McCarrs Creek.

The adoption of overland flow study data in these mainstream extents is due to lack of flood data availability, or it has been assumed that the 2D overland flow data provides a better representation of flood hazard mapping than interpolated 1D results. The adoption of the overland flow hazard mapping in these mainstream locations is an approximate representation, and can be improved in the future through the adoption of future flood study data.

To assess the validity in adopting this data within mainstream floodplains, PMF peak water level results have been compared against 1D model results from the following flood studies:

- Mona Vale / Bayview Flood Risk Management Study and Plan (Cardno, 2008); and,
- Newport Beach Floodplain Risk Management Study and Plan (SMEC, 2004).

For the majority of both floodplains it was found that PMF peak water level results from the Overland Flow Study hydraulic model were typically within 0.5 metres of previous flood study results. These validation results are considered appropriate when considering the following:

- The broad-scale modelling methodology adopted within the Overland Flow Flood Study, while being targeted towards modelling overland flow areas, is still an appropriate representation of mainstream flooding.
- The 1D hydrology / hydraulic modelling conducted within the two studies is distinctly different to the rainfall-on-grid 2D modelling methodology adopted within the Overland Flow Flood Study, meaning differences in the range of 0.5 metres can reasonably be expected.
- The modelling techniques adopted within the Overland Flow Flood Study are more in line with modern day industry best practice, as opposed to those within the two previous floodplain studies. This is as a result of the advancements in flood modelling since the release of these reports in 2004, and 2008, for Newport and Mona Vale / Bayview respectively.
- The Overland Flow Flood Study typically has peak PMF water levels higher than those of the previous studies for the majority of area for both floodplains. This means that the adoption of the Overland Flow Flood Study results can be considered slightly conservative.

Therefore it is concluded that the Overland Flow Study results are suitable for adoption within the two mainstream extents of Mona Vale / Bayview and Newport Beach.

4.2.3 Adopted Flood Data

The adopted flood data within the flood risk classification mapping for each floodplain is summarised in **Table 4-2**.

Table 4-2 Flood Data Summary for Pittwater Floodplains

Floodplain	Adopted Data Source
Narrabeen Lagoon	Narrabeen Lagoon Flood Study (BMT-WBM, 2013)
Mona Vale/ Bayview[1]	Pittwater LGA Overland Flow Mapping and Flood Study (Cardno, 2013)
Newport[1]	Pittwater LGA Overland Flow Mapping and Flood Study (Cardno, 2013)
McCarrs Creek[2]	Pittwater LGA Overland Flow Mapping and Flood Study (Cardno, 2013)
Careel Creek (Including Overland Flow Areas)	Careel Creek Flood Study (WMA Water, 2013)
Great Mackerel Beach	Great Mackerel Beach Floodplain Risk Management Study and Plan (WMA Water, 2010)
Overland Flow (Excluding Careel Creek Catchment)	Pittwater LGA Overland Flow Mapping and Flood Study (Cardno, 2013)

[1] Results from the current FS / FRMS for these mainstream areas are extracted from cross sections in a 1D model, these result types cannot suitably be applied to mapping in 2D.

[2] No available mainstream flood study / floodplain risk management study, therefore overland flow study has been adopted within this floodplain.

4.3 Floodplain Behaviour

4.3.1 Catchment Response Time

The Australasian Fire and Emergency Service Authorities Council (AFAC) 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 this study it is 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 evacuation compared to shelter-in-place.

4.3.2 Duration of Inundation

AFAC 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 noted by the AFAC, the assignment of a safe duration of isolation threshold is subjective due to limited literature on isolation and risk to life at present. Pittwater Council in the interim flood emergency response policy (2012) defined 'long duration flooding' as flooding greater than 6 hours, which has been maintained within this policy as it aligns with the following:

- AFAC definition of 'flash flooding' as outlined in the guideline on emergency planning in flash flood events (2013); and,
- The definition of flash flooding as outlined in the *Weather Services Handbook* (Haynes et al, 2011)

The longest duration flooding, in excess of 6 hours, is anticipated in the lower Narrabeen Lagoon catchment comprising:

- Narrabeen Lagoon foreshore;
- Lower Nareen Creek;
- Lower Fern Creek;
- Lower Narrabeen Creek; and,
- Lower Mullet Creek.

All other catchments throughout Pittwater LGA, including overland flow are considered as 'short duration' flooding (less than 6 hours of inundation in the PMF events).

5 Emergency Response

5.1 Evacuation Potential

As mentioned in the AFAC 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.

5.1.1 Regional Evacuation Timeline

To assess the evacuation timeline, reference is made to the technical guideline for the use of the SES evacuation model (Molino S. et al, 2013). In accordance with the guideline, the minimum time required for regional evacuation by SES can be calculated as:

- Time required: Disregarding Travel Time (TT), and Travel Safety Factor (TSF), the minimum time required to evacuate a region containing just one residence is 2 hours;
- Forecast and actual rainfall monitoring: For Pittwater LGA there is inadequate flood forecasting tools in place for forecasting to be used to inform flood evacuation. Instead actual rainfall monitoring is the only feasible warning system. There is a flood warning systems in place in the area; the Northern Beaches Flood warning system (MHL, 2014). This system recommends response only after 3 hours of sustained heavy rainfall.
- Mobilisation: There is no data available on mobilisation time for local SES services so this has not been included in the evacuation timeline for Pittwater LGA.

Based on the above contributors, the overall time required for evacuation of floodplains within the Pittwater LGA is a minimum of 5 hours. It should be noted that this is a low bound estimate, as various factors such as SES mobilisation have been disregarded.

Though the time available varies for all areas of the floodplain across the Pittwater LGA, the catchment response time summary included in **Section 4.3.1** suggests that flood prone areas in the LGA will have an available evacuation time significantly less than 5 hours.

The combination of the above factors means that co-ordinated regional evacuation as an emergency response is not feasible for Pittwater LGA. This aligns with comments from the AFAC guideline (2013) which states that detection of rainfall or water level provide limited prospects for using such systems to trigger planned and effective evacuation.

5.1.2 Localised Evacuation Timeline

The SES timeline approach to assess time required to evacuate is based on a specific sequence of events; SES monitor, and notify occupants of a region to evacuate following initial reluctance.

However evacuation may occur at a more localised level through a different sequence of events; occupants visually see flooding in their vicinity and respond instinctively by moving to higher ground.

This sequence relies less on emergency services co-ordination and relies on the common sense of the resident to respond to observed flooding through evacuation. It is not dissimilar to the expected sequence of events for shelter-in-place with the exception that occupants evacuate to higher ground rather than elevated buildings.

Compared to the regional timeline above, localised evacuation significantly reduces the time required to evacuate through the following:

- Rainfall forecasting and monitoring, as well as SES mobilisation is irrelevant;

- Warning Acceptance Factor (WAF) for observed flooding could be assumed to be zero as occupants will be far more responsive to observed flooding compared to doorknocking by SES;
- Warning Lag Factor (WLF) for observed flooding will be significantly reduced, instead of preparing house for flooding, it is expected occupants may secure key items and possibly notify friends and family and then evacuate; and,
- Travel Time (TT) and Travel Safety Factor (TSF) would be minimal. This is where the localised concept is important as long distance evacuation routes (in the scale of kilometres) will not be conducive to spontaneous pedestrian evacuation.

These reductions could feasibly result in the time required for localised evacuation being at a sub hourly timescale. Given the catchment response time of the Pittwater LGA summarised in **Section 4.3.1**, these timeframes mean that localised evacuation strategies for developments may be feasible in certain locations within the floodplain, particularly on the fringes of the floodplain where evacuation routes are shorter.

Localised evacuation would be heavily dependent on Rising Road Access availability in accordance with classifications outlined in the Flood Emergency Response Planning classification guidelines (refer to **Section 3.4**).

5.1.3 Available Resources for Evacuation

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: Evacuation is not feasible if the evacuation route is inundated before the property (Flood Islands), it is preferred if there is rising grade for vehicles (Rising Road Access) or for pedestrians only (Overland Escape Route);
- The suitability of the shelter location: The frequency with which the evacuation point is inundated by flooding is the main concern with two categories; those that will never conceivably be inundated (High Flood Island), and those that will (Low Flood Island).

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 is 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 as summarised in **Section 4.3.2**. 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 has been undertaken to determine which areas have road access to a medical emergency centre. Medical emergency centres have been defined as hospitals, and ambulance stations. A summary of the assessment of medical emergency centre access is shown in **Figure 5-1**.

This adopts the conclusion drawn in **Section 5.1.1**, that 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.

As can be seen in **Figure 5-1**, 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.