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Newcastle City-wide Floodplain Risk Management Study and Plan

Final Report June 2012

The City of Newcastle

The Newcastle City-wide Floodplain Risk Management Study and Plan

Prepared For:	The City of Newcastle
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Synopsis :	This document is the complete Floodplain Risk Management Study and Plan for the Newcastle City-wide area. It is the culmination of many years of research and studies, including various Flood Studies for specific catchments, Floodplain Management Studies, and the previous Stage 1 Concept City-wide Flood Plan. The document provides a suite of actions, works and initiatives that when implemented will result in reductions to Risks to Life and Risks to Property across the City. This City-wide Floodplain Management Plan excludes the Wallsend Commercial Centre, as this area already has an adopted Flood Plan (2009). Apart from updating the mapping of floodplain categories, this document does not supersede or negate the Wallsend Plan in any way. Implementation of both the City-wide Flood Plan and the Wallsend Flood Plan should occur concurrently.

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The Newcastle City-wide Floodplain Risk Management Working Party has prepared this document with financial assistance from the NSW Government through the Office of Environment and Heritage. This document does not necessarily represent the opinions of the NSW Government or the Office of Environment and Heritage.

EXECUTIVE SUMMARY

What is this Plan about and how has it been developed?

The Newcastle City-wide Floodplain Risk Management Study and Plan (City-wide Flood Plan) has been developed to direct and co-ordinate the future management of flood prone lands across the City of Newcastle. It also aims to educate the community about flood risks across Newcastle, so that they can make more appropriate and informed decisions regarding their individual exposure and responses to flood risks. The City-wide Flood Plan sets out a strategy of short term and long term actions and initiatives that are to be pursued by agencies and the community in order to adequately address the risks posed by flooding. With the exception of updating the mapping of floodplain categories, the City-wide Flood Plan does not cover the Wallsend Commercial Centre, as this flooding hotspot already has a Flood Risk Management Plan that was adopted the City of Newcastle (CofN), in 2009. Concurrent with the City-wide Flood Plan, CofN is also pursuing opportunities for implementing management actions outlined in the Wallsend Flood Plan.

This Flood Plan is the culmination of many years of studies and on-going research that have aimed to understand the nature and extent of flooding across the catchments of Newcastle. Development of the City-wide Flood Plan has been guided by the NSW Government's Floodplain Development Manual (2005). Importantly, in following this Manual, CofN is managing its liability relating to flooding through provisions made under Section 733 of the *Local Government Act 1993*.

Flooding affects about 1 in 3 properties within the City of Newcastle. The vast extent of flooding across the City necessitates that flooding is managed at a City-wide scale, rather than at a local catchment-scale. This Plan therefore is ground-breaking and it is hoped will assist the future of floodplain management across NSW.

The structure of this City-wide Flood Plan is presented in Figure A1. In essence this Plan assessed the current management of floods in Newcastle against the principles for floodplain management as outlined in the Floodplain Development Manual (2005). Current flood management is a legacy of past works and actions, and also the unique flood environment of Newcastle – that is, flooding can occur as a result of:

- flash flooding from the local catchments;
- river flooding from the Hunter River; or even
- ocean flooding from high water levels in the ocean and harbour.

Based on the considered short-comings of current management, this Plan reviews potential alternative management options and then formulates a future flood management strategy. The strategy includes both short term works and actions as well as longer term initiatives.

The short term works and actions have been chosen to give maximum priority

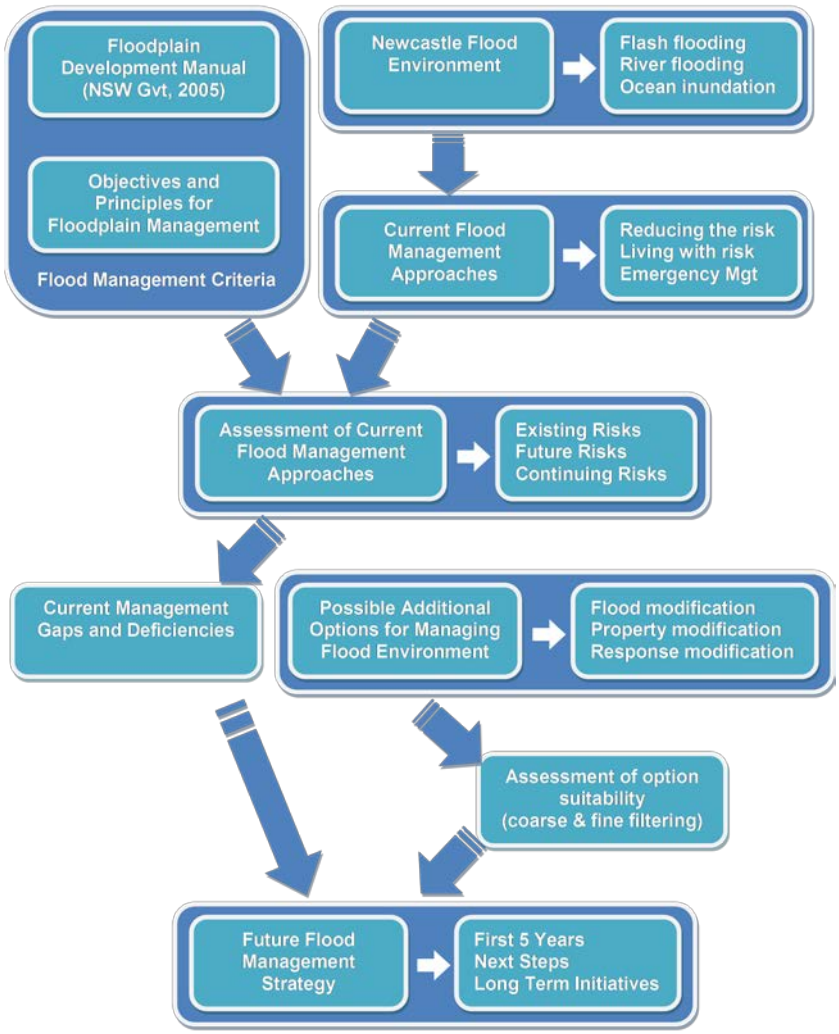

Figure A1: Structure of the City-wide Floodplain Management Study & Plan

benefit while also being readily implementable within envisaged affordable budgets. Implementation is still, however, subject to this albeit limited funding - customarily allocated year by year.

The longer term initiatives are still needed - to address the assessed gaps and deficiencies of current management. The definition of these longer term initiatives is subject to future review before the short term works and actions are completed. Implementation of reviewed longer term flood management initiatives for the Newcastle LGA would be subject to available future funding. It is important that these longer term initiatives are not excluded from Plan, since future communities and Governments will then have opportunity to decide what level of funding is appropriate for ongoing implementation – either accelerated or deferred. These decisions would be made balancing whole of community and Government priorities against practical resourcing, spread across other needs such as health, education, transport and social. Current legislation allows these necessary compromises and protects Governments when they make these decisions.

It is very important to acknowledge that it is impractical to eliminate all flood risks from Newcastle. Instead, the aim of future flood management is to ensure that existing and future development is exposed to an 'acceptable' level of risk, consistent with other risks that people live with on a day to day basis. Most importantly, this Plan seeks to minimise Risks to Life, as there can be no more serious loss during a flood event.

What is a flood?

In the context of this document, a flood is considered to be any significant flow within channel or waterway as well as concentrated overbank flow or temporary storage / ponding of water resulting from rainfall within local catchments, or backwater inundation from elevated downstream waters, such as the Hunter River. In the context of the latter, high waters within the Hunter River can be the result of rainfall further up the large Hunter catchment, or from high ocean water levels caused by storms and low pressure systems (e.g. East Coast Lows).

Local street drainage is outside the scope of this City-wide Flood Plan.

Looking north at flooding in Steel St, Newcastle West, 1908

Quick Definitions

Existing Risk: Flooding risks that affects existing development

Future Risk: Flooding risks that will affect future development, once built

Continuing Risk: The risk remaining after all management works and initiatives have been implemented. This is the risk that people just have to live with, and therefore it must be at an acceptable level

Flash Flooding: Flooding from the local catchments in Newcastle, notably in Ironbark Creek, Dark Creek, Throsby / Styx Creek and Cottage Creek, as well as flooding from direct rainfall

River Flooding: Flooding from the Hunter River. Only an issue for areas around Hexham/Sandgate and the fringes of Hexham Swamp

Ocean Flooding: Flooding from very high ocean water levels, typically as a combination of big tides and storm surge

Risk to Life: Flooding risks that threaten life. This is the worst type of flood risk. Managed for all floods up to and including the PMF (see below).

Risk to Property: Flooding risks that threaten to damage property. Typically only managed up to the 1% AEP flood (see below)

10% AEP flood: There is a 10% (1 in 10) chance that a flood of this size or bigger will occur in any year (sometimes called the 1 in 10 year flood)

1% AEP flood: There is a 1% (1 in 100) chance that a flood of this size or bigger will occur in any year (sometime called the 1 in 100 year flood). The June 2007 was about this big for many areas of Newcastle

PMF flood: This is an extreme flood that is many times larger than the 1% AEP. Whilst it can potentially occur, it has a very low chance of occurring

Why is flooding in Newcastle a problem?

Newcastle has a long history of flooding, given that much of the City has been developed on old swamplands and floodplains. There were a number of significant floods in the Hunter shortly after European settlement, in the first half of the 1800s, while a number of flash floods in the local catchments occurred through the latter half of that century. As Newcastle expanded, the flooding problem amplified, leading to the construction of large open channels during the first half of the 20th Century. These channels were sized by rule of thumb, and using rainfall records from Great Britain (which was usual practice up until about the 1950s).

The rapid urban development of Newcastle throughout the 20th Century gave little consideration to natural flowpaths or the chance of overtopping of stormwater channels. As a result, much of the development in Newcastle today is at risk of flooding. The dramatic flash flooding of June 2007 highlighted the vulnerability of Newcastle to such events and the dangers associated with flash flooding.

Of the 58,000 developed properties within the City of Newcastle, more than 21,000 are located on the floodplain. Despite the large number of properties located on the floodplain, the biggest risk facing Newcastle involves people travelling in cars (or more likely stuck in congested traffic) on roads that become hazardous floodways during high rainfall events. The fact that some 5,000 cars were written off in Newcastle during the June 2007 flood event is testament to this looming hazard.

Flood event	Approximate number of properties affected	Approximate number of properties flooded above floor level
10% Annual Exceedence Probability (AEP)	7,500	250
1% Annual Exceedence Probability (AEP)	11,000	2,000
Probable Maximum Flood (PMF)	21,000	10,000

How have flood issues been addressed in the past?

From the very early days there was a lot of pressure to 'channelise' the creeks and get rid of floodwaters as quickly as possible. Given the flat nature of the floodplains though, the problem cannot be solved just by bigger drains, as floodwater simply cannot get into these channels quickly enough.

Construction of the Waratah-Mayfield channel (circa 1920)

In more recent times, CofN has imposed Flood Planning Levels (FPLs) on all new developments. These are minimum floor level standards, typically taken as 0.5 metres above the predicted 1% AEP flood level. These levels have only recently (within the last 30 years) been able to be calculated using computer modelling of flooding, and are based on rainfall probabilities (Australian, not British!). The standards for rainfall in Australia are currently being reviewed and updated by hydrologists.

Why are these approaches not appropriate now?

Whilst CofN has placed considerable effort on controlling any new development, there still remains an overwhelming flood risk associated with existing development. Of serious concern is the large 'Risk to Life' during an extreme event (many times larger than June 2007), wherein about 15,000 people would not have time to evacuate to safety, and would be either stuck on roads that turn into hazardous floodways, or are taking refuge within buildings that could conceivably collapse under the weight and force of floodwaters.

Flash flooding is a particular issue for Newcastle, as severe flooding problems can occur with very little warning. In most cases, emergency services and combat agencies such as the Police and SES would not have the time to help people in need during a flash flood. Therefore, the Newcastle community needs to know what to do, and more importantly, what not to do, when faced with a flash flood situation.

Streets in Carrington are susceptible to inundation by king tides (photo courtesy B Coates)

The low-lying suburbs of Maryville, Wickham, Carrington and parts of Islington and Stockton are particularly vulnerable to flooding, as it is difficult for these areas to drain freely to the harbour (the ground is bowl-shaped, meaning that floodwaters just fill-up and then drain slowly through the stormwater system). Potential future sea level rise will make drainage even worse in these areas, and will also increase groundwater levels. The on-going suitability of these areas for development would be questionable with a sea level rise of just 0.4 – 0.5 metres. Climate change may also change rainfall in the future, although there is still considerable uncertainty in these projections. The current review and updating of the rainfall standards based on Australia's most recent rainfall data is likely to be just as significant for future planning purposes. Review of land use planning instruments will also be significant to ensure (as far as possible with available knowledge) the incremental, gradual changes to the developed areas of the City of Newcastle eventually become compatible with the flood risks and consequences.

What is proposed to improve flood management in Newcastle?

This City-wide Flood Plan proposes a suite of actions, works and initiatives that when implemented together will make a significant difference to Risks to Life and Risks to Property around Newcastle. Figure A.2 shows individual strategies that will be pursued within the First 5 Years. This "package" of actions focuses on reducing Risks to Life in the first instance, as this is the most important aspect of flood management. Central to the First 5 Years Package is a Complete Flood Warning System for Newcastle, which includes a variety of standard and more innovative ways of getting the warning messages out to the community as quickly as possible. The Flood Warning System is also supported by an extensive Community Education Program aimed at making sure people can be self-reliant during flash floods. This would include knowing what to do if you become trapped in your house, your car, at the shops etc.

The First 5 years Package also includes a scheme to encourage residents to provide a flood refuge, which is high enough to be free from all flooding, and would not collapse during

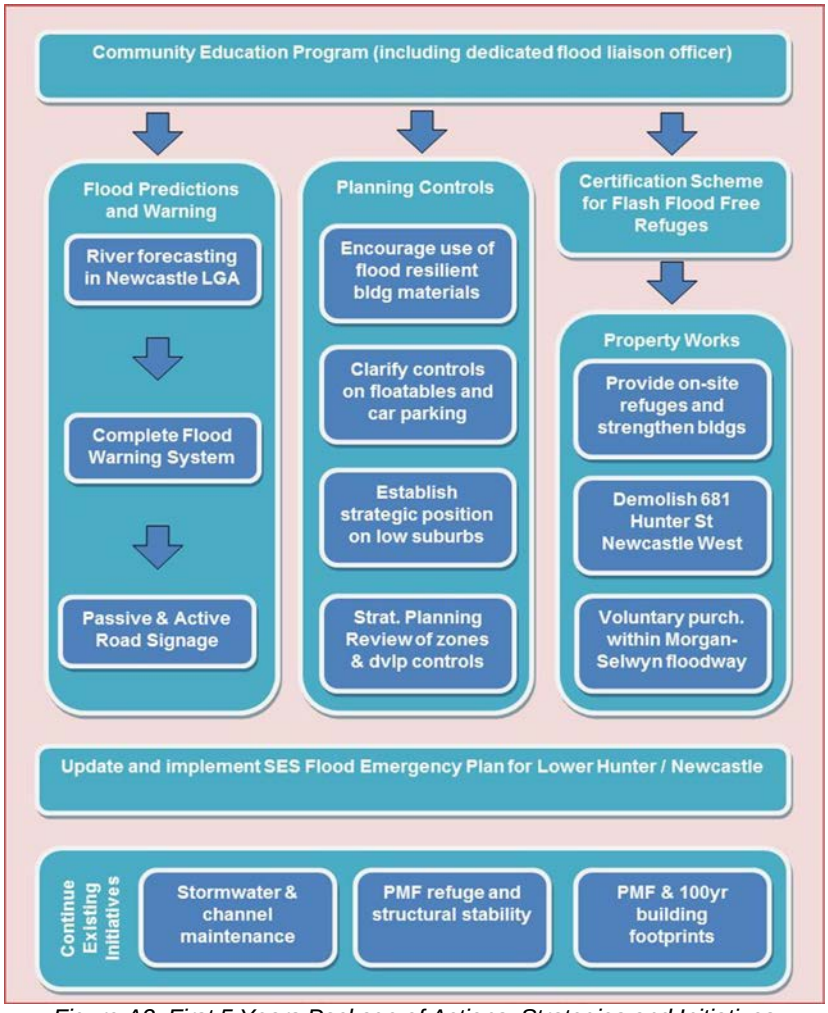

Figure A2: First 5 Years Package of Actions, Strategies and Initiatives

extreme floods. The vast majority of houses in Newcastle would automatically satisfy these requirements, while for some low-lying properties, access into roof space (via an attic ladder) may be all that is required.

Within the First 5 Years, it is recommended that CofN undertake a comprehensive strategic planning review with an aim of establishing consistency between landuses and levels of flood risk. As part of the review, CofN should consider all building and development controls that can be used as mechanisms for managing both risks to life and risks to property.

After the First 5 Years, this Plan recommends further actions and initiatives be pursued, including some structural and stormwater augmentation works, some possible voluntary buy-back of the worst affected properties, and even some possible house raising, focusing on those properties that are affected by frequent flooding.

The area around Hexham is of particular concern, as this area becomes a very deep floodway during large Hunter River floods (in the 1955 flood, Hexham McDonalds was 3 metres underwater). In the medium to long term, residential development on the Hexham floodplain should be phased out.

In the future, Flood Planning Levels (minimum floor levels) may also be reviewed and updated to account for future climate change projections, revised rainfall probabilities for Newcastle, and allowances for the potential blockage of channels and culverts (as occurred throughout Newcastle during the June 2007 event).

What else was considered but is not appropriate?

There have been many options and schemes mooted to alleviate flooding in Newcastle over the years. All potential options were considered as part of this Flood Plan. An assessment process was used to filter out those options that would have the best outcomes in terms of reducing Risk to Life and Risk to Property, for the best value for money. Options considered as part of this Plan, but were subsequently not considered suitable, included the following:

Flood mitigation dams	Large detention basins	River and creek dredging
Levees next to channels	Bypass tunnel to the ocean	Diversion of water to mine voids
Bypass channel construction	Relocating whole suburbs	Larger, deeper concrete channels

What will the City-wide Flood Plan cost and when will it be done?

The First 5 Years Package is estimated to cost approximately $4.7m. Year 1 has a modest cost of $150,000, ramping up to $1m - $2m by Years 3 – 5 (see Figure A3 adjacent). A breakdown of the costs into the specific strategies in the First 5 Years Package is shown overleaf in Table A1. All costs are subject to negotiation between relevant authorities and funding bodies, and may vary as part of detail review. Note that there is no statutory or implied obligation for relevant stakeholders or agencies to commit to the funding and cost sharing arrangements outlined in this Plan.

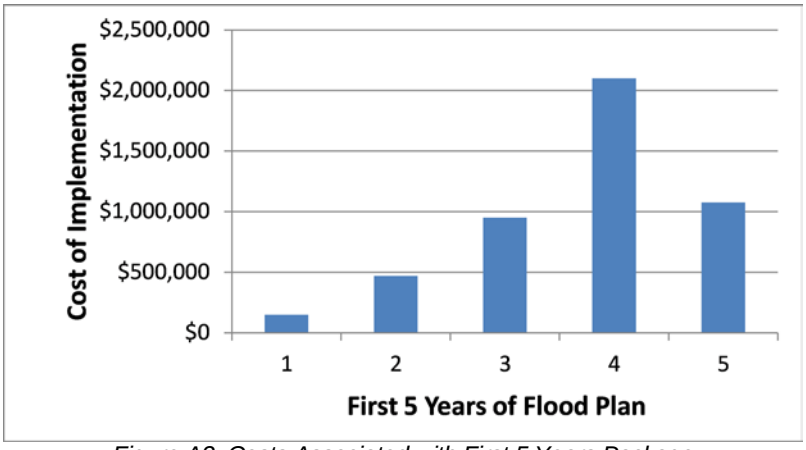

Figure A3: Costs Associated with First 5 Years Package

Many of the proposed strategies in the First 5 Years involve staff time only, and should be pursued without delay. For more costly strategies, CofN and other relevant authorities will need to source suitable funding, which may take some forward planning for budgets and allocations. Most of the strategies would be eligible for funding under the NSW Government's Floodplain Management Program, at a ratio of 2:1 (State:Council) contributions. The State's contribution would be subject to available budgets and priorities for floodplain management across the whole of NSW, with funding

for individual works/strategies considered on a competitive basis. Similarly, other stakeholders, including CofN, will have their own budget priorities which need to be considered when funding this Plan.

Table A1. Costs and timing for the First 5 Years Package of Actions, Works and Initiatives ($, '000)

	Year	1	2	3	4	5
Education Initiatives						
Ed.1	*Undertake community education, facilitated through a flood liaison officer*	*50*	*50*	*350*	*350*	*350*
Flood Prediction & Warning						
Wa.1	*Provide river flood forecasting for locations(s) in Newcastle LGA*				*50*	*nil*
Wa.2	*Develop and operate a complete Flood Warning System for Newcastle (covering Flash, River and Ocean Flooding), including effective broadcasting of warnings and relevant information through multi media and social media channels*	*nil*	*50*	*150*	*150*	*25*
Wa.3	*Install passive and active road signage to relay warnings, advise of flooded roads, and provide other emergency information*	*nil*	*100*	*250*	*450*	*450*
Planning Controls						
Pl.1	*In concert with existing planning reviews, clarify and implement controls on floatables and car-parking in floodways and/or hazardous areas*	*nil*	*nil*	*nil*	*nil*	*nil*
Pl.2	*Encourage redevelopment and renovations with more flood resilient materials and design*	*nil*	*10*	*nil*	*nil*	*nil*
Pl.3	*As a first step towards possible strategic landuse changes, undertake appropriate investigations to develop a Strategic Position that will decide the future management of low-lying areas / suburbs in the long-term (within a 50 yr horizon)*	*nil*	*100*	*200*	*200*	
Pl.4	*Undertake a strategic planning review of all floodplain areas, with recommendations for changes to the LEP, DCP and other guiding policies and plans as appropriate*	*nil*	*nil*	*nil*	*nil*	
Governance Initiatives						
Go.1	*Provide an advisory and certification scheme for "flash flood free" refuge*	*nil*	*10*	*nil*	*nil*	*nil*
Property Works						
Pr.1	*Provide elevated flood-free refuge, in combination with flood vents where required to minimise pressure loading on buildings (1500 required in total across Newcastle to fully meet needs – aim for 200 over first 5 years, although the uptake is voluntary)*	*nil*	*nil*	*nil*	*100*	*100*
Pr.2	*Demolish 681 Hunter St building over Cottage Creek*	*nil*	*100*			
Pr.3	*Investigate voluntary purchase of one or more properties within Morgan – Selwyn floodway, Merewether, and pursue if determined to be appropriate, subject to availability of funding*	*50*			*800*	*150*
Emergency Management						
Em.1	*Update and implement as required the SES Flood Emergency Plan for Newcastle / Lower Hunter to include flash, river and ocean flood risks and issues*	*nil*	*nil*	*nil*	*nil*	*nil*
Existing Initiatives						
Ex.1	*Continue existing development controls for PMF refuge and structural stability needs*	*nil*	*nil*	*nil*	*nil*	*nil*
Ex.2	*Reinforce controls on building footprints in floodways and flood storages*	*50*	*50*			
Ex.3	*Continue maintenance of constructed stormwater system to meet design capacities*	*Continue existing spending*				
	TOTAL ($ '000)	***150***	***470***	***950***	***2,100***	***1,075***

Included in the costs are contributions from some private property owners, who would voluntarily be encouraged to provide flood-free refuge within their houses at their own expense. This is expected to cost no more than about $1000 each (assuming no structural works are required). The First 5 Years of the Newcastle City-wide Flood Plan aims for 200 new flood-free refuges provided by property owners, however, the actual extent of implementation will be dependent on the voluntary decisions of individual property owners.

How will this City-wide Flood Plan make a difference?

Principally, this City-wide Flood Plan aims to reduce the number of people within the Newcastle LGA that potentially will be directly exposed to life threatening situations associated with flooding (including flash flooding, river flooding and ocean flooding). Estimates indicate that implementation of the First 5 Years Package (total investment about $4.7m) will reduce the Risk to Life from 15,000 down to 8,000, while implementation of all recommendations within the Plan will see this reduce down to just 3,000. Approximately 96% of people (i.e. 77,000 out of 80,000) potentially at risk in a PMF event would be adequately managed at this level of implementation.

The potential for property damage has already been managed to some degree by CofN's existing development controls, although there are still a large number of houses in Newcastle that were built before any flood planning regulations came into force. The current annual flood damage bill for Newcastle is about $24 million (including vehicles), when averaged over the long term. This takes into account the probability of flood events, that is, big floods cause big damages, but they occur very infrequently (so their annual average cost is relatively low). Implementing the First 5 Years Package should reduce the future average annual damage cost by about $2 million. Within 5 years of implementation, the reduction in damage costs would therefore be about $10 million. Implementation of the complete Flood Plan and all its recommendations would reduce average annual damages by approximately $6 million. Given the total cost of implementation would be in the order of $40 - $50 million, economic investment in the Plan would be recouped through reductions in damages within 10 years.

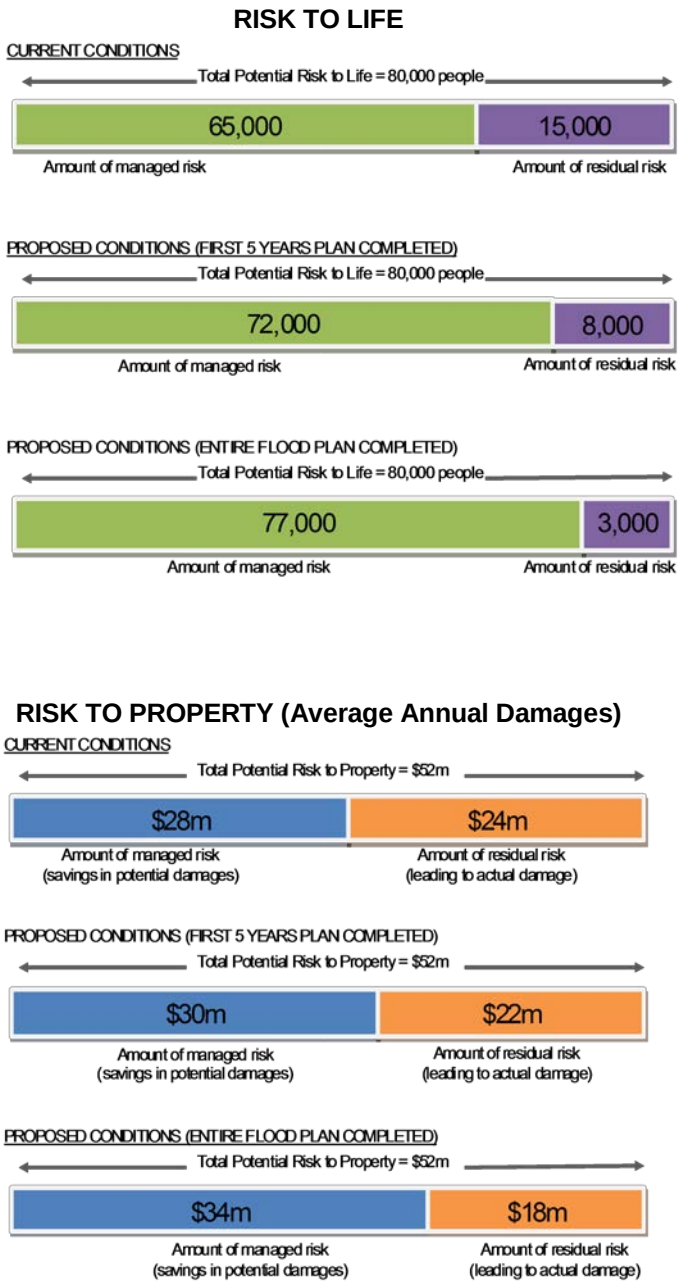

Figure A3. Estimates of improvements to Risks to Life and Property from this Plan

It is important to understand that this Plan will not stop flooding. It also will not stop damages to property when big floods strike. It will, however, help to reduce the impact of flooding, at both a personal and community level, and will help people to recover and get on with their lives as quickly as possible after such events.

What can the community do to help?

During floods, and especially flash floods, people will need to be responsible for their own personal safety. Foolish decisions like driving or wading through floodwaters can be dangerous and even deadly.

This Plan aims to help people make the right decisions when faced with flooding through an extensive Community Education Program. The Program will provide people with a greater understanding of local flooding conditions, including flooding that has not been experienced to date. The Program also aims to arm the community with knowledge about how to respond during a flood event, and more importantly, what not to do in a flood.

The community should be prepared to participate in this Community Education Program, through the various and tailored educational avenues that will be pursued, including:

- Public communications, information products and services e.g. publications, Internet sites, displays, promotional products, media liaison, advertising/marketing, public education campaigns;
- Training, development and industry-specific programs e.g. skills development courses, professional training, workplace induction programs, field days;
- Community development programs e.g. public participation programs, awareness-raising programs, discussion groups, developing education networks;
- Use of social media for learning e.g. Facebook, Twitter, YouTube; and
- Comprehensive personal education programs e.g. school curriculum, university curriculum, personal development courses, action research programs, and community education courses.

From a community perspective, it is important to understand flooding in Newcastle, and be prepared to act appropriately should flooding occur. In essence, the community needs to become 'flood ready'. This would include preparing a personal emergency plan for a house or business, which should include options for evacuation, if possible, or otherwise shelter safely in-place.

The community should also be 'tuned in' to possible flood warnings, thus giving themselves the maximum possible opportunity to prepare and respond to the flood. Once set up, the Newcastle Flood Warning System will allow community members to be included on automatic notifications of flood warnings (such as subscriptions to SMS or email alerts, or connected to Facebook or Twitter accounts used to disseminate warnings).

Effective management of flooding in Newcastle will require bold decisions and significant investment in long term outcomes. It is expected that effective flood management will not be achieved unless there is strong political support for such actions, and this will only occur if the community are active and engaged in the issues, and are placing pressure on the local, state and federal politicians to act and respond with good governance on behalf of the community at large.

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Finally, we wish to thank the community who have willingly contributed to discussions and voiced their concerns, opinions and support throughout the whole process.

FOREWORD

The City of Newcastle is no stranger to the potential devastating effects of flooding. The 2007 storm event was a timely reminder of the vulnerability of our urban environments to such weather extremes, made all the more so to a city like Newcastle because of our unique locality at the mouth of one of the state's largest coastal catchments, historical development across wide areas of low lying floodplain and our extensive ocean frontage. Flooding is both an existing and future concern. Climate change and associated sea level rise and extreme weather events potentially amplify the potential frequency, duration and/or severity of future flooding events.

There are significant risks to life and property from extreme flooding events across many of Newcastle's suburbs where flooding can occur quickly with little or no warning. The City of Newcastle's knowledge of the extent of potential flood risks has been growing over many years as data collection and specialist studies have been progressively carried out over its Local Government Area. Research has confirmed there are no quick fix solutions to flooding in Newcastle. The complete elimination of flood risks is impossible, so it is necessary to find ways to manage and live with the flood risks in Newcastle.

This City-wide Floodplain Risk Management Study and Plan is one several 'big move' projects identified in our 2030 Community Strategic Plan that will help us achieve the vision for the city. It has entailed the contribution of many organisations and has actively sought the contribution of the community and other stakeholders in developing the proposed list of management options for us to consider. The plan describes ways to manage and live with the various flooding types that may unexpectedly arise at any time and place. It also includes maps, descriptions of measures to manage the risks to life and property, cost estimates and possible sources of funding to help implement these measures.

Flood management is a shared responsibility, we all have role to play. CofN can plan for flood events, while agencies such as the SES can prepare to combat flood events, but you, the community, have an equal part to play by being flood aware, prepared and demonstrating appropriate flood response.

.....	.....
Lord Mayor of Newcastle	Chair, Newcastle Floodplain Management Working Party
Clr. John Tate	Clr. Tim Crakanthorp

GLOSSARY

10% AEP flood There is a 10% (1 in 10) chance that a flood of this size or bigger will occur in any year (sometimes called the 1 in 10 year flood).

1% AEP flood There is a 1% (1 in 100) chance that a flood of this size or bigger will occur in any year (sometime called the 1 in 100 year flood). The June 2007 was about this big for many areas of Newcastle.

annual exceedance probability (AEP) AEP (measured as a percentage) is a term used to describe flood size. It is a means of describing how likely a flood is to occur in a given year. For example, a 1% AEP flood is a flood that has a 1% chance of occurring, or being exceeded, in any one year. It is also referred to as the '1 in 100 year flood'. The AEP terminology has been used primarily in this document.

attenuation Weakening in force or intensity.

Australian Height Datum (AHD) National survey datum corresponding approximately to mean sea level.

BoM Bureau of Meteorology

catchment The catchment at a particular point is the area of land that drains to that point.

CofN The City of Newcastle (formerly called Newcastle City Council).

continuing risk The risk remaining after all management works and initiatives have been implemented. This is the risk that people just have to live with, and therefore it must be at an acceptable level.

design flood A hypothetical flood representing a specific likelihood of occurrence (for example the 1% AEP flood).

development Existing or proposed works that may or may not impact upon flooding. Typical works are filling of land, and the construction of roads, floodways and buildings.

discharge The rate of flow of water measured in terms of volume per unit time, for example, cubic metres per second (m^3/s). Discharge is different from the speed or velocity of flow, which is a measure of how fast the water is moving for example, metres per second (m/s).

existing risk Flooding risks that affect existing development.

flash flooding Flooding from the local catchments in Newcastle, notably in Ironbark Creek, Dark Creek, Throsby / Styx Creek and Cottage Creek, as well as flooding from direct rainfall.

flood Any significant flow within channel or waterway as well as concentrated overbank flow or temporary storage / ponding of water resulting from rainfall within local catchments, or backwater inundation from elevated downstream waters. In the context of the latter, high waters within the Hunter River/Newcastle Harbour can be the result of rainfall further up the large Hunter catchment, or from high ocean water levels caused by storms and low pressure systems (e.g. East Coast Lows), but not tsunamis.

Local street drainage is not considered a flood in the context of this report.

flood behaviour The pattern / characteristics / nature of a flood.

flood fringe Land that may be affected by flooding but is not designated as floodway or flood storage.

flood hazard The potential for damage to property or risk to persons during a flood. Flood hazard is a key tool used to determine flood severity and is used for assessing the suitability of future types of land use.The degree of flood hazard varies with circumstances across the full range of floods.

flood level The height of the flood described either as a depth of water above a particular location (eg. 1m above a floor, yard or road) or as a depth of water related to a standard level such as Australian Height Datum (eg the flood level was 7.8 mAHD).

flood liable land see flood prone land.

floodplain Land susceptible to flooding up to the Probable Maximum Flood (PMF). Also called flood prone land. Note that the term flood liable land now covers the whole of the floodplain, not just that part below the flood planning level.

floodplain risk management study Studies carried out in accordance with the Floodplain Development Manual (NSW Government, 2005) that assesses options for minimising the danger to life and property during floods. These measures, referred to as 'floodplain risk management measures / options', aim to achieve an equitable balance between environmental, social, economic, financial and engineering considerations. The outcome of a Floodplain Risk Management Study is a Floodplain Risk Management Plan.

floodplain risk management plan The outcome of a Floodplain Risk Management Study, which provides specific implementation details on actions, works and initiatives to improve floodplain management.

flood planning levels (FPL) The combination of flood levels and freeboards selected for planning purposes, as determined in Floodplain Risk Management Studies and incorporated in Floodplain Risk Management Plans. The concept of flood planning levels supersedes the designated flood or the flood standard used in earlier studies.

flood prone land Land susceptible to inundation by the Probable Maximum Flood (PMF) event. Under the merit policy, the flood prone definition should not be seen as necessarily precluding development. Floodplain Risk Management Plans should encompass all flood prone land (i.e. the entire floodplain).

flood storage Floodplain area that is important for the temporary storage of floodwaters during a flood.

flood study A study that investigates flood behaviour, including identification of flood extents, flood levels and flood velocities for a range of flood sizes.

floodway Those areas of the floodplain where a significant discharge of water occurs during floods. Floodways are often aligned with naturally defined channels. Floodways are areas that, even if only partially blocked, would cause a significant redistribution of flood flow, or a significant increase in flood levels.

freeboard A factor of safety usually expressed as a height above the adopted flood level thus determing the flood planning level. Freeboard tends to compensate for factors such as wave action, localised hydraulic effects and uncertainties in the design flood levels.

future risk Flooding risks that will affect future development, once built.

high flood hazard For a particular size flood, there would be a possible danger to personal safety, able-bodied adults would have difficulty wading to safety, evacuation by trucks would be difficult and there would be a potential for significant structural damage to buildings.

HWC Hunter Water Corporation.

hydraulics The term given to the study of water flow in rivers, estuaries and coastal systems.

hydrology The term given to the study of the rainfall-runoff process in catchments.

low flood hazard For a particular size flood, able-bodied adults would generally have little difficulty wading and trucks could be used to evacuate people and their possessions should it be necessary.

m AHD metres Australian Height Datum (AHD).

m/s metres per second. Unit used to describe the velocity of floodwaters.

m^3/s Cubic metres per second or ‘cumecs’. A unit of measurement for creek or river flows or discharges. It is the rate of flow of water measured in terms of volume per unit time.

overland flow path The path that floodwaters can follow if they leave the confines of the main flow channel. Overland flow paths can occur through private property or along roads. Floodwaters travelling along overland flow paths, often referred to as ‘overland flows’, may or may not re-enter the main channel from which they left; they may be diverted to another water course.

peak flood level, flow or velocity The maximum flood level, flow or velocity that occurs during a flood event.

probable maximum flood (PMF) The largest flood likely to ever occur, many times larger than the 1% AEP. The PMF represents extreme flooding conditions and defines the extent of flood prone land or flood liable land, that is, the floodplain. The extent, nature and potential consequences of flooding associated with the PMF event are addressed in the current study. The PMF is primarily used in the management of Risk to Life. Whilst it can potentially occur, it has a very low chance of occurring.

probability A statistical measure of the likely frequency or occurrence of flooding.

OEH The Office of Environment and Heritage, NSW Department of Premier and Cabinet (in the context of this report, serves a similar function as the former Department of Environment, Climate Change and Water).

ocean flooding Flooding from very high ocean water levels, typically as a combination of big tides and storm surge.

risk Chance of something happening that will have an impact. It is measured in terms of consequences and likelihood. In the context of this study, it is the likelihood of consequences arising from the interaction of floods, communities and the environment.

risk to life Flooding risks that threaten life. This is the worst type of flood risk.

risk to property Flooding risks that threaten to damage property.

river flooding Flooding from the Hunter River. Only an issue for areas around Hexham/Sandgate and the fringes of Hexham Swamp.

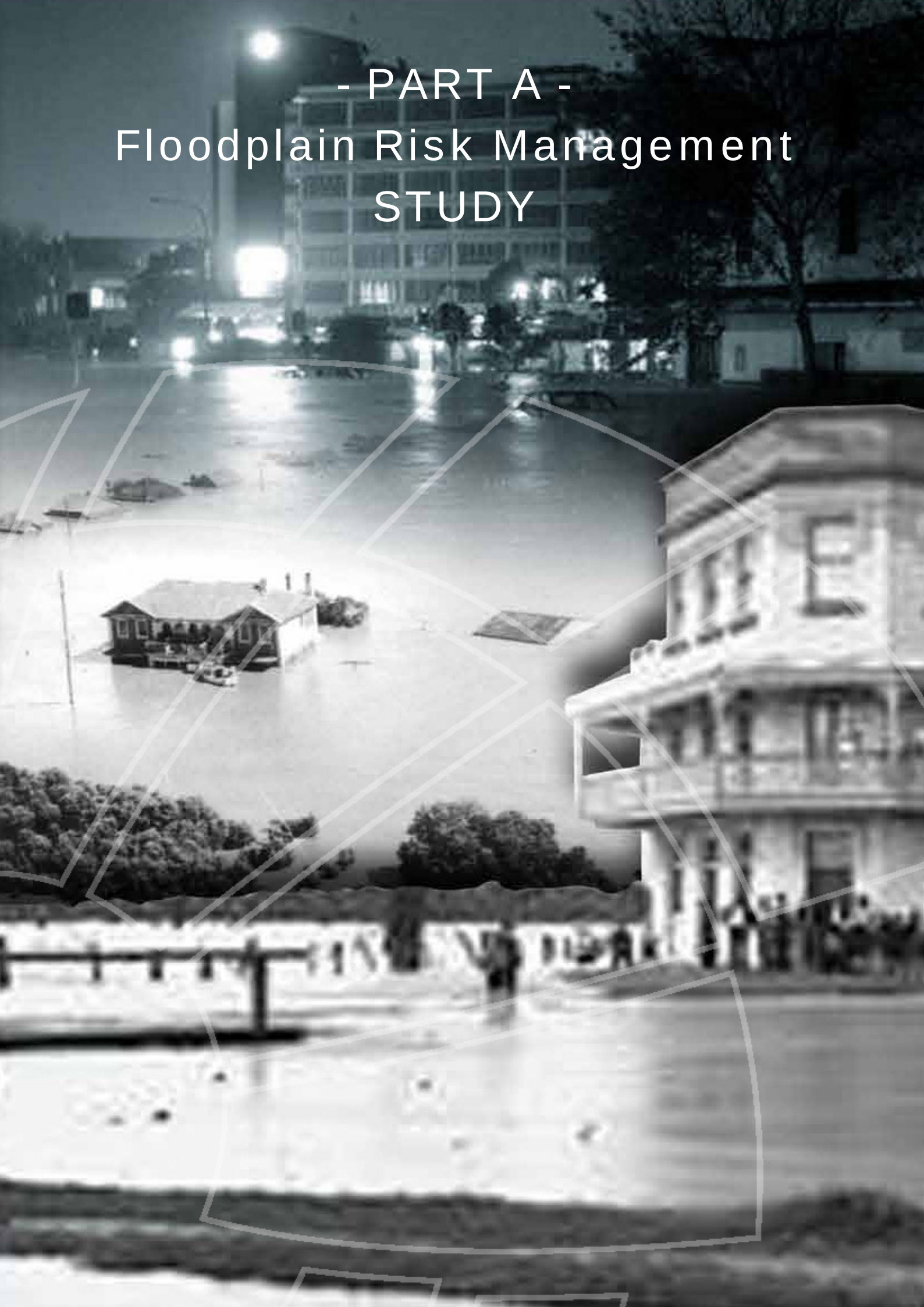
runoff The amount of rainfall from a catchment that actually ends up as flowing water in the river or creek.

topography The shape of the surface features of land.

velocity The term used to describe the speed of floodwaters, usually in m/s.

water level See flood level.

- PART A -
Floodplain Risk Management STUDY



1 INTRODUCTION AND FRAMEWORK FOR FLOODPLAIN MANAGEMENT

1.1 Background and Purpose

Floodplains are low-lying areas adjacent to waterways and oceans that are periodically inundated by floodwater. Whilst supporting a multitude of environmental values they are also often the focus of a variety of human activities such as agriculture, industry, commercial and residential land use. Major transport infrastructure such as highways and railway lines, and community facilities such as schools, are also often situated in low lying areas so as to service these communities.

Flooding of such land is a natural process that can occur at any point in time with the cause, extent and potential impact of such events highly variable and complex. In the majority of instances, flooding truly is a force of nature that can never be completely controlled or eradicated. Because of the multiple uses of floodplains, we will always need to accept and adapt to flooding events if communities wish to continue to utilise them as they currently do so.

Floodplain management is a broad concept, encompassing the continuous process of making decisions about whether and how floodplain lands are to be used in light of the obvious impact of flooding events. It incorporates the decisions made at all levels of government and choices made by the community. Floodplain management is not typically about radical movement of populations away from floodplains but rather is concerned with minimising or abating existing and future flood risks. The goal of floodplain management is to reduce risks such that all on-going, or continuing, flood risks are considered acceptable to the communities that are at risk, whilst ensuring that the communities are still fully aware of these on-going risks.

The primary guiding document for floodplain management in NSW is the State Government's Floodplain Development Manual (2005). This document embodies current thinking that has evolved over the last 50 years, and requires a strategic merit based approach to the management of the full range of possible flood risks considering risk management, economic, social and environmental issues.

Section 733 of the *NSW Local Government Act 1993* highlights that the primary responsibility for floodplain risk management rests with Councils. To assist in this role, Council's are provided with financial and technical support by the State and Commonwealth Governments. By managing flood risks in accordance with the Manual, Council's are afforded indemnity from liability arising from flooding. While Council's have the primary responsibility for the management of flood prone land, it is still recognised that many other agencies and the community have important roles.

Flooding within the Newcastle Local Government Area (LGA) can occur from three mechanisms (and combinations thereof):

- Flash flooding, as a result of intense rainfall within the local catchments (e.g. June 2007 'Pasha Bulker' storm);
- River flooding, as a result of backwater inundation from the adjacent Hunter River (e.g. the great 1955 Hunter flood); and

- Oceanic inundation, as a result of high ocean tides, storm surge etc (e.g. king tides).

Risks associated with these forms of flooding in Newcastle are primarily a legacy of historical floodplain development. That is, extensive areas and even whole suburbs have been established across Newcastle when there was less awareness and understanding of potential flooding extent and likelihood. Channelisation and the filling of adjacent low lying areas to maximise developable land further exacerbate the problem. As a result of detailed studies undertaken in recent years, it is now understood that approximately 22,000 properties, or about 1 in 3 lots, are potentially affected by flooding within the Newcastle Local Government Area (LGA). This flooding can range from slow-moving shallow backwaters with long warning time to fast flowing torrents that pose a risk to life and buildings within very short timeframes from the event commencing.

This document, the Newcastle City-wide Floodplain Risk Management Study and Plan (City-wide Flood Plan), is intended to form the basis for the immediate and future management of flood prone lands across the Newcastle LGA. The City-wide Flood Plan aims to help direct and coordinate the responsibilities of Government and the community in undertaking immediate and future flood management works and initiatives.

The culmination of many years of studies and research, this document aims to manage risks associated with the vast 'legacy development' across Newcastle's floodplains, as well as guiding appropriate future development on these floodplains (i.e. minimising any further flood risks without unreasonably precluding development from within the floodplain). The document also considers future challenges such as climate change and associated changes in sea levels and rainfall events.

The City-wide Flood Plan is innovative because it is City-wide – across the whole LGA – rather than being focused on a specific catchment as historically would have been the approach. As funding for flood management is always limited, this approach was adopted, aimed at ensuring equity across suburbs and communities through the ability to rank potential flood management actions on merit and in doing so focus funding opportunities to those localities and actions of greatest return.

1.2 Locality

Newcastle is located about 160 km north of Sydney at the mouth of the Hunter River. The Hunter River catchment is one of the largest coastal catchments in New South Wales, with a drainage area of more than 20,000 km^2. This large catchment area is the driver of the infrequent large river flood events that periodically affect the city's low lying areas exposed to the Hunter River floodplain.

The Local Government Area (LGA) itself covers an area of approximately 215 km^2 and is populated by more than 156,000 people. The majority of the LGA falls south of the Hunter River though Kooragang Island and the suburb of Stockton, located to the north of the Hunter River entrance, also fall within the LGA. The Pacific Ocean fronts the coastal suburbs of Stockton, Newcastle East, The Hill, Bar Beach and Merewether.

Key local waterways include Ironbark Creek, Throsby Creek/Styx and Cottage Creek though a number of lesser tributaries and portions of waterways draining outside of the LGA are also present. Ironbark Creek is the largest tidal creek draining to the Hunter River in the City. Its catchment covers some 12,500 hectares and has a diversity of landuse, including residential, industrial and commercial buildings, important transport and communication corridors, and recreational and conservation lands.

The waterway flows from the hills in the south of the catchment, through the suburb of Wallsend before winding its way over a large floodplain known as Hexham Swamp and entering the Hunter River at Sandgate. Much of Newcastle's present and future potential urban living areas are within Ironbark Creek (NCC, 2005).

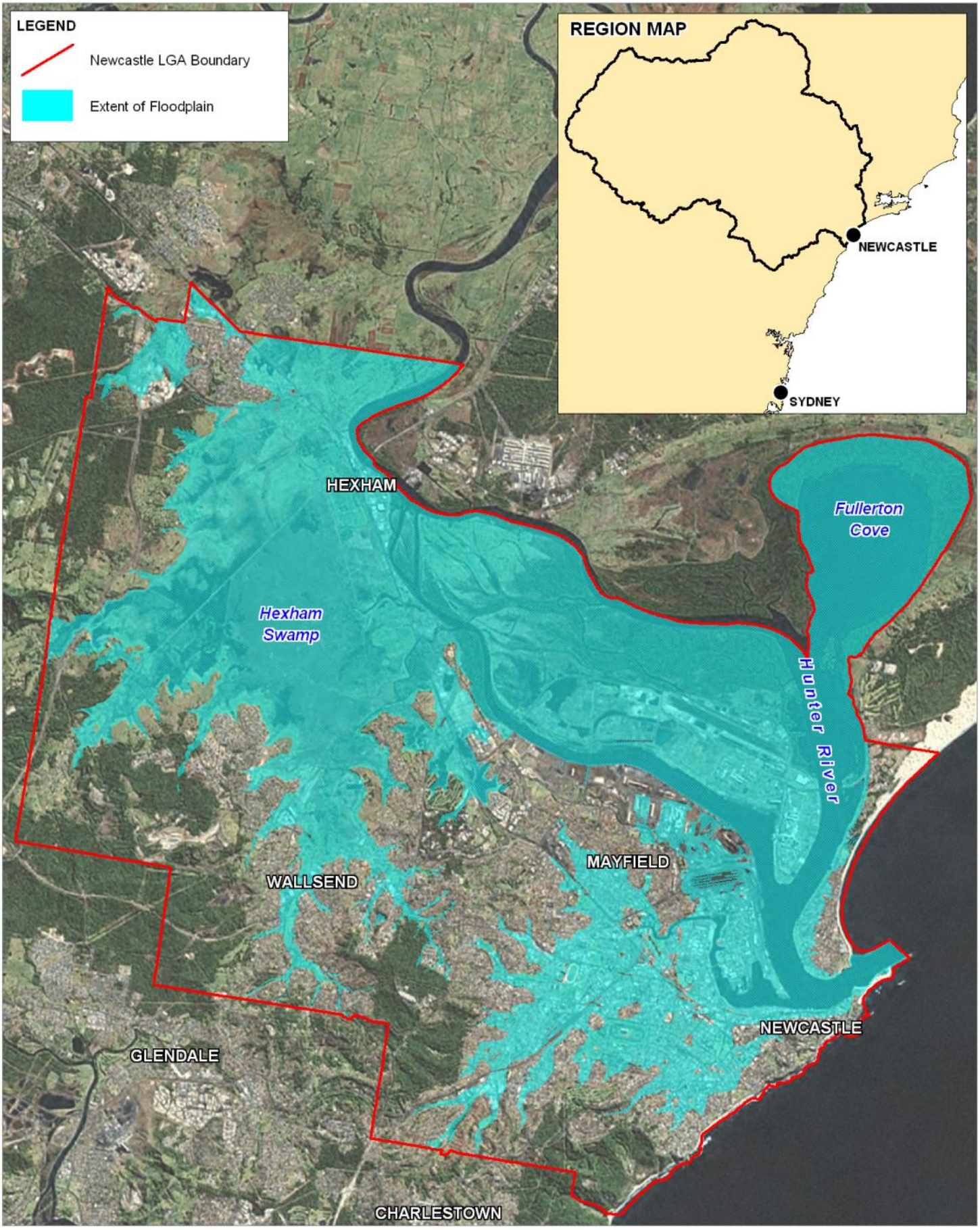
Throsby/Styx Creek and its tributaries form a highly modified drainage network that collects stormwater from the major part of central Newcastle and conveys it to Newcastle Harbour. The catchment of the creek covers an area of approximately 3,000 hectares. Few places within Throsby catchment remain in a relatively natural state with the majority of the drainage network being channelised in concrete stormwater drains and the landuse predominantly residential (NCC, 2005).

The Cottage Creek catchment covers an area of approximately 800 hectares of medium density residential and commercial development in the south-eastern section of Newcastle City. The majority of the catchment is concrete piped and open stormwater drainage (NCC, 2005).

Historically about 70% of Newcastle's LGA was natural pre-existing floodplain, but today wetlands cover less than 20% of the LGA reflecting the degree of development that has occurred on flood prone land. Despite such development, internationally recognised Ramsar wetlands still form a key landscape feature of the LGA and much work has been undertaken in recent years to protect and enhance these much valued wetlands and the important habitat they provide, especially to migratory shorebirds but also a host of other endangered and threatened flora and fauna and ecological communities. The majority of these important wetlands are now contained with the Hunter Wetlands National Park.

The City-wide Flood Plan covers the whole of the Newcastle LGA, with the exception of the Wallsend Commercial Centre. This specific area is excluded because a separate Floodplain Management Plan has already been prepared and adopted by CofN in 2009 (due consideration to the outcomes and recommendations of the Wallsend Commercial Centre Flood Plan have nonetheless been made within this Plan to ensure consistency and equity across the LGA). Notwithstanding, the updated mapping of flood categories presented in this Plan and the accompanying compendium of maps is still applicable to the Wallsend Commercial Centre, to provide consistency in approach, including the definition of both PMF and 1% AEP floodways.

A locality plan of the Newcastle LGA and the area of interest for this City-wide Flood Plan is shown in Figure 1-1.



Title:

Locality Plan for Newcastle Floodplains

Figure: **1-1**

Rev: **A**

N

0 2.5 5km

Approx. Scale

BMT WBM

www.bmtwbm.com.au

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1.3 Historical Context of Flooding and Flood Management in Newcastle

1.3.1 Past Flood Experiences

Before Newcastle and its extensive wetlands were taken up for agricultural settlement by several European families in the 1820s and 1830s, traditional aboriginal peoples (in this area Awabakal and Worimi) would have experienced a wide range of floods over time.

Flooding clearly was of interest to CofN even in the 1800s. For example, within the Newcastle Chronicle on the 15 June 1864 it was written "Alderman Flemming said a letter had been received of there being too much water at Honeysuckle … He thought it would benefit … to run a culvert into the sea to relieve the ward of a great mass of water."

The floods of June 2007 reminded most current Novocastrians of their exposure to significant flood risk. In June 2007, heavy rainfall over the catchment, and particularly over the steep upper catchments that fringe the Newcastle metropolitan area, caused flash flooding across vast areas of the city. Flood depths in some locations reached 1.8 metres. The same storm resulted in the grounding of *MV Pasha Bulker* on Nobby's Beach.

Fortunately loss of life has been small to date. However, from earliest European settlement there have been reports of 'close calls'. There were many reports of people in life threatening situations in the June 2007 floods – people trapped in cars or just managing to escape before the car was washed into a storm water channel, people clinging to power poles and many more. It is thought that if the 2007 flash floods were only slightly worse there would have been a much greater loss of life.

In recognition of the need for advancing floodplain risk management in Newcastle, CofN adopted a Flood Policy in 2004, which committed to the development of a City-wide Floodplain Risk Management Plan across the Newcastle LGA following the principles of the Floodplain Development Manual (2005). In 2005, CofN adopted a Development Control Plan which contains a Flood Management element.

The Wallsend catchment has long been recognised as a flash flood 'hotspot'. There are reports of a Commission of Enquiry into drainage in Wallsend in 1890's, which may have led to the early construction of a concrete stormwater channel soon after in the area of the emerging business district (now Nelson Street). The form of the present stormwater channel in this area suggests it was doubled in size at some time – possibly around the time of the Great Depression. Yet there are still reports of shop windows in Nelson St being broken by flood waters soon after World War II – which was before the majority of the present development in the upper catchment. In more recent times, Wallsend again was confirmed as a high risk catchment by the flash flooding during April 1988, February 1990 and in the "Pasha Storm" flash floods of 8 June 2007. This historic propensity to high impact flash flooding in the Wallsend catchment led to a focus of investigations after the 1988 floods, for example in the years 1996 (Ironbark Creek Total Catchment Management Committee), 2000 (CofN) and 2006 (CofN).

The 2006 Wallsend catchment investigations included community consultation and resulted in a Draft Wallsend / Plattsburgh Floodplain Risk Management Study and Plan being completed in March 2007 (that is before the 8 June 2007 flash floods). The Draft Plan highlighted the concentration of

extraordinary flash flood risks within the Wallsend Commercial Centre (from Cowper Street to the upstream end of Federal Park).

Following the 2007 flash floods, which had a profound impact on the people and businesses in the Wallsend Commercial Centre, coupled with the new knowledge gained of the full extent of potential flood risk in the commercial centre (especially to life), it was decided to consult with the Wallsend Commercial Centre community and businesses to prepare a Floodplain Risk Management Plan for the Commercial Centre ahead of the preparation of a City-wide Floodplain Risk Management Plan. The aim was to gain funding and commence actions to manage what were considered the highest flood risks in the LGA.

The elected Council adopted the Wallsend Commercial Centre Floodplain Risk Management Plan in August 2009. CofN received and accepted Grant offers in the 2011/12 financial year to commence detailed design of the flood reducing works proposed in the Plan, and the development of a property acquisition strategy to enable the works to be carried out, in the event funding becomes available. Some actions, such as the provision of an elevated walkway from Wallsend Plaza Shopping Centre, and strengthening of buildings combined with the provision of upper storey refuges (mostly in existing second storeys) would be voluntary and at the owner's expense. Whilst the management measures outlined in the Wallsend Commercial Centre should still be pursued, the mapping of floodplain categories through this area has been updated as part of this City-wide Flood Plan. Further, strategic planning measures proposed in this Plan should also consider and incorporate the Wallsend Commercial Centre.

At the same time as the Wallsend Commercial Centre Floodplain Risk Management Plan was being developed, CofN also engaged specialists through the NSW Government Floodplain Management Program to develop a conceptual framework to enable the development of a City-wide Floodplain Risk Management Study and Plan. This was also completed in 2009, and forms the guiding document for this work. Table 1-1 shows a timeline of significant flood events during the recent history of Newcastle. Also shown in this timeline are the efforts that have been made by CofN and others to try and better understand and manage the risks to people and property arising from floods.

1.3.2 Summary of City-wide Strategic Outcomes from Stage 1 Concept Planning

Strategic concept City-wide Flood Planning was carried out in 2009 under the NSW Government Floodplain Management Program. This strategic planning included a world wide search for all possible options and techniques to manage flood risks. A panel of experts from other Councils, Government and consultants were also engaged to guide and review potential flood management strategies for Newcastle. Subject to detailed review by later investigations, the concept strategy found:

- The greatest potential flood risk was found to be large loss of life for extreme flash flood events in many of Newcastle's existing suburbs;
- The concept cost of implementation would likely be beyond CofN's and Government's ability to fund (possibly between $200m and $2billion). This cost would largely be due to the apparent need to purchase many severely flood affected properties (in order to remove Risk to Life); and
- Opportunities to control flooding are very limited.

Table 1-1 Timeline of Significant Events in Newcastle's Flood History

Flood Event	Year	Planning Event
Hunter River flood event, perhaps biggest on record	1806	
Hunter River flood event. Seven fatalities. Hunter River peak at 8.9m at Maitland	1832	
Hunter River flood event. Hunter River peak at 8.9m at Maitland	1834	
Hunter River flood event. Floodwaters peak at 9.2m at Maitland	1857	
Flash flooding in the Ironbark Creek Catchment	1864	
	1870	Floods in the Hunter Report. Moriarty became president of the Hunter River Floods Commission.
Flash flooding in the Ironbark Creek Catchment	1889	
Hunter River flood event. Nine fatalities	1893	
Flash flooding in Wallsend (Ironbark Creek catchment)	1895	
Flash flooding in Newcastle. Near King St "the rooves of houses stood out line islands in the sea".	1908	Around this time compulsory filling of low lying land in Wickham Maryville and Carrington required when new buildings erected ("Unhealthy building land")
Hunter River flood event	1913	
Wickham Maryville extensively flooded a short time after WW1	1919	
Flash flooding in Wallsend (Ironbark Creek catchment)	1920	
Widespread Flash flooding in Wallsend and other suburbs such as Adamstown, and the west end of Newcastle.	1927	
Hunter River flood event	1930	
Hunter River flood event	1931	
Flash flooding in Wallsend (Ironbark Creek catchment)	1937	
Flash flooding in Wallsend (Ironbark Creek catchment)	1946	
Hunter River flood event	1949	
	1950	Hunter Valley Conservation Trust formed
Hunter River flood event	1951	
Hunter River flood event	1952	
Hunter River flood event. Maitland Floods. Twenty five fatalities	1955	Legislation enacted to enable the financing and construction of the Hunter Valley Mitigation Scheme as a partnership between the Hunter Valley conservation Trust and the NSW Government.
Major flash flooding in Newcastle's suburbs – e.g. New Lambton	1963	Continuous rain gauge (pluviometer) installed at Maryville (Hunter Valley Research site). Council proposes to devise a scheme of improved drainage "so as to eliminate flooding".
Hunter River flood event	1971	
Ocean flood Sygna Storm Event	1974	
Hunter River flood event	1978	
Flash flooding in Newcastle's suburbs, such as New Lambton and Merewether	1984	NSW Flood Prone Land Policy (First Release) Ombudsman requires Council and HWC to each purchase one severely flood affected house in Morgan St Merewether and to work out responsibilities.
	1985	NSW Floodplain Development Manual (First Release) – Merit based – not prescriptive.
Severe Flash flooding in many of Newcastle's suburbs, such as Wallsend, Jesmond, Birmingham Gardens Mayfield, Adamstown, New Lambton.	1988	
	1989	Throsby Creek Total Catchment Strategy "Hydrology" Study.

Flood Event	Year	Planning Event
		Detention basins recommended (in excess of $100M in $2011) but Federal Government declines to fund since economic benefits not demonstrated.
Flash flooding in many of Newcastle's catchments, but not severe as 1988	1990	
Hunter River flood event	1992	
	1993	Hexham Swamp Inundation Study
	1994	Lower Hunter River Flood Study (Green Rocks to Newcastle)
	1995	HWC carries out investigations into the feasibility of detention basins in parks. Later concludes mostly not feasible.
	1996	Ironbark Creek Total Catchment Management Strategy (Includes Flood Management).
	1996	Lower Hunter Valley Floodplain Management Study: Assessment of Strategic Options
	1996	Lower Hunter River Geomorphology Study. First grants offered to CofN to commence investigations of urban flooding under the NSW Government Flood Program.
	1999	Lower Hunter River Model Verification – February 1990 Flood Event.
	1999	Honeysuckle (includes Linwood and Carrington) Flood Management Plan
	1999	Design Water Levels Joint Probability Study
	2000	City-wide Historic Flood Level Data Collection Study
	2000	Wallsend Plattsburg Floodplain Management Study Cottage Creek Flood Study
Local flash flooding in New Lambton Area	2001	NSW Flood Prone Land Policy and revised Floodplain Management Manual (not gazetted) Lower Hunter Valley Floodplain Management Study: Planning Implementation
	2003	CofN Flood Policy: Technical Manual
	2004	CofN Flood Policy adopted. Includes commitment to complete City-wide Floodplain Risk Management Plan.
	2005	NSW Floodplain Development Manual. The Management of Flood Liable Land gazetted - (to include local flash flooding in urbanised catchments like Newcastle – and give consistency in the management of floods up to the most extreme). Newcastle Flood Development Control Plan
	2006	Throsby Creek Flood Study
Pasha Bulker Storm (8 June) Flash Flooding. Eight fatalities	2007	Floodplain Risk Management Guideline: Practical Consideration of Climate Change NSW Flash Flood Warning Guidelines
	2007	City-wide June 2007 post flood level and damages data collection
Flash flooding in some areas – e.g. Hamilton	2008	Dark Creek Flood Study Analysis of Extreme Ocean Water Levels at the Hunter River Entrance
	2008	Wallsend Plattsburg (Ironbark Creek) flood Study (upgrade and calibration to 2007 flood information).
	2009	Newcastle Flash Flood Detection Equipment installed Floodplain Risk Management Plan and Study for the Wallsend Commercial Centre NSW Sea Level Rise Policy Statement Newcastle Flood Planning-Stage 1 Concept Planning
	2010	NSW Flood Risk Management Guide. Incorporating sea level rise benchmarks in flood risk assessments

1.3.3 Lower Hunter River Draft Flood Plan

Newcastle and Port Stephens Councils jointly developed a draft Floodplain Management Study for those portions of the Lower Hunter River floodplain in their respective Local Government Areas. This work ceased in 2001 when the two Councils mutually agreed to use the draft strategic work in each of their LGA's to carry out detailed flood planning, ensuring consistency.

There was community consultation and public exhibition of this work leading up to the draft management study. In Draft, the main findings for the Newcastle LGA were:

- Additional flood mitigation works such as higher levees or river channel works are not warranted – and the community did not support higher levees;
- Management of very large floods (larger even than the notorious 1955 flood) is probably the most important issue, primarily because of the limited amount of land available for rezoning for redevelopment and the huge areas of significant infrastructure that would be affected.

1.3.4 Wallsend Flood Planning

Options for managing the severe flood risks in the Wallsend Catchment were publicly exhibited in 2006, and a draft Floodplain Risk Management Plan developed for the Wallsend catchment in March 2007 (before the disastrous 8 June 2007 flash floods). After the June 2007 floods it was decided to focus on the Wallsend Commercial Centre as the highest priority in the LGA. The elected Council adopted a Floodplain Risk Management Plan for the Wallsend Commercial Centre in 2009. This Plan contains a package of mutually interdependent measures that in essence required:

- Opening-up of the floodway through the Commercial Centre by the acquisition of some buildings, and widening of the channel, together with widening of the bridge over Ironbark Creek at Minmi Road (Estimated cost $28million- public funds);
- Strengthening of buildings and provision of last resort refuges above the highest possible flash flood. (Estimated cost $16million – voluntary private funds by owners); and
- Enhanced Emergency Management – A complete city-wide flash flood warning system – and emergency response – even where the SES cannot respond and people do not have time to safely walk out of the flooding and up the hill to flood free land.

The development of the Draft Wallsend Flood Plan provides some important guidance on applying the principles of the NSW Government Floodplain Development Manual (2005) in highly hazardous urbanised flash flood environments, which have been considered in preparing this City-wide Flood Plan.

1.4 Framework for Floodplain Management

The development of this City-wide Flood Plan has been fundamentally guided by the NSW Government's Floodplain Development Manual (2005). The objectives of the manual and the broad principles of floodplain management advocated within the manual have been used as the "criteria" against which the current flood management approaches in Newcastle have been assessed. The NSW Government's Floodplain Development Manual (2005) and overall approach to floodplain management is one of the most forward-thinking, as recognised during the recent Queensland Floods Commission of Inquiry.

Current approaches to flood management have evolved over the period that the Newcastle floodplains have been progressively developed. The current approaches aim to address the unique flood environment of Newcastle, although in many respects, the totality of the flood environment has not been historically appreciated (due to a lack of firsthand experience). Only in recent years have computer models been developed that uncover the full picture of flood risks across the LGA (right up to the extreme but very rare Probable Maximum Flood [PMF] event).

Considered gaps or deficiencies of the current approaches to flood management in terms of meeting the fundamental objectives and key management principles of the Floodplain Development Manual (2005) have been identified through an assessment process. The Manual emphasises a balanced strategic merits based approach be taken when applying its principles to the specific circumstances and variations of flood risks and potential consequences across the Newcastle LGA. The Manual is not prescriptive in the sense of setting minimum standards such as, for example, would be found in a book of traffic rules for drivers, or a prescriptive building code that might set minimum sizes for windows. Instead, giving consideration to a broad range of possible additional floodplain management options guided by the principles of the Floodplain Development Manual (2005), new and additional measures and actions have been identified in order to address the considered outstanding gaps and deficiencies in the current management approaches.

The new and additional measures have been ranked and prioritised according to the practicalities of implementation, within short and long term horizons. In accordance with the principles of the Floodplain Development Manual (2005), the flood management measures comprise a broad mix of approaches, including structural works, community education, improvements to emergency management, and future development controls.

The short term works and actions have been chosen to give maximum priority benefit while also being readily implementable within envisaged affordable budgets. Implementation is still, however, subject to this albeit limited funding - customarily allocated year by year.

The longer term initiatives are still needed - to address the assessed gaps and deficiencies of current management. The definition of these longer term initiatives is subject to future review before the short term works and actions are completed. Implementation of reviewed longer term flood management initiatives for the Newcastle LGA would be subject to available future funding. It is important that these longer term initiatives are not excluded from the Plan, since future communities and Governments will then have opportunity to decide what level of funding is appropriate for ongoing implementation – either accelerated or deferred. These decisions would be made balancing whole of community and Government priorities against practical resourcing, spread across other needs such as health, education, transport and social. Current legislation allows these necessary compromises and protects Governments when they make these decisions. In this regard, it is recognised that the management of flood risks does take place in the wider arena of a whole community, society and government. Many of these aspects are summarised in prior Council discussion papers reproduced in Appendix E.

So it is important to recognise that not all flood risks can be eliminated. The framework adopted for this City-wide Flood Plan therefore aims to ensure that the residual risks are manageable and acceptable to the community. On-going development controls that are more cognisant of the total flood risks than in the past means that overall flood risks across Newcastle will slowly reduce, as existing houses and buildings are progressively replaced and redeveloped. Residual risks therefore

are expected to reduce in the future over a timeframe of 100 years or so (the expected design life of most buildings and urban developments). Notwithstanding, this timeframe is too long to manage flood risks purely through development controls. Furthermore, the Floodplain Development Manual (2005) requires consideration and management of the full flood risk today (as discussed more in Chapter 2). The mix of measures proposed as part of this City-wide Flood Plan therefore incorporates a range of measures that can be implemented in the short to medium term, which will supplement on-going development controls, to provide an integrated suite of management actions.

A schematic overview of the framework that underpins the structure of this City-wide Flood Plan is given in Figure 1-2 overleaf.

1.5 Community and Stakeholder Consultation

1.5.1 Background to Consultation

The Floodplain Development Manual (2005) emphasises the need for inclusive community consultation during the development of a Floodplain Risk Management Plan. In compliance with the Floodplain Development Manual (2005), extensive community and external stakeholder consultation has taken place as part of the Newcastle City-wide Floodplain Risk Management Study and Plan process. Both community and agency consultation are considered key layers in the research underpinning this Plan. No single organisation, person or group of people has a sole responsibility for management of all flood risks. Rather, a coordinated, unified and partnered approach is necessary to successfully manage flood risks. The Plan should therefore be thought of as a "Partnership of Floodplain Management" consisting of affected and interested people, community groups and associations, Government agencies and Council working together to manage and live with flood risks.

The "Partnership of Floodplain Management" for the Newcastle City-wide Floodplain Risk Management Plan includes:

- Owners of land within the floodplain (public and private);
- Owners / operators of buildings, businesses and assets within the floodplain (public and private);
- The City of Newcastle (Floodplain risk management is, primarily, the responsibility of Councils. For example: Land use planning, flood data and hazard mapping, engagement of expert consultants to advise, convening Newcastle Floodplain Risk Management Committee);
- Hunter Water Corporation (HWC) (ownership and maintenance of the major stormwater channels and piped infrastructure);
- NSW Government, including the Office of Environment and Heritage (OEH) for Policy support (the Floodplain Development Manual (2005)), financial assistance, technical assistance; the Department of Planning and Infrastructure (DoPI) for regional strategies and plans, approvals of major development and (s117) planning directives to Councils; and Catchment Management Authorities (specifically the Hunter-Central Rivers Catchment Management Authority (HCRCMA));
- Commonwealth Government (financial natural disaster relief, flood forecasting and warning through the BoM, direct assistance for management measures where required. Also through the Commonwealth Office for Emergency Services to coordinate natural disaster mitigation funding);

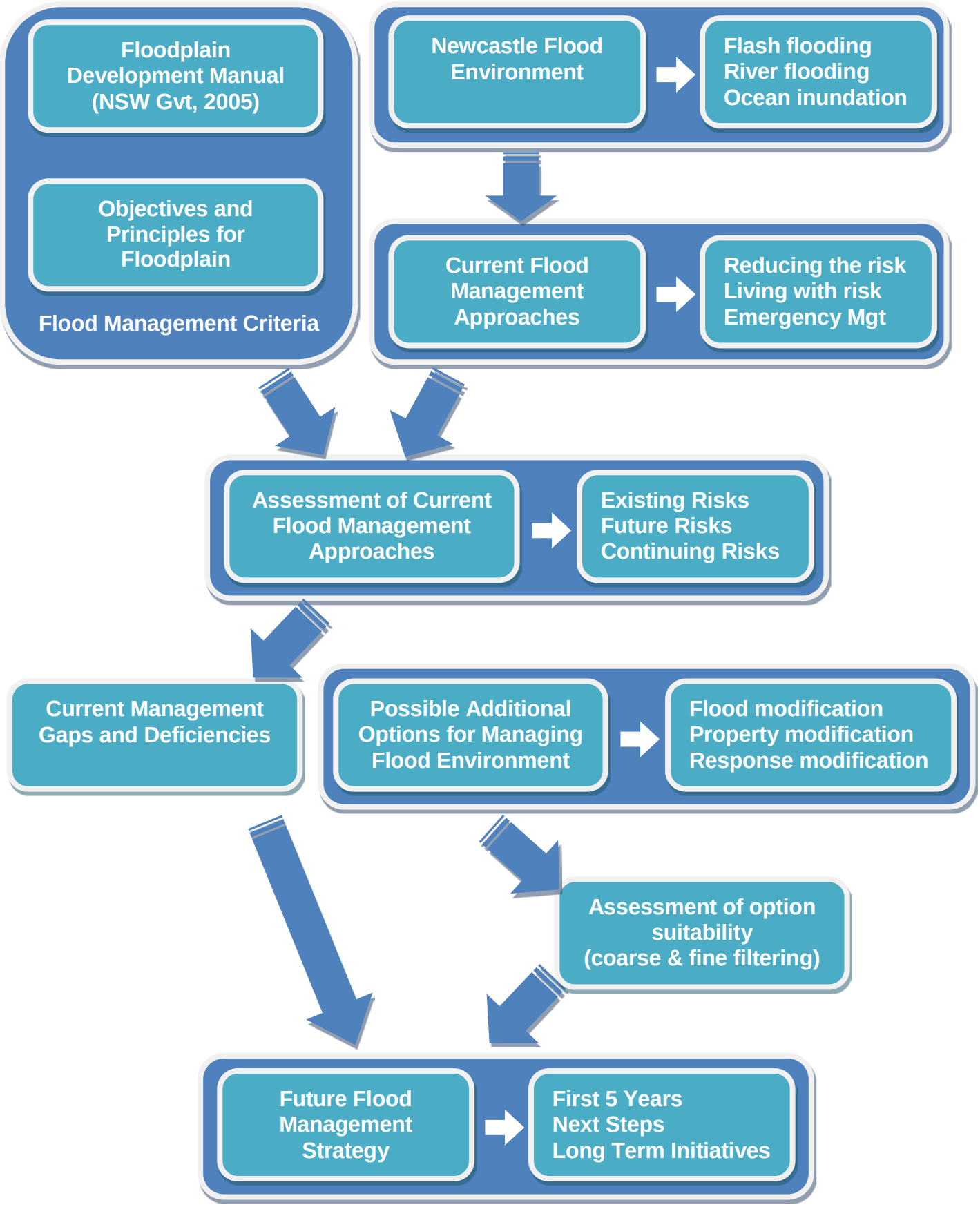


Figure 1-2 Conceptual Framework for Development of Floodplain Risk Management Plan

- NSW State Emergency Service (SES) (combat agency to lead the development and maintenance of local flood (emergency) plans for response to, and initial recovery from, floods, flood emergency response education);
- Local Emergency Management Committee (LEMC);
- Department of Family and Community Services (welfare relief in the aftermath of a flood);
- Department of Health (maintaining health during and after a flood);
- Developers; and
- Insurers.

Community involvement is essential to the effective management of flood risks across Newcastle and in all phases of the floodplain risk management process, particularly in the development, acceptance and implementation of such planning. Community involvement is relied on for effective management measures in aspects such as flood warning, flood awareness and flood response.

1.5.2 Community Engagement

Community engagement is seen as a fundamental component of effective flood risk management planning. Without community support and a sense of ownership, the best-made Plan will be destined for failure due to the lack of political will to implement it.

From the beginning of the development of this Floodplain Risk Management Study and Plan, the community has been engaged, through the:

- Review of correspondence to CofN over past 25 years, which provided flood mitigation advice and suggestions; and
- Consultation with CofN's Floodplain Risk Management Committee, which includes a number of community members.

The City-wide floodplain management process has also directly involved the local community as a key role in the development, research and identification of priority areas and development of recommendations in a floodplain risk management plan.

The community and key stakeholders have been comprehensively included through consultation in the development of this City-wide Flood Plan through:

- Continuing community and agency representation on the advisory working party convened by CofN as required by the NSW Government;
- Consultations for floodplain risk management of the Lower Hunter River floodplain held jointly with Port Stephens Council in the year 2000, with a drop in centre at Hexham Bowling Club for the Newcastle Local Government Area;
- Public meetings and consultation sessions with professional and business groups and organisations in 2003 leading to CofN's adopted Flood Policy in 2004;
- Public meetings / information sessions and extensive letter distributions to key property owners and businesses in the Wallsend catchment in 2006;

- Public meetings after the devastating floods of June 2007 in the Wallsend Commercial Centre area. These included a breakfast for businesses convened by the SES;
- Leading up to the development of a Floodplain Risk Management Plan for the high priority Wallsend Commercial Centre - a briefing to the Wallsend Town Centre Committee in 2009 followed by public meetings and opportunity for feedback;
- Publishing the preliminary Concept City-wide Floodplain Risk Management Planning report on CofN's web site in 2009 –which included broad-scale flood maps;
- A City-wide cluster of publicly advertised consultation forums aimed at finding what the community and key stakeholders wanted to express and convey about flooding in Newcastle – before progressing from the published City-wide concept flood planning to the development of a City-wide Floodplain Risk Management Plan. The Forums took place in April / May 2010. Forums were held in:
    - Hexham;
    - Wallsend;
    - Hamilton North; and
    - Dixon Park Surf Club.
- Over one hundred letters were written to key stakeholders – such as energy suppliers, relevant sections of CofN itself, government departments and business and community groups at the same time the Forums were convened - seeking their views and comments. Meetings were held with some key agencies;
- Second round of City-wide feedback and consultation was held in March 2011. The focus groups were advertised for the same locations as those held in 2010. Letters were also sent to the key stakeholders and critical infrastructure organisations (see Appendix A); and
- Feedback on the development of the Plan and the installation of flash flood detection equipment has been provided to the Local Emergency Management Committee (SES, Police, Fire Brigade, adjacent Councils and other emergency / disaster management agencies).

Community consultation involved two major rounds during April/May in 2010 and March in 2011. These rounds involved focus groups that were planned for each of the four wards. This gave a total of eight workshops for each round. The attendance numbers at these focus groups ranged from 7 to 25 people. The total number of attendees can be found in the Appendix A.

The workshop locations were chosen because they were spatially distributed to capture different portions of the city and in high priority areas by ward locations. The times for these group sessions varied from morning, afternoon and night-time sessions to enable convenient and varied session times to anticipate community member's schedules and time constraints.

The first round of focus groups involved introducing the community and people to the project and process. During these sessions the facilitator explained the outcomes of the initial concept planning and asked for community input into options to be investigated. The focus groups were facilitated and organised by the expert consultants in liaison with CofN.

The second round of focus groups provided the communities with the results of the estimation of option costs and benefits and asked for the communities views on preferred options. These sessions also gave the community the option to hear how CofN and the consultant had considered the community feedback from the first round of consultation in 2010.

These workshop sessions were promoted and made aware through:

- Advertisement in local newspapers such as The Star and Newcastle Herald (see Appendix A);
- Notifications in Newcastle Voice, CofN's community reference panel;
- Information and brochures in all of Newcastle's branch libraries, CofN's City Administration Centre as well as on CofN's website; and
- Letters sent out to previous attendees and people who have previously made comment (see Appendix A).

During this consultation process the community was given the opportunity to voice their opinions in a number of ways, including from the direct contact details of the CofN officer, by mail, email, at the focus groups or on an online comment form on CofN's website (see Appendix A).

During this process a working party was formed to oversee the development of the plan and study. This working party consisted of elected members of Council, Council staff, community, agency representatives and relevant industry bodies (e.g. OEH, NSW State Emergency Service [SES] as well as other government agency representatives) as well as environmental groups. A complete list of the Newcastle City-wide Floodplain Risk Management Working Party can be found in the Appendix A.

Outcomes from the consultation with both the community and stakeholders are documented in Appendix A.

Other relevant Floodplain Management Studies that have involved community input have also been considered in the City-wide Flood Planning process, including:

- *The Lower Hunter Valley Floodplain Management Study (2001);*

This study involved extensive community consultation from November 1996. Various submissions were received from the general public and representatives of relevant government agencies. During this process activities included; television coverage, press releases, poster-board displays (with community information brochure), advertisements, letter drops and public drop in centres that had questionnaires for attendees and the opportunity for informal discussions with engineers, consultations and CofN staff (held in various locations in the Newcastle area). Distribution of 25 copies of the study report was given to relevant Government agencies (such as HWC, RTA).

- *The Wallsend Floodplain Risk Management Study and Plan (2007).*

The Wallsend Flood Study and Plan similarly aimed to engage the community and affected parties with multiples means of notification and awareness. Elements of the engagement process included; highly visual flood mapping displays, prior notification to key stakeholders on exhibition and consultation, public notifications, Lord Mayoral article in local newspaper, media interviews, advertisements in newspapers, brochure on draft options, public information meetings, exhibition

information and response form in all Newcastle branch libraries, information on CofN's website, presentation to CofN's community forum and meetings with key stakeholders.

1.5.3 Experts Workshop

A panel of experts in floodplain management was assembled and used during this project. An interactive "Experts Workshop" was held on 30 October 2008 to draw on the significant pool of existing knowledge with respect to floodplain risk management in NSW. Participation in the Experts Workshop involved representatives from various Councils, DECC (now OEH), SES and consultants, all of whom are well experienced with floodplain risk management. A list of workshop participants is provided in Appendix A.

1.6 Climate Change Considerations

Climate change is now largely accepted by the scientific community. The Intergovernmental Panel on Climate Change (IPCC) reports evidence of increases in global average air and ocean temperatures, widespread melting of snow and ice and rising global average sea levels. Regardless of the cause, it very likely that these trends will continue well into the future.

The NSW Government has made a concerted effort to incorporate climate change into relevant planning. Despite efforts to reduce greenhouse gas emissions, some level of climate change is now inevitable. Adaptation (adjustment in natural or human systems in response to actual or expected climatic changes or their effects, which moderates harm or exploit beneficial opportunities) is a way of managing climate change. The *City of Newcastle Strategic Climate Change Policy* (NCC, 2010) reinforces the objectives of developing and implementing adaptation and mitigation actions as a response to climate change.

Sea level can have a significant impact upon the tidal range and flood levels in tidal waterways. The NSW Sea Level Rise Policy Statement (NSW Government 2009) was prepared to support consistent adaptation to projected sea level rise impacts. The policy statement includes sea level rise planning benchmarks for use in assessing potential impacts of sea level rise in coastal areas, including in flood risk and coastal hazard assessments. The benchmarks are a projected rise in sea level, relative to the 1990 mean sea level, of 0.4 metres by 2050 and 0.9 metres by 2100. These benchmarks may change in the future as new information comes to hand.

Coastal flooding in lowland areas will be of particular future concern as a consequence of sea level rise. This will include increased likely frequency, duration and height of flooding and consequent emergency evacuations and associated property and infrastructure damage. Areas where tidal water flows back up the stormwater drains in king tides under current climatic conditions (e.g. at Carrington, refer Figure 1-3) will be subjected to more frequent tidal inundations (DoP, 2010).

Regional climate change studies (e.g. HCREMMS, 2010) indicate that aside from sea level rise, there will also be an increase in the frequency of extreme rainfall events in the region in summer and autumn and an increase in the maximum intensity of extreme rainfall events. Rainfall projections indicate that average annual rainfall may increase in the region, especially during summer and winter. Such climatic changes are likely to change future flood risk.

The NSW Floodplain Development Manual (2005) requires consideration of climate change in the preparation of flood studies. Key elements of future climate change (sea level rise, rainfall frequency and intensity) have been incorporated into the various background studies facilitating the City-wide Flood Plan and considered in the risk management framework.

Figure 1-3 Inundation during king tide at Carrington, January 2010 (Courtesy: B. Coates)

2 OBJECTIVES AND PRINCIPLES OF FLOODPLAIN RISK MANAGEMENT (FLOOD MANAGEMENT CRITERIA)

2.1 Chapter Overview

As outlined already in Sections 1.1 and 1.4, the NSW Government's Floodplain Development Manual (2005) has been used as the guiding document for constructing this Floodplain Risk Management Plan. Compliance with the Manual will afford CofN indemnity under Section 733 of the *Local Government Act 1993* (LG Act).

This Chapter identifies and discusses what are considered the fundamental objectives and key principles for floodplain management, as derived from the Floodplain Development Manual (2005). "Objectives" in this context has been taken to mean goals and outcomes. These are typically high level and not detailed. (An example of an objective is reducing the impact of flooding and public and private losses.) On the other hand, "Principles" in this context has been taken to mean guiding "rules" to assist meeting the goals and outcomes. Principles will typically be more detailed than objectives. (An example of a principle is that the definition of Floodprone land is based on the PMF – and not the lesser flood event used to set Flood Planning Levels.) It is acknowledged that sometimes the distinction between an Objective and a Principle is somewhat artificial. However, it was felt best and most helpful to present the two separately in this Study.

Objectives from the Manual are set out in Section 2.4 of this chapter. Key principles from the Manual are set out in Section 2.5. It is possible that different experts might have differing opinions on what are the objectives and principles of the Manual, since it is a strategic document, and not prescriptive. For this reason, CofN has considered over a period of many years the application of the Floodplain Development Manual (2005) to the Newcastle LGA. This consideration has been assisted by CofN's engagement of many specialist floodplain risk management consultants under the NSW Government Flood Program and representatives from the NSW Government (which is acknowledged). In 2009 the Newcastle Floodplain Risk Management Committee (with community and NSW Government representation) endorsed a strategic document based on CofN's interpretation of the NSW Government Manual as the basis of preparing this Study and Plan, which is reflected in the Study brief approved by the NSW Government.

In recognition of the fundamental importance of the NSW Government's Flood Policy and Floodplain Development Manual (2005), the key objectives and principles as carefully derived and understood by CofN - that drive this Study and Plan - are explicitly drawn out and presented in this Chapter so as to be transparent.

As a starting point, these objectives and principles are used as the "Flood Management Criteria" against which existing flood management approaches are assessed. New flood management approaches are then developed in this Floodplain Risk Management Plan specifically to meet the objectives and principles of the Manual - where gaps are considered to have been identified; this will ensure a complete suite of recommended management measures.

2.2 Primary Objective

The primary objective is to reduce the impact of flooding and flood liability on individual owners and occupiers of flood prone property, and to reduce private and public losses resulting from floods, utilising ecologically positive methods where possible.

2.3 Supporting Objectives

To support the primary objective of reducing impacts of flooding, the following supporting objectives are also required.

2.3.1 Provide Strategic Management

The strategic management of the occupation and use of floodplains includes:

- Assessing cumulative impacts on a long term strategic basis (for example future development);
- Accounting for future growth in the numbers of occupants in the floodplain;
- Categorizing floodplains to understand where flood flow conveyance needs to be preserved, and where development may need to be restricted or reasonably prevented; and
- Ensuring the management plan is fully integrated with the local (SES led) flood (emergency response) plan, catchment management planning, CofN's corporate, business and strategic plans, existing and proposed Environmental (land use) Planning Instruments.

2.3.2 Be Specific

The Floodplain Risk Management Plan should be specific to the individual floodplain and specific locations within the floodplain due to variation in flood hazard, exposure and vulnerability.

2.3.3 Evaluate and Balance all Factors

Address all of the following three types of flood risk in a comprehensive manner and evaluate all factors (including social, economic, ecological and cultural) that affect the use of flood prone land:

- Flood risk associated with current development ("Existing Flood Risk");
- Flood risk associated with new development ("Future Flood Risk"). Ensure future development is controlled in a manner compatible with the flood risk and associated danger to personal safety. Future development also needs to satisfy the objectives of the *Environmental Planning & Assessment Act 1979* (EP&A Act); and
- Flood risk associated with both existing and future development from rarer overwhelming floods, which is principally a concern for personal safety ("Continuing Risk").

2.3.4 Establish a Cohesive Relationship between the SES and CofN

Establishment of a cohesive relationship between the SES and CofN is essential to ensure both planning and operational aspects of floodplain risk management and flood planning are adequately addressed. It is essential that CofN's adopted City-wide Floodplain Risk Management Plan be complementary to the SES led Local Flood (emergency management) Plan for the Newcastle LGA.

2.3.5 Be Flexible and Merit-based

CofNs should be flexible and merit based when dealing with development or redevelopment on flood prone land.

2.3.6 Not Unnecessarily Sterilise Land on the Floodplain

Floodprone land can be a valuable resource. Floodplain management recognises the value associated with the use and occupation of floodplains. Indeed communities may have been established and prospered because of the benefits of floodplain land (e.g. deep fertile soils, flat terrain, available water supplies and close access to water transport). The aim is to reduce risks associated with flooding to acceptable levels without being unnecessarily restrictive on existing and future land use activities by:

- Not being rigid and prescriptive for new development; and
- Maximising the positive opportunities of living on floodplains.

2.3.7 Manage Future Development

Flood risk to future development should be managed (by appropriate planning and development controls) so it is contained to an acceptable level based on social, economic, ecological *and flooding* considerations. Strategic planning for future development needs to be coordinated with relevant regional planning and associated controls.

2.3.8 Be Ecologically Sustainable

The principles of ecologically sustainable development (ESD) need to be explicitly taken into account. In particular, consideration should be given to ways to enhance riverine and floodplain ecology.

2.3.9 Be Socially and Culturally Sustainable

The Floodplain Risk Management Plan needs to contain actions and measures that are both socially and culturally sustainable.

2.3.10 Take Climate Change into Account

The potential implications of projected climate change on flooding behaviour and the implications of these changes needs to be taken into account through the mix of measures and actions proposed.

2.3.11 Provide a Balanced and Integrated Mix of Management Measures

Provide an integrated mix of management measures that address flood risks to development that already exists, risk to development that is projected to take place in the future, and flood risks posed by very low probability overwhelming flood events beyond the capacity of normal management measures.

Processes need to be followed that enable decisions to be made on balanced consideration of economic, social and environmental issues from a flood risk management perspective so as to achieve effective robust outcomes in an informed and consultative manner.

Actions arising out the Plan should be economic, and maximise positive while minimising negative impacts.

2.3.12 Obtain Best Value

Danger to personal safety, economic losses, social and ecological factors should be balanced and should provide best value for investment capital.

2.3.13 Provide Direction for Implementation

Recognising it is unlikely any management plan could be implemented immediately in its entirety, a detailed implementation strategy is required with staged components that are considerate of available funding. Priority works should be targeted, including the provision of interim measures if time is required to secure necessary funding, land etc. Implementation details should include potential funding mechanisms, responsibilities, constraints and monitoring.

2.3.14 Promote Community Awareness, Seek and Take Into Account Public Comment

The community should be alerted to the extent and degree of hazard of the flood prone land. Comments from the community regarding the Plan should be sought and taken into account. It is essential that the adopted Floodplain Risk Management Plan has the support of the local community.

2.3.15 Meet Legislative Requirements and Act in Good Faith

It is necessary to meet all flood management related legislation, policy and legal precedent that impact the application of the Floodplain Development Manual (2005), as well as to substantially act in accordance with the principles of the Manual, such that the indemnity provided under S733 of the LG Act is afforded.

2.3.16 Continuous Improvement

A management plan represents ‘best’ appraisal of existing and future circumstances at the time it is ‘adopted’. Management Plans should be reviewed regularly to ensure that their provisions remain appropriate.

2.4 Some Fundamental Considerations for Floodplain Risk Management

The Floodplain Development Manual (2005) points out “It is important to recognise that management plans do not purport to eliminate all risk but to ensure that it is effectively managed”. Consistent with this, it must be recognised that complete removal of flooding and / or flood risks is impossible in the practical context of the Newcastle LGA. Significant historical development and a continuing economic impetus means that future development (largely associated with existing and redevelopment) will remain on floodplain areas. Therefore, a level of flood risk will need to be accepted.

It is crucial to appreciate that flood risks cannot be eliminated entirely. There will always be a level of risk that needs to be accepted by the community. Indeed flooding risks have been inherently

accepted by Novocastrians ever since development commenced on the vast Newcastle floodplains more than 150 years ago.

It is also crucial to appreciate that floods need to be managed across the full spectrum of floods, right up to the extreme PMF conditions. This is a requirement of CofN's existing Flood Policy and is mandated within the NSW Government's Floodplain Development Manual (2005).

The fundamental considerations for Floodplain Risk Management are:

- Manage Risk to Life; and
- Manage Risk to Property (Public and Private).

In addition to the above, and in particular recognition of the flooding environment that threatens Newcastle, it is considered that this City-wide Flood Plan should also give special attention to the heightened risks on roads versus the risks to people taking refuge in buildings.

2.4.1 Risk to Life

Loss of life is considered to be the worst possible consequence in the management of any hazard. Therefore the consideration and management of hazards that may result in loss of life become the highest priority for a community and society overall. In the Newcastle LGA, managing the potential risks to life for flooding is particularly difficult because the vast majority of flood affected properties are affected from flash flooding. In a flash flood scenario the absence of effective warning time means that it is not always possible to remove people from areas under threat by formal evacuation plans. There is simply no time to execute such plans, and people can become trapped in life threatening situations with no escape.

The principal focus of floodplain management should be to prevent loss of life during flooding. Whilst it is not possible to anticipate an individual's (often irrational) behaviour during a flood, it is possible to minimise their exposure to risks associated with the potential for loss of life. Managing risks to life across the full spectrum of floods (i.e. up to PMF) is advocated within CofN's existing Flood Policy (refer Section 4.3.2.1 for details) and the Floodplain Development Manual (2005).

With respect to Managing Risks to Life, there are really only two options:

- Evacuate to high ground. This should be the first choice, but should only be executed if 1) it is safe to do so, 2) there is sufficient warning, 3) if people know what to do during an evacuation and know where to go, and 4) if people are physically able to be relocated with limited time (an issue for elderly, mobility-restricted and infirm population). Clearly this is dependent on people's personal preparedness, knowledge/education and awareness of flooding. For river and ocean derived flooding, there should be sufficient warning to enable a complete evacuation of all people potentially at risk, facilitated through Combat Agencies and Emergency Services. For Flash flooding, however, evacuation will be more problematic, as there may be little if any warning time, and little if any assistance and direction provided by others. People will need to have the skills to self-evacuate during a flash flood be it by foot, vehicle, or other means; and
- If evacuation is not safe, then the only other alternative is shelter-in-place, and get as high as possible (preferably to an upper storey, roof space, or even standing on tables or benches if floodwaters are continuing to rise).

For both of these options, flood education, combined with maximum flood warnings and emergency response, are critical to the success of the evacuations and/or sheltering within refuges.

2.4.2 Risk to Property

The risk to property is a relatively tangible risk that can be measured and assessed in terms of costs and benefits for various risk reduction options.

2.4.3 Risk on Roads versus Shelter-in-Place

It is important to recognise that the Floodplain Development Manual (2005) has been developed and written (incrementally over about 20 years) primarily with large rural riverine flooding in mind. Therefore, there is some disconnect between the underlying rationale of the Manual and the overland flash flooding experienced in urban Newcastle. Of particular issue is the premise in the Floodplain Development Manual (2005) that evacuation can generally be afforded in order to manage risks to life. Within Newcastle, however, the sheer quantum of population that would need to be evacuated, even for a 1% AEP flood event, would not be possible within the very limited warning time available. Indeed failed attempts to evacuate in Newcastle may actually increase risks to life substantially as many of the City's roadways become floodways, seriously endangering anyone within their vicinity. This was highlighted clearly during the June 2007 flash flood event when some 5000 cars were affected by floodwaters – most left stranded as occupants braved the elements to seek refuge elsewhere.

Australian and international literature on flood related deaths indicate that the biggest threat to life and limb during floods is people in transit (Coates, 1999; Fitzgerald *et al*., 2010; Jonkman & Vrijling, 2008; Jonkman & Kelman, 2005). Alarmingly, the majority of deaths during floods could have been avoided if the victims had not placed their own lives (and others) at risk, through either attempting to drive, wade or otherwise travel, through swift-flowing or rapidly-increasing floodwaters.

Flash floods are considered the most dangerous due to the unpredictable and sudden onset of dangerous conditions. Globally, flash floods have an incredibly high mortality rate of >0.001, on average (Jonkman & Vrijling, 2008). That is, there is more than 1 fatality per 1,000 people exposed to each flood event. Clearly there are differences from flood to flood and from community to community, however, translating this figure to Newcastle for the June 2007 event, which was exposed to say 10,000 people (counting the properties and vehicles most affected), the death toll could have been expected to exceed 10. Instead, just one person lost their life in the Newcastle LGA, although the dozens of reported "close calls" suggest that a much higher number could easily have been the result. It is expected that more extreme flash floods would have an even higher mortality rate given that bigger floods tend to have more widespread impacts throughout communities and they occur much quicker and are more unexpected. Jonkman & Vrijling (2008) report many flash flood events wherein mortality rates are 0.01 or higher.

For an extreme PMF event, which may directly impact up to 80,000 people in Newcastle, the death toll could conceivably be up to 800 or more, making it the worst flooding disaster in recorded Australian history. In a PMF event, the floodwaters would rise so fast that roads would quickly become channels, conveying torrents of water at depths that would sweep cars and occupants away. Drivers and passengers would literally have to make split second decisions to abandon vehicles and

flee to safe refuges before vehicles would become 'death traps'. Cars can become buoyant when flooded by as little as 10 – 20cm, especially under fast flowing waters (Jonkman & Vrijling, 2008).

In Newcastle, it is considered that many people would tragically perish on roads during a PMF flood well before the first buildings collapse under the weight of floodwaters.

As made evident during the June 2007 event, people will under-estimate the risks associated with driving and wading through floodwaters. Irrational behaviour and poor judgment put many lives in danger, unnecessarily. This characteristic behaviour is supported by literature on flood fatalities in Australia (Fitzgerald *et al*., 2008), which indicated that almost half of the 73 flood deaths between 1997 and 2008 were vehicle related, while a further 16% were attempting to wade or swim across a waterway. Disappointingly, some 27% died as a result of purely inappropriate and highly-risky behaviour, such as swimming or surfing in floodwaters. Young males (10 – 29) are over-represented in these statistics reflecting their greater predisposition for risk-taking (Fitzgerald *et al*., 2008). International statistics for western countries are very similar to Australia, particularly in the US, where there is a relatively "short history" and poor cultural appreciation for flooding, compared to European countries that have slightly better statistics (especially in terms of vehicle-related flood deaths) (Jonkman & Kelman, 2005).

The fundamental consideration here is that it is often people's personal response to a flooding situation that will greatly determine their fate. As such, the most effective way of minimizing risks to life is to change people's behaviour during a flood event. Flood education, combined with improved flood warnings and emergency response therefore are the most critical elements of the Floodplain Risk Management Plan. Secondary to this is the ability to modify flood behaviour and/or removing/modifying dwellings and structures in high risk areas of the floodplain.

2.5 Key Principles for Floodplain Management

The key principles of Floodplain Risk Management for the preparation of a City-wide Floodplain Risk Management Study and Plan for the Newcastle LGA are derived and adapted from the Floodplain Development Manual (2005), as described below.

2.5.1 Councils are primarily responsible for managing floodprone land

The management of flood prone land is primarily the responsibility of Councils.

2.5.2 Take a Merit Based Approach to Development Considerations

A merit approach shall be adopted for all development decisions in the flood plain to take into account social economic and ecological factors, as well as flooding considerations.

Both mainstream and overland (flash) flooding shall be addressed using the merit approach in the preparation and implementation by Councils of strategically generated flood plain risk management plans. relating to development considerations.

Similarly, a merit approach shall be taken to the management of ocean flooding for all development decisions (excluding tsunami which is beyond the scope of floodplain risk management as limited by the NSW Government Floodplain Development Manual (2005)).

2.5.3 Floodprone Land is Based on the PMF

The definition of the floodplain and floodprone land is based on the PMF event – and not on the more limited flood planning area.

2.5.4 Accommodate the Full Range of Flood Risks

Consider and manage the full flood risk to the largest conceivable floods (the PMF), and manage all flood types:

- Ocean flooding (but not tsunami);
- River flooding; and
- Flash flooding from the overflow of (or inability of water to enter) major drains.

Ensure the safety of people and critical infrastructure (where appropriate) is effectively managed for extreme floods up to and including the PMF. This is to include residents, visitors and emergency personnel. Cases where water enters buildings or overtops levees built at Flood Planning Level (FPL), which results in need for removal of people from the flood risks. It also includes where hazards may be benign at the FPL, but become significant at larger events. Effectively manage constraints or impediments to removing people from the flood risks.

Effectively manage flood risks and consequences where there are large differences between the FPL and PMF. For floods lesser than the PMF, up to the FPL, address and manage risk to property as well as personal safety.

Recognise and manage the potential implications of climate change on flood behaviour / impacts.

Apply risk management techniques and principles to full range of flood behaviours.

2.5.5 Risk to Life Needs to be Managed from the Present Onwards - for All Possible Floods

A principle of The Manual is that there is a “need to ensure that risk to life is managed for the full range of floods”. Future development needs to have personal safety addressed for the full range of flood events.

“The PMF (or extreme event) provides an upper limit of flooding and associated consequences … It is used for emergency response planning purposed to address the safety of people.

A larger flood than the one used to determine the FPL can always occur. It is not a matter of if but when. The difference in flood levels, damages, and the area of inundation and the number of dwellings to be evacuated in the PMF.

It is critical that relevant information on evacuation is provided on events up to the PMF – including any special evacuation problems.

As the PMF is unlikely to be adopted for protecting development from flooding, a continuing risk of flooding remains. This is principally a concern for personal safety which generally needs to be managed through emergency response and community education. Analysing the PMF provides an upper bound of flood behaviour and consequences for emergency response planning. It can identify critical factors, such as key levels for loss of evacuation routes and inundation of entire areas, so that appropriate emergency response and recovery planning and community education programs can be developed.

Response planning for the consequences of the PMF provides for effective management of smaller events, particularly those rarer than the flood event selected as the basis for the FPL.

There is a need to develop additional management measures such as response modification measures to mitigate the danger to personal safety associated with overwhelming flood events".

In some areas (where floods rise and fall in hours) complete isolation during a flood may be acceptable. It needs to be remembered however, that this only applies to smaller floods, as larger floods invariably involve evacuation.

It is critical that relevant information on evacuation is provided on events up to the PMF, where necessary.

2.5.6 Give Consideration to Cumulative Impacts of Development – Developments Cannot be Considered in Isolation

Case-by-case decision making cannot account for the cumulative impacts on flood behaviour and risks, caused by individual developments or works. This form of ad hoc assessment contravenes the principles of the Floodplain Development Manual (2005).

Cumulative impacts should be accounted for through a range of management measures (e.g. works and planning controls), viz:

- Future development scenarios;
- Future growth in numbers of people on the floodplains;
- Ensure future density increases do not increase future flood damage and personal danger exposures;
- Incorporate the management of cumulative impacts into Environmental Planning Instruments (EPI's); and
- Strategically assess future development flood impacts if fully implemented to FPL (fill, buildings, fences).

2.5.7 There are Areas where Development would Reasonably be Excluded

There are certain areas where development would reasonably be excluded. These include:

- Areas where development would have significant adverse impacts on flood behaviour;
- Areas where flood hazard is too high – and cannot be reduced to acceptable levels, with emergency management being an important consideration; and

- Areas of important flood dependent ecosystems.

2.5.8 Exclude Complying Development

A recommended principle is that Councils should exclude complying development from areas that require flood related development controls (and develop suitable standards for complying development to ensure minimal flood damage to property).

2.5.9 Existing Development Cannot Always be Abandoned

Even if existing development does have a high potential for flood damage (as distinct from high risk to life), the scale of existing development is frequently such that it cannot reasonably be abandoned.

2.5.10 It can be Appropriate to Cease Occupation

In certain high hazard areas of the floodplain it may be impractical or uneconomic to mitigate flooding existing properties at risk. In such circumstances it may be appropriate to cease occupation of such properties in order to free both residents and potential rescuers from the danger and cost of future floods. This is achieved by the (voluntary) purchase of the properties and their removal or demolition. Such areas should be rezoned to a flood compatible landuse.

2.5.11 Incorporate Community and Stakeholder Input in Decision-Making

Effective community consultation is vital to gaining community acceptance. The local community, both flood prone and otherwise, has a key role to play in the development, implementation and success of a flood management plan.

Some communities may decide to accept a greater flood risk, because there are significant benefits from occupying the floodplain. Other communities may see little advantage in remaining at risk to flooding and accept the cost and benefits of management measures including mitigation works.

2.5.12 Consider Climate Change / Future Climate Environment

Floodplain management also needs to consider a change to flood risks in the future associated with projected climate change, including sea level rise.

2.5.13 Consider Societal Wellbeing and Socio-Economic Values of Floodplains

The risk to wellbeing can apply at both an individual and at a community level, and can reflect a general lack of confidence within the community associated with simply living in their particular neighbourhood (e.g. personal trauma during and after a flood, opportunities lost, and even increased 'fear').

2.5.14 Maintain Environmental Sustainability Through Floodplain Management

Floods are a natural part of the environment, indeed flooding provides many environmental benefits. Floods play an important role in maintaining key ecosystem functions and biodiversity by increasing

habitat complexity (such as deepening pools, providing woody debris), recharging groundwater and surface water storages, providing resources such as nutrients and food, allowing the movement of plant and animal populations and stimulates or enhances recruitment. In agricultural areas, sediment helps to replenish soil and improves fertility.

Flooding nonetheless has the potential to create many short and long term detrimental environmental impacts. Excess nutrients and sediment can impact on water quality, certain habitats may be lost or degraded (for example if ocean flooding occurs, previously freshwater habitats may become saline), the timing of the flood event may disadvantage certain species and weeds and other pest species maybe dispersed.

Within urbanised catchments, other impacts can arise as a result of the disturbance and dispersal of pollutants such as chemicals, oils, heavy metals and debris. Sewerage infrastructure may be compromised and untreated sewage released into waterways with associated pathogens. Environmental infrastructure such as equipment, fencing and establishing revegetation sites may also be damaged or lost.

Certain environmental assets in the region, such as some endangered ecological communities and threatened species populations, may be at peril from large flood events. Overall, however, the environment impacts from flooding events tend to be short lived and the environmental benefits that flooding brings usually exceed impacts.

2.5.15 A Range of Measures are Required

There should not be an unthinking acceptance of the limited level of protection provided by, say, flood or property modification measures, but there is a need to develop additional management measures such as response modification measures to mitigate the danger to personal safety associated with overwhelming flood events. Therefore a range of management measures are necessary to manage the full range of flood risk.

A fundamental principle of good floodplain risk management is that risk management measures should not be considered either individually or in isolation. They must be considered from within an all embracing framework that allows their interactions, their suitability and effectiveness and their social, environmental and economic impacts to be assessed on a community-wide basis.

2.5.16 Promote Flood Education

Councils, in conjunction with the SES, should promote community flood readiness by supplying flood data and advice. Councils should focus on issues relating to land use, supplying data and advice to property owners, residents, visitors, potential purchasers and investors, whereas the SES focuses on the issues of public safety and property protection when flooding occurs.

2.5.17 Principles for Staged Implementation

An implementation program is to be included in the Floodplain Risk Management Plan. This is to be ranked and based on how soon the management measures can be implemented, what constraints exist, and how effective the measures are. Measures that cost little and can be readily implemented and which are effective in reducing damage or personal danger should have a high ranking.

On-going development controls that are more cognisant of the total flood risks than in the past means that overall flood risks across Newcastle will slowly reduce, as existing houses and buildings are progressively replaced and redeveloped. Residual risks therefore are expected to reduce in the future over a timeframe of 100 years or so (the expected design life of most buildings and urban developments).

Notwithstanding, this timeframe is too long to manage flood risks purely through development controls. Furthermore, the Floodplain Development Manual (2005) requires consideration and management of the full flood risk today. The mix of measures proposed as part of this Flood Plan therefore incorporates a range of measures that can be implemented in the short to medium term, which will supplement the on-going development controls to provide an integrated suite of management actions.

3 NEWCASTLE FLOOD PHYSICAL ENVIRONMENT

3.1 Chapter Overview

The flood environment of Newcastle is relatively unique in that it can be the result of a number of very different mechanisms, including:

- Flash flooding from the local catchment rainfall(e.g. June 07);
- River flooding from the adjacent Hunter River (e.g. 1955); and
- Ocean inundation (e.g. as a result of high ocean tides plus storm surge etc plus potential future sea level rise).

These flooding mechanisms and the resulting flood environments are described in detail within this Chapter.

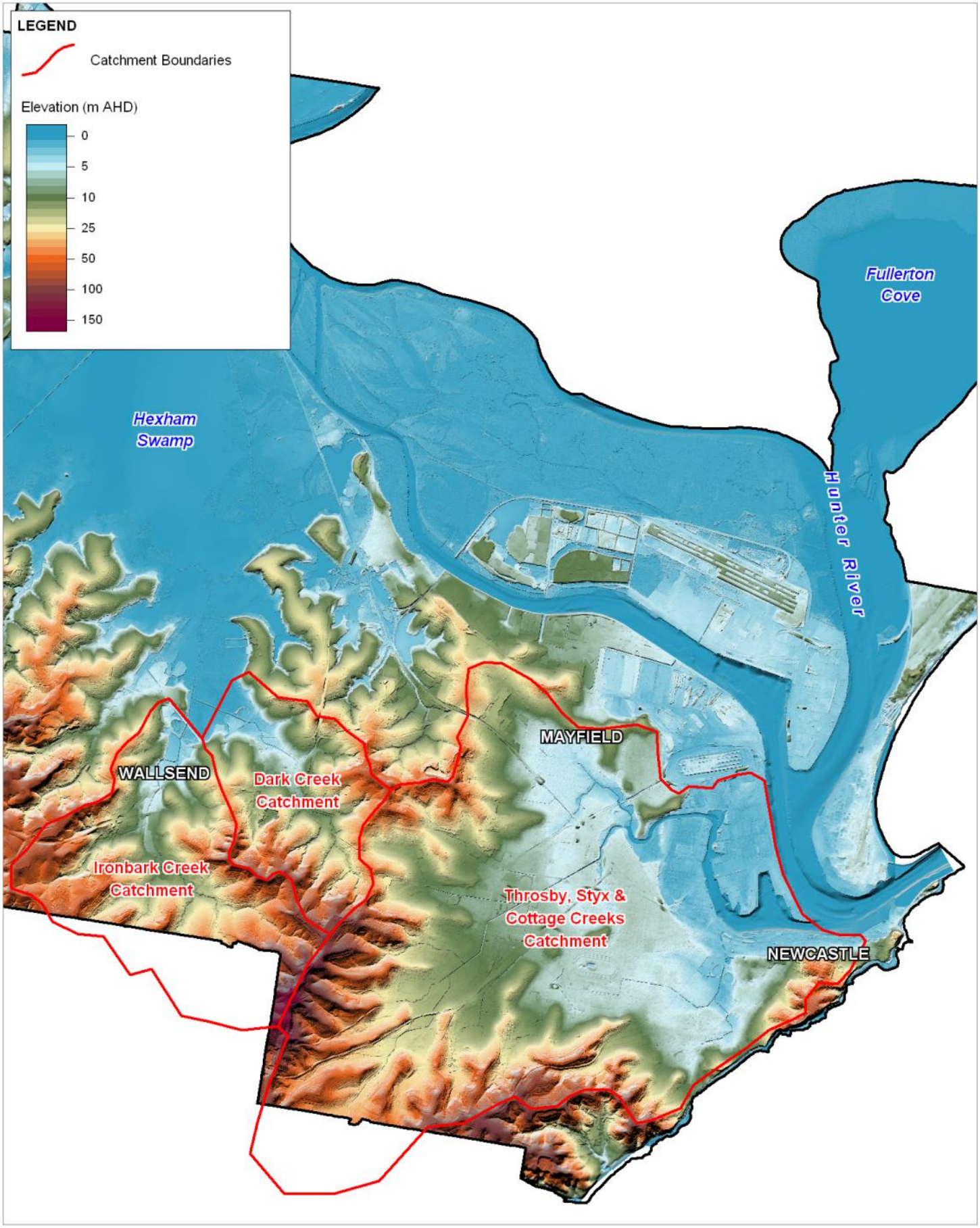
3.2 Geomorphic Setting for Flooding in Newcastle

The City of Newcastle is essentially located on an alluvial floodplain (of the Hunter River), flanked by steeply incised and highly weathered bedrock ridges. Historically, development within Newcastle expanded out from the Port area, being the main focus of early commerce. As such, low-lying and swampy ground surrounding the Port area was artificially drained and developed for urban and semi-urban enterprises (industry, residential, commerce, market garden).

For the eastern half of the city, there are few natural drainage lines remaining (replaced by an extensive network of stormwater pipes and open channels). In most cases, the capacity of the open channel drainage system is restricted to small to medium sized floods only. Larger floods, such as that which occurred in June 2007, quickly exceed the capacity of the system, and are redirected along natural overland flowpaths that now comprise streets and some private properties.

For the western half of the city, runoff from the ridges runs down Ironbark Creek, Dark Creek, Maryland Creek, Wentworth Creek, Minmi Creek and other smaller tributaries before all joining in Hexham Swamp. Hexham Swamp acts as a large storage basin for local runoff before discharging to the south arm of the Hunter River. Development has encroached into some areas of the upper and lower floodplain, most notably at Wallsend and Jesmond, where the establishment of the town centres has now formed ‘pinch points’ for floods in Ironbark Creek and Dark Creek. Given these significant flood impediments, the most acute areas for flood risks in Newcastle are thus located in these western catchments.

The extent of the Hunter River floodplain, along with the local catchments covering the Newcastle LGA, is highlighted in the land relief map presented as Figure 3-1.



Title:

Topography and Catchments Across the Newcastle LGA

Figure: 3-1

Rev: A

N

0 1.25 2.5km

Approx. Scale

BMT WBM

www.bmtwbm.com.au

Filepath : K:\N2246_Newcastle_FRMS_Stage2\Mapinfo\workspaces\DRG_002_111221_Topography.WOR

3.3 Flash Flooding

3.3.1 Flash Flood Environment

Flash flooding in Newcastle occurs quickly following intense rainfall. The small and steep catchments ensure that runoff is propelled onto the floodplain with relatively little warning, and generally at high velocity. The main catchments within the Newcastle LGA that are affected by flash flooding include (refer Figure 3-1):

- Ironbark Creek;
- Dark Creek; and
- Throsby/Styx and Cottage Creeks (including the Newcastle CBD area).

The catchments of Throsby Creek (including Styx Channel) and Cottage Creek (as well as the CBD area) have generally been considered together, as during large events there is cross-connection between the catchments across the low-lying floodplain areas. This was evident during the June 2007 event in the vicinity of Broadmeadow Racecourse (with some of the worst flooding occurring along the supposed catchment boundary).

3.3.2 Historical Flash Flooding Experiences

3.3.2.1 June 2007: City-wide

The most recent and significant flash flooding event to affect Newcastle occurred on Friday 8th June 2007. The East Coast Low storm system that ravaged the Hunter, Central Coast and Sydney region caused widespread damage (c. $1.4b) and claimed nine lives in total (one in the Newcastle LGA). It is estimated that some 5,000 cars were written off and approximately 10,000 properties were inundated within the Newcastle LGA alone.

Rainfall for the 24 hour period exceeded 300mm at a number of stations in the local area. The highest intensity rainfall occurred from 3:00pm to 8:00pm, and was concentrated in the southern Newcastle/northern Lake Macquarie area. Croudace Bay, on the edge of Lake Macquarie to the south of Newcastle, recorded 155mm between 4pm and 6pm. For a six hour storm duration, seven gauges across the Newcastle / Lake Macquarie region recorded rainfall that exceeded the 1% AEP (of 149mm) provided by ARR (1987), in some cased by up to 63%. Nobby's Head rain gauge experienced rainfall 10% higher than the 1% AEP event.

Flooding was also highly variable across the Newcastle area, and as expected, areas most affected by flooding corresponded with areas of highest recorded rainfall. Comparison of actual flood information with probabilistic flood models suggests that in some areas, such as Throsby/Styx and Cottage Creeks, the resulting flood had an indicative recurrence probability of 1% (i.e. 1 in 100 annual chance) (with some areas possibly even more severe), while for Ironbark Creek at Wallsend, the flooding was about 1 in 40 annual chance. Despite this, actual flood levels recorded in Wallsend correspond more to a 1 in 500 annual chance flood, which is likely explained by blockages that occurred within the stormwater channel and culverts (e.g. cars, wheelie bins, general debris etc) (see Figure 3-2). Blockage was a big issue in many areas, including the lower reaches of Cottage Creek at Newcastle West, where two shipping containers were swept into the channel and blocked two separate culverts within the main drainage channel.

Figure 3-2 Car in channel at Federal Park, Wallsend (possibly causing blockage)

Figure 3-3 Underground carpark at Junction Square, The Junction

Given the steep nature of the upper catchment areas, flooding within most Newcastle suburbs lasted less than one hour. Flood depths and velocities across overland flowpaths were high, and caused considerable traffic chaos as the event coincided with a Friday afternoon peak hour. Thousands of cars were left abandoned as many of the roads quickly turned into floodways and pseudo flood channels.

The peak rainfall in the late afternoon of 8th June coincided with low tide in the harbour, during a neap stage (ie small tides) of the tidal cycle. Had the flood occurred one week either side (i.e. during spring tides), flooding in the lower-lying harbourside suburbs would likely have been significantly worse.

Transportation, telecommunications, electricity, and gas services all suffered significant disruption during and following the storm. At the height of the event, more than 200,000 homes were without power (across the Hunter, Sydney and Wollongong regions). More than 18,500 calls for help were made to the SES, with more than 2,500 requesting assistance from flooding.

The damage bill and personal injury / loss of life would have been significantly higher had the event been only slightly larger, as many thousands of properties reported floodwaters 'almost' reaching house floor levels, and there were many reports of "close calls".

The floods of 8th June 2007 were devastating to many in the community. Some in the community took more than a year to move back into their flood affected homes. Many in the community were left bewildered, belligerent and hurting, fearful every time it rains that the same degree of flooding would all happen again. The elderly were especially affected by the event. "Reminder" storms on 9 December 2007 and again on 28 February 2008 (both involving 30mm of rainfall within a 30 minute period) prompted a wave of correspondence to CofN, with Notices of Motion and enquiries from Councillors, and letters from Members of Parliament.

3.3.2.2 1990: Wallsend to Merewether

This was a widespread monsoonal-like event that covered large areas of Australia lasting several days. In some areas of Newcastle a total of nearly half the average rainfall fell during this extended event.

The suburbs with the most rainfall and flooding included Wallsend, Jesmond, Kotara, Lambton, New Lambton and, to a lesser degree, Merewether. Around 300 mm of rain fell in a 48 hour period on the 2nd and 3rd February 1990, and included several very intense rainfall bursts. The records show that the rainfall across the catchments was relatively uniform varying from around 316 mm in the west to 250 mm in the east.

The first and largest peak, which caused the worst overland flooding, occurred around 3pm on the 2nd February, 1990. There was no loss of life, but there was extensive damage to property.

Figure 3-4 Bridges Road near St James Road intersection, New Lambton

3.3.2.3 1988: Jesmond

There were reports of people getting sunburnt playing golf at Beresfield Golf Course, while fridges were being washed down the road in Rankin Park. Severe flash flooding in the suburbs was caused by a highly variable pattern of thunderstorm activity during the day and night of 27th and 28th April 1988. There were two peaks - one in the day and one in the night.

In the Newcastle LGA, affected suburbs included Wallsend, Jesmond, Birmingham Gardens, New Lambton, Lambton, Mayfield, and Adamstown.

Unlike the February 1990 flood, the April 1988 flood rainfall was extremely varied. For the 48 hour period from 9am, 27th April, 141 mm of rain fell at Rankin Park Hospital, 101 mm to the south at Kotara Bowling Club, 44 mm in Waratah, 22 mm in Merewether and just 8 mm at Nobbys Head. At Rankin Park Hospital, 75 mm (3 inches) of rain fell in just one hour from 9:30pm to 10:30pm on the 27th causing flash flooding in nearby creeks.

The thunderstorm activity varied widely in time, and 'pulsed' as it travelled across the catchments. Even though some areas like Jesmond did not receive large volumes of rainfall (about 60mm in total) the very short time and rainfall patterns within the upper catchment areas produced unprecedented flash flooding. Eyewitness accounts indicate the flood came down Bluegum Road like a tidal bore.

Figure 3-5 Outside Stocklands Centre, Bluegum Road, Jesmond

Figure 3-6 Fraser Street, Jesmond (channel to left in image)

3.3.2.4 Earlier Events

There are many early newspaper records of floods in Newcastle. Reports like "the roofs of houses stood out like islands in the sea" from the floods of 1908 - on the land where Marketown Shopping Centre is now built. These accounts are evidence of the legacy that much of Newcastle has been built on natural floodplains.

Figure 3-7 Tudor Street Extended, west of Samdon Street, 1927

Figure 3-8 166 Morgan Street, Merewether 1984 (property now acquired and demolished by CofN)

Figure 3-9 Premier Hotel, Nine-Ways, Broadmeadow, 1892

3.3.3 Frequent Flash Flood Events (10% AEP)

Numerical hydrodynamic computer models of flooding within the flash flood catchments have been developed on behalf of CofN and the NSW Government. The results from these computer models have been interrogated and incorporated into the development of this City-wide flood management Plan.

The 10% Annual Exceedence Probability (AEP) design conditions have been used to represent 'frequent' flash flooding across Newcastle. The 10% AEP approximately accords with a 1 in 10 chance of occurring in any year (referred sometimes as a 1 in 10 year flood).

Maps 1A and 1B (refer ***Map Series 1*** in accompanying ***Compendium of Maps*** document) show the extent of floodplain inundation for these frequent flood conditions. As can be seen in these maps, there is relatively limited overbank inundation, contained mostly to a handful of pockets within the Throsby/Styx and Cottage Creek floodplains, as well as areas close to the more incised floodplains of Dark Creek and Ironbark Creek. Flood levels are generally less than 0.3 – 0.5 metres.

3.3.4 Infrequent Flash Flood Events (1% AEP)

The 1% Annual Exceedence Probability (AEP) design conditions have been used to represent 'infrequent' flash flooding across Newcastle. The 1% AEP approximately accords with a 1 in 100 chance of occurring in any year (referred sometimes as a 1 in 100 year flood).

Maps 2A and 2B (refer ***Map Series 2*** in accompanying ***Compendium of Maps*** document) show the extent of floodplain inundation for these infrequent flood conditions.

The 1% AEP design conditions are similar to those conditions experienced during the 2007 flood event for some areas of Newcastle, particularly in the Throsby and Cottage Creek catchments. Apart from a few isolated areas where flood depths exceed 1 metre, the typical inundation depths across the Throsby/Styx and Cottage floodplains is generally less than 0.5 metres. This relatively small overland depth would resulted in limited above floor flooding. During the 2007 flood, levels reached just below floor levels for many hundreds (if not thousands) of properties. Indeed it was noted often that properties were not flooded above floor level until a four wheel drive vehicle drove through the floodwaters past the property creating a bow wave, which subsequently pushed floodwaters into the building.

Flood depths within the main flowpaths are Dark Creek and Ironbark Creek are also high for the 1% AEP event.

3.3.5 Extreme Flash Flood Events (PMF)

The PMF design conditions have been used to represent 'extreme' flash flooding across Newcastle.

Maps 3A and 3B (refer ***Map Series 3*** in accompanying ***Compendium of Maps*** document) show the extent of floodplain inundation for these extreme flood conditions.

The probability of an extreme flood occurring is very low, however, if it does occur, it could potentially have devastating effects, with significant loss of life and major damage to property and infrastructure.

Flood depths for the PMF are very high for all flooding mechanisms (flash, river and ocean). Extensive areas across the Throsby and Cottage floodplains would have depths exceeding 1.5 metres, while in Dark Creek and Ironbark Creek, virtually the whole floodplain to the edges of the flooding extents has depths of more than 1.5 metres.

3.4 River Flooding

3.4.1 River Flood Environment

Newcastle is located immediately adjacent to the Hunter River. As such, flooding of the Hunter River can result in inundation of some areas of Newcastle. The Hunter River has a total catchment area of some 22,000km^2, with many separate sub-catchments including the Williams River, Paterson River, Wollombi Brook, Glennies Creek and the Goulburn River.

Whilst several major storages exist in the catchment (such as Glenbawn, St Clair, Lostock and Chichester), these storages are primarily operated for water supply, irrigation and energy generation. They cannot be relied upon to control or mitigate Hunter River flooding within the Newcastle LGA.

Being at the very downstream end of this vast river system, Newcastle is generally afforded a significant warning time of any floods that are moving down the catchment. Further, unless multiple catchments are in flood at the same time, flood levels at Newcastle are generally significantly attenuated compared with more upstream locations.

The Port of Newcastle is very wide and artificially deep (due to dredging for large ship navigation), and as such, riverine flooding has minimal effect on areas surrounding the Port. Upstream of the Port, however, flood levels can be elevated, potentially inundating extensive overbank floodplains and wetlands. Developed areas around Hexham are at most risk, as flood levels in this vicinity can rise by several metres.

3.4.2 Historical River Flooding Experiences

The earliest documented flood in the Lower Hunter occurred in 1820. European settlement in the valley had only existed for 7 years and details of the extent and nature of flooding are scant. Nonetheless, based on historical records (extracted from Moriarty, 1868, in PBP, 2002), the 1820 flood reached an equivalent height of 12.2 metres on the current gauge at Belmore Bridge near Maitland, and is considered to be amongst the most severe floods to have occurred since European settlement (and is comparable with the 1955 flood which reached 12.1 metres).

Since 1820, major flooding in the Lower Hunter Valley has occurred on numerous occasions. A review of the flood record for Belmore Bridge suggests that distinct periods of major flooding have occurred over the years. The most significant periods of flooding occurred between 1863 and 1880, during the 1890's, and between 1949 and 1956. In particular, 7 major floods occurred in the Lower Hunter between 1949 and 1955, culminating in the devastating flood of February, 1955, in which 14 lives were lost (reported in Hawke, 1958, in PBP, 2002). The 1955 flood is estimated to be rarer than the predicted 1% AEP flood. It destroyed the levee system that had been progressively developed over the preceding 90 years.

Following the 1955 flood, the NSW Government passed legislation in the form of the *Hunter Valley Flood Mitigation Act 1956*, which authorised the coordinated construction of flood mitigation works for the entire valley. A flood mitigation system was designed and constructed to control flooding and to reduce land degradation during major floods. The Lower Hunter Flood Mitigation Scheme was commenced in 1956 and today comprises over 160 kms of levees, 140 kms of drains, 200 floodgate structures, 40 kms of control and diversion banks, and more than 30 kms of river bank protection works. The Scheme is the cornerstone of flood protection for the region between Maitland and Hexham.

Since the 1955 flood, significant flooding in the Lower Hunter (*i.e., to a level greater than RL 2.5 m AHD at Raymond Terrace*) has occurred in 1971, 1972, 1977, 1978, 1985, 1989, 1990 and 2007 (refer timeline of flooding in Table 1-1).

3.4.3 Frequent River Flood Events (10% AEP)

Numerical models of flooding within the Lower Hunter River have been developed on behalf of local Councils and State Government over the past 20 years. The models have been periodically refined over this time. Most recently the Lower Hunter River model was upgraded to include particular detail within the Hexham area. The results from these computer models have been interrogated and incorporated into the development of this City-wide Flood Plan.

The 10% Annual Exceedence Probability (AEP) design conditions have been used to represent 'frequent' river flooding in Newcastle. The 10% AEP approximately accords with a 1 in 10 chance of occurring in any year (referred sometimes as a 1 in 10 year flood).

Map 1C (refer ***Map Series 1*** in accompanying ***Compendium of Maps*** document) shows the extent of floodplain inundation for these frequent flood conditions.

Overbank inundation in the vicinity of Hexham is in the order of 0.5 to 1 metres. Relict feeder channel from Hexham Swamp are generally more low-lying and thus have deeper flooding. The current rail embankment and Pacific Highway, combined with floodgates on the entrance to Ironbark Creek, would generally restrict the broader expanse of Hexham Swamp to inundation under 10% AEP river floods.

3.4.4 Infrequent River Flood Events (1% AEP)

The 1% Annual Exceedence Probability (AEP) design conditions have been used to represent 'infrequent' river flooding in Newcastle. The 1% AEP approximately accords with a 1 in 100 chance of occurring in any year (referred sometimes as a 1 in 100 year flood).

Map 2C (refer ***Map Series 2*** in accompanying ***Compendium of Maps*** document) shows the extent of floodplain inundation for these infrequent flood conditions. 1% AEP Hunter River flooding produces flood depths across Hexham in the order of 2 to 3 metres. This is generally consistent with the approximate level of flooding that occurred in 1955 (refer Figure 3-10).

Figure 3-10 Flooding in Hexham (1955), showing only the second storey of the Travellers Rest (now McDonalds). Note only roofs showing for single storey buildings behind

3.4.5 Extreme River Flood Events (PMF)

Given the enormity of the Hunter River catchment, an estimate of the PMF event using traditional approaches is not possible. Therefore, the extreme event included in the modelling is a flood some 2.5 times larger than the 1% AEP event, by discharge.

Map 3C (refer ***Map Series 3*** in accompanying ***Compendium of Maps*** document) shows the extent of floodplain inundation for these extreme flood conditions. PMF depths at Hexham are about 5 metres under these conditions, and would completely overwhelm any development located in the floodplain.

3.5 Ocean Flooding

3.5.1 Ocean Flood Environment

The third flooding type that potentially affects Newcastle is inundation from elevated ocean water levels. In addition to normal astronomical tides, low air pressure causes ocean levels to increase (called inverse barometric set-up), while strong onshore winds can also 'pile-up' water against the coastline.

The highest water levels recorded within the Port of Newcastle coincided with the extreme coastal storm of May 1974, and reached a level of approximately 1.4m above mean sea level (some 0.6m higher than the predicted tidal levels). During normal king tides, some low lying drainage systems in Newcastle are impacted by ocean flooding. Inundation is generally restricted to roadways and low-lying parkland (primarily around Maryville, Wickham and Carrington) (refer Figure 1-3).

3.5.2 Projected Sea Level Rise

The NSW Sea Level Rise Policy Statement (2009) advises that mean sea level could potentially rise, up to 0.4m by 2050, and up to 0.9m by 2100, relative to the 1990 levels. The NSW Government advises that these values be used for strategic planning and landuse management purposes.

A rise in sea level would have a significant impact on low-lying coastal lands throughout NSW, including many harbourside suburbs in Newcastle. By 2050, the current highest recorded level in Newcastle Harbour (i.e. 1.4m AHD) would be reached several times per year (under king tide conditions), while by 2100, almost every high tide will exceed this level, with king tides reaching a level of about RL 2.0m AHD.

Ground levels in the low-lying suburbs of Maryville, Wickham and Carrington are typically around 1.0 to 1.3m AHD. It is expected that under a sea level rise of about 0.4 metres, roads, structures and even ground vegetation would start to become detrimentally impacted by high groundwater levels, while a sea level rise of 0.9 metres would lead to deep inundation within many streets and yards on a frequent basis. In essence, the area would dramatically return to swampland.

3.5.3 Frequent Ocean Flood Events (10% AEP)

For harbourside areas around the Port of Newcastle, potential ocean inundation can be determined from the ground levels and an adopted water level in the harbour. This "bathtub" approach is a simplistic representation of ocean inundation, as it ignores coincident flooding from the local

catchments or from the Hunter River. Given that ocean storm surge is typically caused by strong low pressure systems that would also generally bring rainfall, there is reasonable chance that coincident catchment flooding would also occur.

Frequent ocean flood events have been approximated by the current 10% AEP ocean water level. That is, this is a stillwater level that the ocean has reached, on average once every 10 years, for the current data record. It does not make any allowance for future sea level rise. The adopted frequent ocean flood level for Newcastle Harbour is RL 1.35m AHD (refer NSW Government, 2010).

Map 1D (refer ***Map Series 1*** in accompanying ***Compendium of Maps*** document) shows the extent of floodplain inundation for these frequent flood conditions. The 10% AEP ocean level would potentially affect a number of streets within the low lying suburbs of Maryville, Wickham and Carrington.

3.5.4 Infrequent Ocean Flood Events (1% AEP)

The 1% AEP design sea level conditions have been adopted as RL 2.3m AHD. This level has been calculated as the current peak recorded ocean level within Newcastle Harbour (RL 1.4m AHD) plus an allowance for sea level rise of 0.9m, representing projected level at about 2100. As such, it is essentially the equivalent of a 1% AEP ocean inundation condition occurring in 100 years time.

Map 2D (refer ***Map Series 2*** in accompanying ***Compendium of Maps*** document) shows the extent of floodplain inundation for these infrequent flood conditions.

1% AEP inundation from ocean flooding would again affect the low suburbs of Maryville, Wickham, Carrington and parts of Islington and Stockton to depths of up to 1 metre. Backwater inundation would also extend up Cottage Creek to affect National Park and surrounding areas, while there would also be a small amount of overbank inundation within Mayfield, close to the open channel.

1% AEP ocean inundation would also affect low lying sections along the river, including Hexham. The inverse flood profile from the ocean upstream under high sea conditions has not been investigated fully as part of this analysis. Assuming that river levels reach the same peak water level as the ocean, then 1% AEP ocean inundation at properties in Hexham could be in excess of 1 metre.

3.5.5 Extreme Ocean Flood Events (PMF)

Numerical oceanographic modelling by DHI (2008) has estimated extreme ocean flooding levels within Newcastle Harbour of 3.4m AHD, including sea level rise allowance of 0.9 metres. This assumes coincidence of several extreme meteorological conditions, and can therefore be considered to have a very low likelihood of occurrence (approximately equivalent to a PMF event).

Maps 3D (refer ***Map Series 3*** in accompanying ***Compendium of Maps*** document) shows the extent of floodplain inundation for these extreme flood conditions. The low suburbs would be inundated by depths of more than 2 metres for PMF ocean conditions.

As well as more extensive inundation throughout the downstream ends of Cottage and Throsby Creeks and along the Stockton foreshore, PMF ocean conditions would have impacts up to Hexham and beyond. At Hexham, existing low-lying properties could be inundated by more than 2 metres of water.

3.6 Coincident Flood Events

The flood environments described above generally assume that the flooding mechanisms occur independently of each other. Some areas of Newcastle are impacted by two or even three flood mechanisms, and therefore there is the chance that these flood events occur concurrently, potentially compounding flood risks.

It is considered that East Coast Lows and other deep low pressure systems that would lead to significant local catchment rainfall would also cause significant ocean level set-up. It is recommended therefore that all future consideration of local catchment flooding incorporate a true and rigorous joint probability analysis for elevated ocean levels as tailwater conditions.

It is less likely, however, that elevated ocean levels or high local catchment rainfall will coincide with elevated river flood levels. This is because the river responds to high rainfall within the larger Hunter River catchment, which is expected to take several days to impact on the lower river reaches within the Newcastle LGA (by which time the low pressure system responsible for local flooding would likely have moved on). Nevertheless, it also recommended that the validity of this conclusion be further investigated at the same time.

It is further recommended that the potential impact of projected sea level rise and possible influence of climate change on the probability of rainfalls over increasing time horizons be investigated and reported.

3.7 Floodways, Flood Storages and Flood Fringes

3.7.1 Definitions

Standards set out in the Floodplain Development Manual (2005), and replicated in CofN's Flood Policy and DCP allow for the floodplain to be compartmentalised into different flood impact categories, generally comprising:

- Floodway;
- Flood Storage; and
- Flood Fringe.

There are no prescriptive methods for determining what parts of the floodplain constitute floodways, flood storages and flood fringes. Descriptions of these terms within the Floodplain Development Manual (2005) are essentially qualitative in nature. Of particular difficulty is the fact that a definition of flood behaviour and associated impacts is likely to vary from one floodplain to another depending on the circumstances and nature of flooding, for example comparing between the riverine floodplain adjacent to the Hunter River the broad and flat floodplain of Throsby/Styx and Cottage Creeks.

In accordance with the Floodplain Development Manual (2005), Floodways are areas and flowpaths that convey the majority of flood flows. In simple terms, flood flow at any location can be approximated by the product of velocity and depth (v*d). Using the results of the computer modelling, a v*d threshold was able to be determined wherein approximately 80% of total floodplain flows were contained. For the 1% AEP flash flood conditions, this threshold was approximately v*d=0.3, while for the PMF flash flood conditions, this was v*d=1.0.

Flood Fringes are non-floodway areas that, if filled, would not have a significant impact on flood levels, velocities and flowpaths. Computer model simulations were again carried out to iteratively assess the differentiation between Flood Storages and Flood Fringes. Based on these modelling results, it was established that for flash flood environments, Flood Fringes are areas where flood depths are less than 0.5m for a 1% AEP event, or 1.0m for a PMF event.

The principles of the Manual relating to flood impact categories have been implemented by CofN in accordance with the following Sections.

3.7.2 Principles Summary

In simplified terms the Manual guides that:

- **Floodways Areas** are areas of the floodplain where significant discharge of water occurs during floods, and where even if only partially blocked would cause as significant redistribution of flood flows, or increase in flood levels.
- **Flood Storage Areas** are those parts of the floodplain which are important for the temporary storage of floodwaters during the passage of a flood.
- **Flood Fringe Areas** are the remaining area of flood prone land.

In considering the full range of floods for floodplain classification, CofN's practice since the 1990's with the Honeysuckle has been to use the following approach consistent with the above principles:

- Ensure there are no adverse cumulative impacts for frequent flood events (say 10%AEP) - OR – correspondingly, no increase in the likelihood / frequency of relatively minor flood events.
- Ensure there are no significant adverse impacts for major flood events (typically the 1% AEP) focusing on risk to property. This will normally be expressed as small (measured in mm) increase in flood levels that must not be exceeded.
- Ensuring that in overwhelming and extreme flood events (including up to the PMF) there are no significant adverse risk to life / personal safety changed hazards (for example, in flash flooding, the risk to life hazard category does not change from and "L3" category [where no refuge would be required] to an "L4" where refuge would be required – refer Section 5.2 for further definition of flood hazard categories). There is no need to examine small changes in water levels for risk to property at such rare and unlikely events.
- If the mapping of floodways and flood storages is refined over time (for example by an approved submission by a proposed development) then the floodplain categorisation maps held by CofN will be updated.

3.7.3 Historical Management Perspective

CofN's adopted Flood Policy (2004) reinforced the need to categorise floodplains across the Newcastle LGA into floodways, flood storages and flood fringe areas. The principles of the 1986 and 2001 Manuals for this categorisation were collated in Technical Manual section of the Policy. These

principles have not changed in the current gazetted NSW Government Floodplain Development Manual (2005). CofN's adopted Technical Manual noted:

> "…, the 1986 NSW Government manual states:
>
> *"In the absence of a flood study, the hydraulic category (floodway. flood fringe or flood storage)…will need to be determined by the council. In most circumstances, an assessment can be made by an experienced engineer…At the same time, there must be acceptance that reassessments may be required, when the more accurate information contained in a flood study becomes available."* (s 4)
>
> In the longer term, when city wide flood management plans are being prepared with broad community input and consultation, a more rigorous approach will be explored."

At the time of adopting its Flood Policy (2004) only the Wallsend had floodplain classification defined based on numeric computer flood modelling. The Flood Policy noted that for all other areas floodway, flood storage flood fringe area mapping would be provided when Flood Management Plans are completed.

Interim City-wide floodplain classifications were progressively determined by CofN over time in accordance with the above 1986 Manual provision in the absence of flood studies providing this mapping. This was done by judgement assessments using aerial photography topographic and historic flood information. In the Lower Hunter, remaining wetland and mangrove extents as identifiable from aerial photography largely guided the interim floodway mapping.

The interim floodplain classifications were amended opportunistically whenever a development proposed commissioned a supporting study that enhanced the confidence of floodplain classifications.

By 2008, CofN had completed flood studies for all major catchments and the Lower Hunter floodplain to scientifically calculate and map design floods for a range of probabilities up to and including the PMF. This included an upgrade of the Lower Hunter Flood model (1996) to overcome previously identified modelling deficiencies – that in particular hampered the ability to define floodways in the Hexham area.

In 2009, CofN completed its Newcastle Flood Planning – Stage 1: Concept Planning. This work included research into using velocity depth relationships as a 'shorthand' way of categorising floodplains in the Newcastle LGA, taking into account the specific nature of flooding in the Newcastle LGA. The findings were:

- The (flash) flood modelling based floodplain categorisation of the Wallsend catchment should continue to be used (although this has now been reviewed and improved as part of this City-wide Flood Plan);
- A very useable mapping of floodways, flood storages and flood fringe for the flash flood catchments can be produced by velocity depth relationships for the other flash flood catchments (Dark Creek, Throsby / Cottage / CBD) was produced. This correlated well with a test comparison against the incremental modelling derivation done by others previously in the Wallsend Catchment; and

- No comparable velocity depth relationship could be readily found for the Lower Hunter floodplain, and so it was recommended that incremental modelling be undertaken (using the latest CofN model) in Stage 2 – the preparation of a City wide Floodplain Risk Management Study and Plan.

It was also recognised that there would be benefits in refining the flash flood models and closely examining the flood management environments property by property in later work to more exactly define the flash floodplain classification mapping.

3.7.4 The Lower Hunter Flood Study Model Upgrade

A Flood Study for the Lower Hunter was completed jointly by Newcastle and Port Stephens Councils under the NSW Government Floodplain Program in 1994 – based on initial modelling work in the late 1980's. At the time computer power limited the resolution that could be achieved – and a one dimensional model with quite widely spaced cross sections was the best that could be achieved.

Limitations and some discrepancies in this model were identified in the Lower Hunter Floodplain Risk Management Study later carried out jointly with Port Stephens Council. These were dominantly in the Hexham area – from Tarro Beresfield to Sandgate. For these (and other reasons), CofN commissioned (under the NSW Government Floodplain Management Program) further study to upgrade the model. Fundamentally, this incorporated:

- The insertion of a high resolution 2D area over Hexham swamp and adjacent areas to best support floodplain categorisation, allowing significant flow paths and storage areas to be identified and scenario tested;
- A complete review of the underlying floodplain wide 1D model, which supplied boundary conditions to the new 2D areas; and
- Full re-calibration and verification of the modelling.

The following process was followed to derive improved floodplain categorisation for the Lower Hunter:

<u>Establish Criteria</u>

The principles outlined above were applied. In the case of major flooding – at the 1% AEP event – where the main acceptance criteria is a small cumulative increase in water levels, for consistency, the same acceptable limit that was recommended in the most recent prior flood management work on the Lower Hunter by CofN under the NSW Government Floodplain Management Program was adopted. This was from the Lower Hunter Valley Floodplain Management Study Volume B – Planning Implementation Strategy (PBP, 2001). In this study the threshold of acceptable increase in water levels around the perimeter of Hexham Swamp was taken as 40mm.

Accordingly, for the assessment at the 1% AEP Hunter River flood event, a cumulative impact of no more than a 40mm increase in flood levels was taken as the objective.

<u>Carry out incremental scenario testing</u>

The scenario testing was carried out by Mr Grantley Smith (WRL), who under previous employment was the primary author and worker in the Lower Hunter Flood Study Model Upgrade.

An initial estimate of where the floodways, storages and fringe areas was made jointly with CofN and the Consultant, with the objective of trying the maximise development potential through minimising the areas of floodway and flood storage.

The upgraded model was run for the 1% AEP event. It was found that this would cause unacceptable increases in water levels – for example, the flood water levels in Hexham Swamp would rise between 100 and 200mm.The consultant advised the broad scale unacceptable increases would have been contributed to by the amount fill on Kooragang island in the scenario simulation.

However, when the fill in critical areas on Kooragang Island was removed in the next simulation, there were still unacceptable impacts. The consultant then identified that scenario testing fill on industrial lands in the Hexham area (near the Hexham Bridge and the Ironbark Creek area) should be removed. The next simulation found this reduced the increase in water levels around the perimeter of Hexham Swamp to less than the 40mm criteria, but there were still unacceptable impacts upstream of Hexham Bridge – extending into the Port Stephens LGA. The Consultant advised that removing simulated development in the Newcastle LGA upstream of the Hexham Bridge could reduce these impacts. That is removing obstructions to the main flow entry area to Hexham Swamp.

The last set of iterative scenario testing tried to balance reducing impacts on the adjacent Port Stephens LGA land and around the perimeter of Hexham Swamp in the Newcastle LGA, while preserving as much development potential as possible – particularly in the Hexham area. It was concluded that while the 40mm target could be achieved for much of the floodplain, it could not be achieved everywhere without significantly further reducing fill in the simulations in the Hexham area and particularly at Ironbark Creek.

3.7.5 Further Refinement of Floodplain Categories

As part of this City-wide Floodplain Risk Management Study, the categorisation of the floodplain into ‘floodway’, ‘flood storage’ and ‘flood fringe’ was further refined to convert the previous numerical / modelling results into a more meaningful representation of hydraulic conditions across the floodplain. While for the most part the categorisation was adopted based on the numerical rules and definition (refer Table 3-1 for further details for example), some localised manual adjustments were also required, including:

- ‘filling’ small areas of floodway where direct modelling results had left ‘holes’ in the floodway;
- ‘filling’ areas of floodway that had been purposely excluded from the modelling associated with buildings (within the Dark Creek catchment);
- Ensuring that all upstream floodways maintained connection with downstream floodways;
- Considering the impact of buildings or other flow impediments; and
- Smoothing of boundaries between floodplain categories.

In the vast majority of locations, especially for flash flooding, the floodways are contained within existing roadways and parklands. This is to a degree a result of the lower friction and blockage within these areas. As such, the lateral extents of some floodways have also been adjusted/trimmed to correspond more with the relevant landuse conditions. Notwithstanding, there are still many areas where floodways occur on private property, including lands that contain existing residential development.

It is considered the refinement of floodways, flood storages and flood fringes, as defined in this document and the accompanying maps, should be used as the basis for future development controls and landuse planning that are dependent on these floodplain categories. This includes the refinement of floodplain categories through the Wallsend Commercial Centre, which is subject to a separate Flood Plan (2009) already adopted by CofN.

3.8 Results of Floodplain Categorisation

The resulting definition of flood impact categories are defined in Table 3-1, and generally accord with other similar flood studies elsewhere.

Table 3-1 Definitions of flood impact categories (flash flooding)

	1% AEP	PMF
Floodway	velocity * depth > 0.3	velocity * depth > 1.0
Flood Storage	velocity * depth < 0.3 & depth > 0.5 m	velocity * depth < 1.0 & depth > 1.0 m
Flood Fringe	velocity * depth < 0.3 & depth < 0.5 m	velocity * depth < 1.0 & depth < 1.0 m

Geospatial analysis was used based on the computer modelling results from the previous flood studies to determine areas of Floodway, Flood Storage and Flood Fringe across the Newcastle LGA for both 1% AEP and PMF conditions. Care was required in performing the geospatial analysis, however, as localised nuances in the modelling needed to be considered and corrected, as detailed in Section 3.7.5.

Computer modelling of ocean flooding was not carried out, and therefore could not be included in the geospatial mapping analysis. It was regarded, however, that ocean flooding would involve relatively low flood velocities, as it is essentially backwater inundation only. Also, infilling of the area affected by ocean flooding would not have any significant effect on adjacent areas – instead just less water would spill onto the floodplain from the harbour. As such, all areas potentially affected by ocean inundation were categorised as Flood Fringe.

The definition of Floodways, Flood Storages and Flood Fringes for river flooding was carried out iteratively using the Hunter River flood model. For these iterations, the 1% AEP conditions were used to define the Floodway and Flood Storage, and then verified for the PMF.

3.8.1 1% AEP Floodways, Flood Storages and Flood Fringes

The 1% AEP flood impact categories (Floodways, Flood Storages and Flood Fringes) across the Newcastle LGA are shown in **Maps 4A to 4L** (refer ***Map Series 4*** in accompanying ***Compendium of Maps*** document).

The 1% AEP floodways across Newcastle are almost exclusively contained within either open channels, parklands or roadways. Key exceptions to this include:

- the overland flowpath that connects Morgan Street to Little Edward Street in Merewether;
- The overland flowpath between Dangar and Irving Streets, Wallsend;

- Robert Street and Bluegum Road, Jesmond; and
- The Wallsend Commercial Centre (note that this area is subject to a separate Floodplain Management Plan already adopted by CofN in 2009, however, it is recommended that definition of floodplain categories still be refined there for consistency with the remainder of the LGA).

A significant proportion of Hexham Swamp is classified as floodway, along with most of the existing development located along the Pacific Highway at Hexham, notably in the vicinity of the old Travellers Rest stop (currently McDonalds). Flooding in this area exceeded 3 metres during the 1955 flood, which is crudely approximated as about the 1% AEP river flood conditions (refer Figure 3-10).

There are few 1% AEP flood storage areas within the urban area of Newcastle, these being localised pockets of deeper flooding, including some within Hamilton, Merewether, New Lambton and National Park. Dark Creek and Ironbark Creek have virtually no flood storage areas, with floodways extending close to the edges of the 1% AEP flood extents.

3.8.2 PMF Floodways, Flood Storages and Flood Fringes

The PMF flood impact categories (Floodways, Flood Storages and Flood Fringes) across the Newcastle LGA are shown in **Maps 5A to 5L** (refer ***Map Series 5*** in accompanying ***Compendium of Maps*** document).

The PMF Floodways are not dissimilar to the 1% AEP floodways, and are still mostly confined to open channels, parklands and roadways. Some notable areas of PMF floodway include:

- Deeper flooded areas in Hamilton around Gregson Park;
- The lower end of Kotara adjacent to the stormwater channel and around Northcott Drive;
- Some areas within the lower flats of New Lambton (around St James Rd) as well as around the Orchardtown Road shops;
- Some overbank areas in Mayfield near open channels;
- The lower reaches of Jesmond around Bluegum Road through to Fraser Street;
- Extensive areas between Wilkinson Avenue and Sandgate Road, Birmingham Gardens; and
- A broader area through the Wallsend Commercial Centre (as outlined above, this area is subject to a separate Floodplain Management Plan but new floodplain category mapping from this Plan should be adopted).

Some of the areas above have not previously been mapped as floodways by CofN. It is envisaged that the categorisation of PMF floodways will weigh into considerations as part of future strategic landuse planning and development controls across the LGA.

PMF floodways for river flooding are the same as the 1% AEP floodways, and include the majority of Hexham.

3.9 Flood Warning Times

The amount of warning available for an approaching flood can have a significant impact on the risk to life. Less warning time clearly represents a greater risk to the community as there is less opportunity to response appropriately and implement risk-reduction measures. Minimal warning time also means that emergency services and combat agencies are unlikely to be able to provide any assistance or direction for affected communities. Indeed during the June 2007 events, many volunteer service providers (e.g. SES crews) were unable to reach areas affected due to impassable roads, congested traffic, their own personal trauma, and so on.

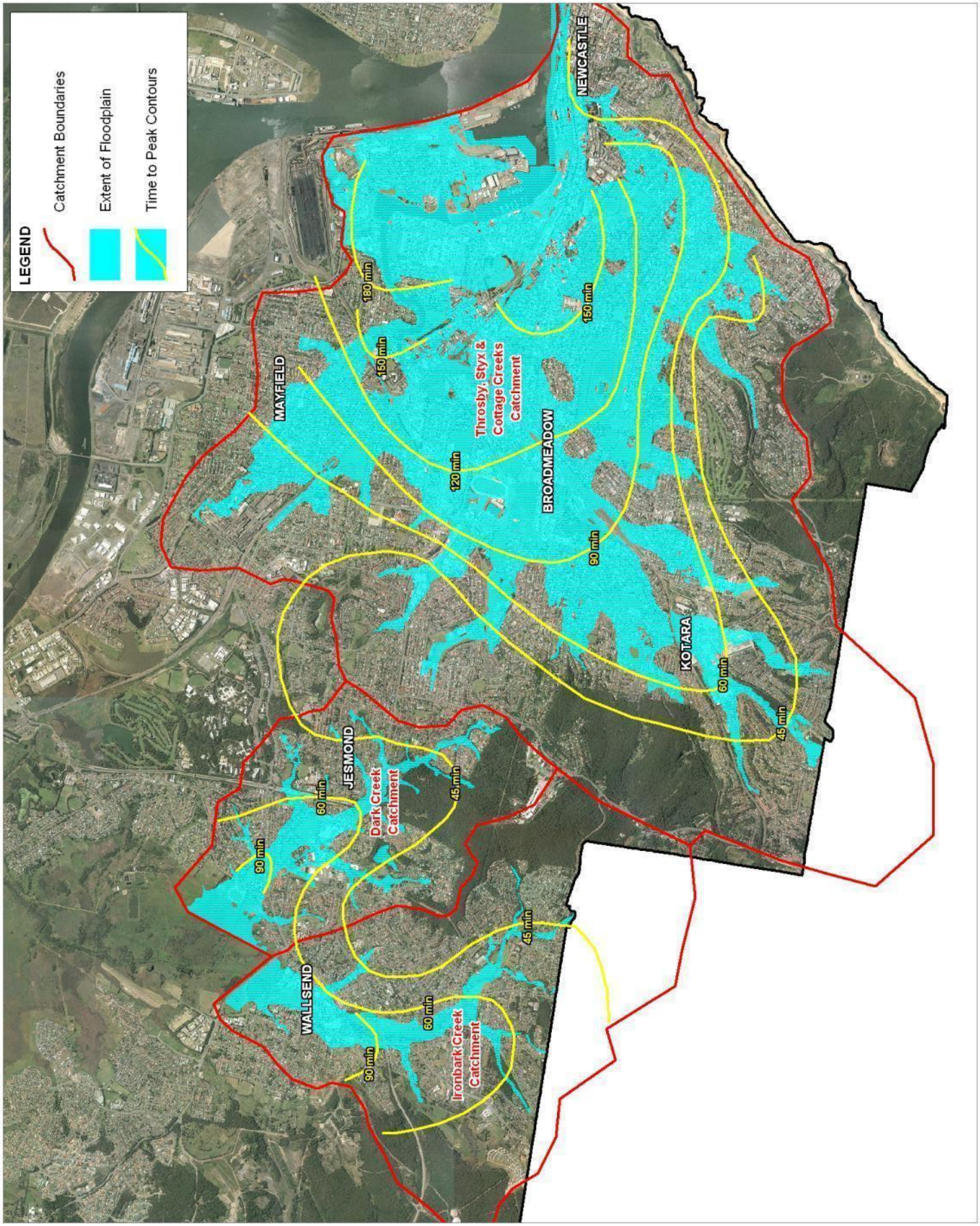
To facilitate flood risk management in Newcastle, consideration has been given to the levels of warning times as defined in Table 3-2.

Table 3-2 Flood warning time categories

no effective warning	<1 hr from onset of major rainfall	No time for pro-active and systematic organisation of flood mitigation, evacuation, emergency response etc. Individuals would be self-directed in regards to emergency response.
minimal warning	1-6 hrs from onset of major rainfall	Limited assistance and direction likely from emergency services and combat agencies. Measures requiring minimal time for implementation may be appropriate for flood management.
moderate warning	6-12 hrs from onset of major rainfall	Assistance and direction likely from emergency services and combat agencies, depending on time of day. Measures requiring moderate time, or less, for implementation may be appropriate for flood management.
good warning	12+ hrs from onset of major rainfall	Significant assistance and direction from emergency services and combat agencies can be expected, including assistance with evacuation. Most measures requiring some form of on-demand implementation would be appropriate for flood management.

3.9.1 Flash Flooding

Flash flooding in Newcastle is the result of intense rainfall occurring over local catchments. The steep nature and relatively small size of the catchments means that runoff is conveyed through the floodplains relatively quickly. Figure 3-11 shows the time to flood peak from the commencement of a typical 2 hour duration design rain event across the Newcastle local catchments. This figure illustrates the very limited time available for flood warning, as flood peaks generally occur within 60 minutes for all areas within the upper catchment areas, and within about 120-180 minutes for the remainder of the floodplain.



Title:

Approximate Times to Reach Peak Flash Flood Conditions (Based on 2hr Duration Storm Events)

Figure: 3-11

Rev: A

N

0 1 2km

Approx. Scale

BMT WBM

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Based on the categories defined in Table 3-2, the vast majority areas affected by flash floods can expect no effective warning, or minimal warning at best. Consequently, it is regarded that for flash floods in Newcastle, there would be little to no opportunity for emergency services and combat agencies to provide assistance prior or during the peak of the flood event. They would, however, provide essential services during the recovery phase, after a significant flash flood event.

3.9.2 River Flooding

River flooding of Newcastle occurs only following significant and persistent rainfall within the very large Hunter River catchment. Given that Newcastle is located at the very downstream end of the large catchment (with tailwater influence from ocean conditions), flooding from the Hunter River is expected to have a significant and good warning time (in the order of days). Additionally, major flooding in the Hunter River is expected to be preceded, or would at least be exacerbated, by persistently wet conditions that saturate the catchment, thus maximising surface runoff.

It is expected that extensive emergency services and combat agencies could be deployed to assist with evacuation and flood management prior to the onset of river flooding.

3.9.3 Ocean Flooding

Ocean flooding in Newcastle will be significantly affected by the predictable astronomical tide. Meteorological factors may influence the magnitude of the tide level (e.g. storm surge), however, the timing of the tidal peak is well documented (within tide tables, charts etc). Meteorological factors that elevate normal tide levels (e.g. storm surge) are generally observed over timeframes of 12 hours or more. Therefore, warning times for ocean flooding can generally be expected to be in the order of 6 - 12 hours. The magnitude of meteorological factors is generally less than that for astronomical tides. Therefore, the most critical times for meteorological factors is when the astronomical tides are at their largest (e.g. syzygy, perigee, solstice tides), which are all predictable.

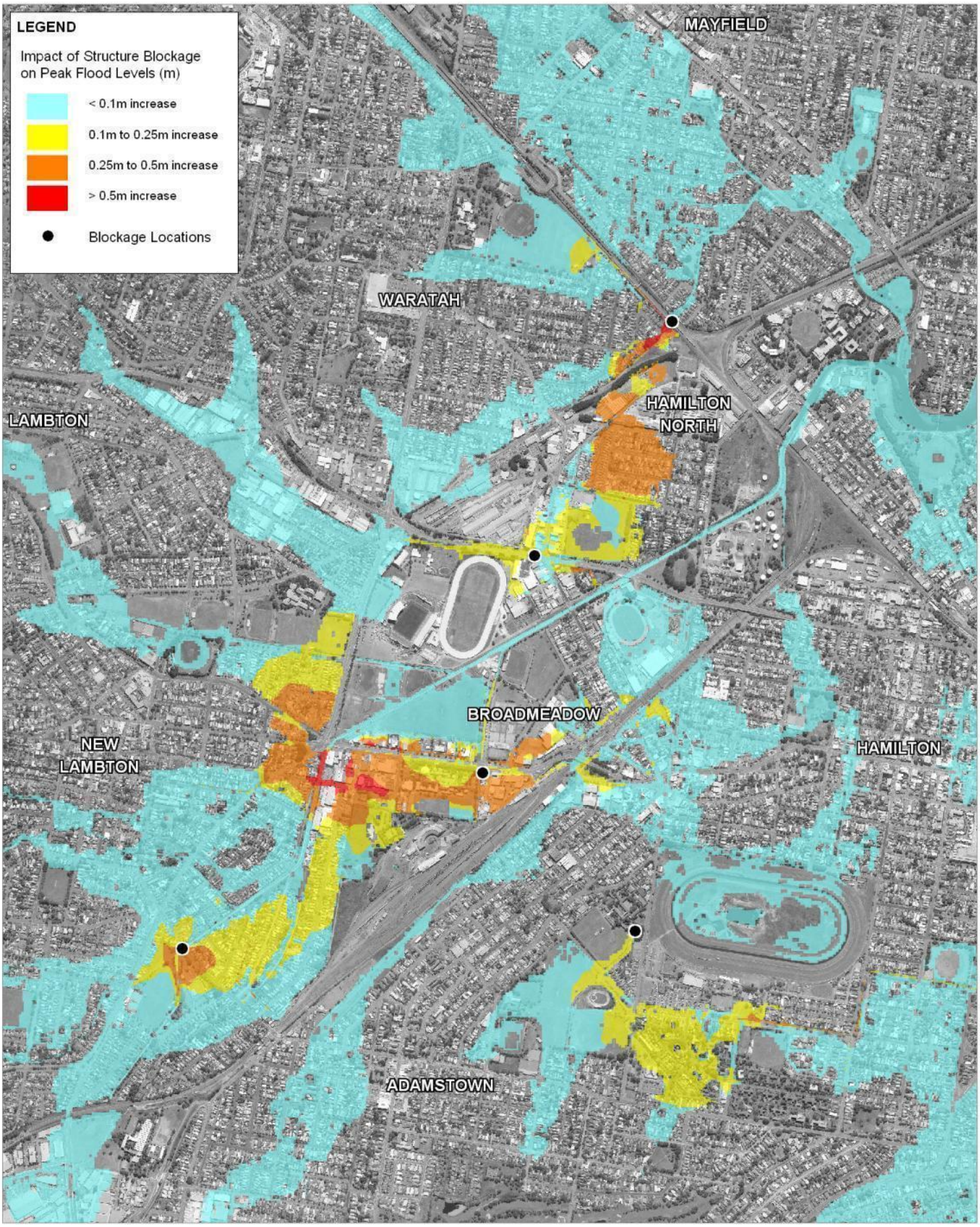
3.10 Impact of Blockage on Flood Behaviour

The open channels found throughout Newcastle are regularly punctuated by culverts and bridges, providing road and pedestrian access over the constructed drainage lines. As highlighted during the flash floods of June 2007, these culverts and bridge opening are susceptible to blockage (see Figure 3-12). Once blocked, flood flows become diverted, with more overland flow than would normally be the case. For the most extreme cases, such as experienced in Wallsend Commercial Centre and Newcastle West during June 2007, blockage caused significant elevation of floodwaters, as waters became ‘dammed’ behind the blockage.

Preliminary sensitivity analysis has been carried out using the existing computer models to investigate the impact of blockage of various culverts (see Figure 3-13 for example). While the results of the analysis confirm that flood results are indeed sensitive to blockage, the overall magnitude of flood level increases differs depending on location of the blockage. For example, blockage within the broad flat floodplain of Throsby or Cottage Creek would result in a small localised increase in flood level, however, the extensive overland flow means that an alternative flowpath is generally readily available (generally along the closest roadway). This response contrasts to the more incised nature of Dark Creek and Ironbark Creek, where a blockage would potentially result in a significant back-inundation of water along the flowpath. There are also some critical sections of

waterway within Newcastle that if blocked could potentially cause devastating impacts. These are typically under rail embankments that have been constructed across the floodplain and significantly constrain flood flows.

Figure 3-12 Blockage of Culvert at Beaumont Street, Hamilton (near racecourse)



Title:

Preliminary Sensitivity to Blockage within Selected Culverts

Figure: 3-13

Rev: A

N

0 375 750m

Approx. Scale

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4 HISTORICAL AND CURRENT FLOOD MANAGEMENT

4.1 Chapter Overview

Flooding in Newcastle is already managed to a large degree through a range of initiatives that have been established and supported by CofN and other agencies, including the SES. Current flood management approaches are described in this chapter.

Current flood management approaches have been divided into elements that aim to:

- Reduce specific flood risks;
- Improve resilience in living with flood risks; and
- Facilitate emergency management.

These approaches are described below, while assessment of the current approaches against the Floodplain Development Manual (2005) criteria is provided in Chapter 5.

4.2 Reducing Flood Risks

4.2.1 Historical Drainage and Flood Mitigation Works

Works aimed at modifying the natural pre-existing catchments, floodplains and estuarine environments have been advocated and carried out since earliest European settlement.

Typically these works (such as major stormwater trunk drainage channels) were intended to drain water as rapidly as possible to the ocean (refer Figure 4-1). Other reasons drainage works were built over time include stream bank and bed erosion control, and public health improvements by preventing the ponding of water and accumulation of rubbish in waterways and wetlands.

Levees were also sometimes constructed with the aim of preventing or delaying flood waters entering land where flooding was undesirable, such as land used for agriculture or houses and townships. The only significant levee in the Newcastle LGA is for Hunter River flooding at Hexham – near to the Ironbark Creek outlet. Other works carried out since European settlement have had both beneficial and detrimental effects on flood behaviours. For example, the construction of rail lines has created obstructions across the natural floodplains. This would increase flooding potentials on the upstream side, whilst potentially reducing flooding on the downstream.

In 1888, CofN commenced the construction of a piped system to serve the residential areas. Nineteen kilometres of sewers were constructed to carry off roof water, as well as human sewage and house sullage. The Public Works Department criticised this approach, and when the Newcastle Sewerage Scheme was implemented, the drains were retained solely to discharge stormwater. In the early 1890s, Public Works began taking out estimates for the construction of stormwater drains in Newcastle West, around Cottage Creek, in Newcastle Pasturage Reserve and in Wallsend and Plattsburg. The drainage of low-lying parts of Newcastle Pasturage Reserve, which encroached upon Adamstown, New Lambton, Lambton and Hamilton was a comprehensive aspect of the project.

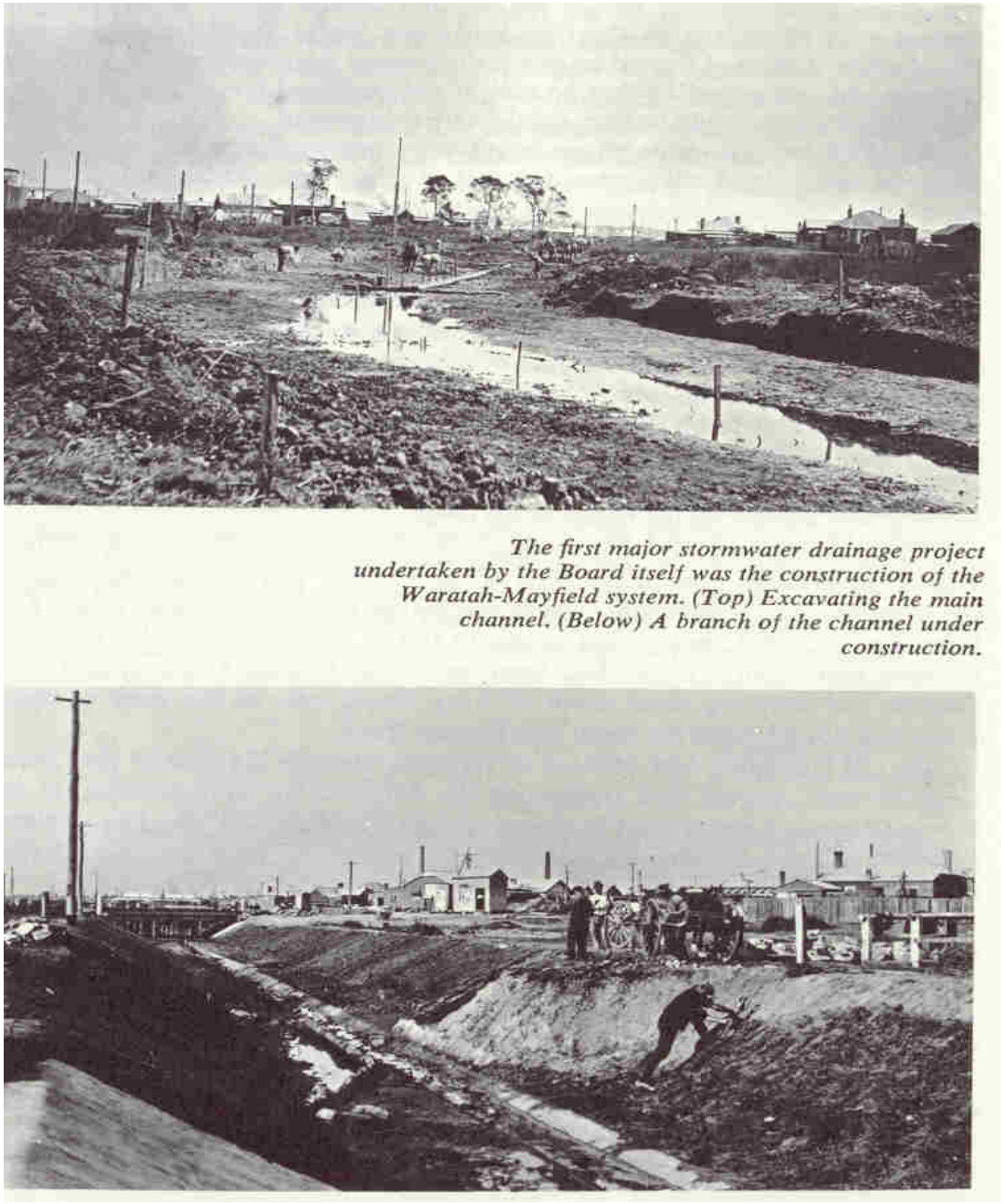


Figure 4-1 Historical photo of section of Throsby Creek being channelized. Extracted from Armstrong, J.W. (1967), *Pipes and People in NCC(2005).*

The natural course of Throsby Creek was also adjusted with the construction of a 3km channel and branches from Mitchell St, Tighes Hill to St James Rd, New Lambton. In 1898 the Public Works Department concluded that the earth banks of the channels were unable to resist erosion by the water and needed to be protected. Teatree scrub was used to construct fascines, with couch grass growing through to consolidate the banks. By 1902, every stage of the Pasturage Reserve drainage scheme was completed. The labour for the various drainage schemes came from men who had lost their jobs when local coal mines were closed down in the depression of the 1890s. The government claimed that while the work was done to appease the purchasers of crown land, it also helped to relieve the existing distress in the district. Newcastle's growth early that century, stemming from the

establishment of iron and steel works and subsidiary industries, emphasised the shortcomings of the original drainage system. In the 1920s, schemes were introduced to dispose of the larger quantity of run-off created by residential settlement and to eliminate local flooding in low-lying areas.

Before 1924, the drainage system consisted mainly of earth channels of limited capacity. The transformation of the catchment was reportedly described by J.B Henson, the first Water Board engineer:

> *"Originally, the catchments were flat, sandy, scrub-covered ground containing swamps and bounded by tree covered steep hills. Rainwater flowed quickly off the hills and accumulated in the swamps and on the flats, from which it flowed through natural watercourses to the Hunter River and percolated underground through the sand beds to the same outlet. The settlement of the area has caused changes in the natural conditions, resulting in the general acceleration of the off-flow of stormwater. This is due to the clearing of trees and scrubs, formation of roads and streets, kerb and guttering, pavements, the erection of houses and the construction of surface and underground channels...The old swamps are being filled up and these areas are now no longer available for storage and so reduce the rush of water to the outlets (and) raise the flood water level." (Armstrong, J. 1967 p. 178)*

In the first decade of the 1900s, growth in the Cottage Creek catchment was rapid. The inefficiency of the system was highlighted in February 1908 when a storm caused flooding of Cottage Creek into Hunter and Steel Streets (refer Figure 4-2).

Figure 4-2 Historical photos of Steel Street and the lower sections of Cottage Creek, under flood in 1908

By 1915, flooding had become so frequent that the Public Works Department was petitioned to prepare schemes to augment drainage in Newcastle, Hamilton, Wickham, Merewether, Lambton and Adamstown. A branch of Throsby Creek known as Houghton-Le-Springs Creek then drained the low-lying part of Mayfield. The Council at the time advised the Water Board that the creek badly needed attention. A scheme was prepared which drained the creek with an open channel stretching from Tighes Hill, under the Port Waratah railway, and then by a partly covered and partly open channel following the course of the creek, across Hanbury St to Fitzroy St. The work was undertaken by the Public Works Department in the 1920s to give work to unemployed men.

Council's Engineer, J. F. Shine said of the Cottage Creek drainage system:

> *"Its bed is an accumulation of ooze in which all debris that washes, or is thrown into the channel is caught and follows the process of decay, more or less dangerous to health, offensive and unsightly...The condition of the creek is an invitation to the large unthinking body of the public, anxious to get rid of rubbish, to throw it into the channel. The consequence is that it has become a kind of garbage dump for a great number of people who live in its vicinity." (Armstrong, J. 1967, p. 186)*

The Parliamentary Standing Committee on Public Works found that it was 'expedient' for the Cottage Creek stormwater channel to be widened and extended and work was commenced in 1925. The old concrete and rubble channel at Newcastle West was widened by removing one wall and extending the width. The channel under the railway line and Hunter St was duplicated to take the increased flow of water. The main practice of the scheme was to excavate and construct new channels through National Park and branches to Merewether, Hamilton South, Merewether East and The Glebe. Some sections were covered due to safety concerns.

With the commencement of the Cottage Creek scheme, residents of the Throsby Creek catchment began to complain about insufficient drainage in their area. There was concern that the reclamation of land in the northern harbour outlet of Throsby Creek would cause serious flooding. Flooding was also a concern between Gregson Park, Hamilton and Broadmeadow Railway Station, which was drained by Styx Creek, a branch of Throsby Creek (refer Figure 4-3).

Figure 4-3 Historical photo of Gregson Park in flood in 1908

In 1928, the Assistant Colonial Treasurer, B. S. Stevens agreed to the Throsby Creek stormwater scheme, principally to alleviate the acute unemployment situation. The Public Works Department regraded and concreted the old earth channels of the Throsby Creek system to increase the velocity of run-off (refer Figure 4-4). The work took the total length of the new drainage system to 42km. As part of the project, the drainage of residential areas near Broadmeadow Station, Newcastle Racecourse and Adamstown West was diverted from Styx Creek to a new underground system with an outlet near the showground. In the 1930s, the Government handed the drains of the Cottage and Throsby Creek Systems over to the Water Board. Constructed sections of the Jesmond and Wallsend system were handed over in 1953. The Wallsend system had been constructed by the government around the turn of the century, while the Jesmond system was built in 1938-39.

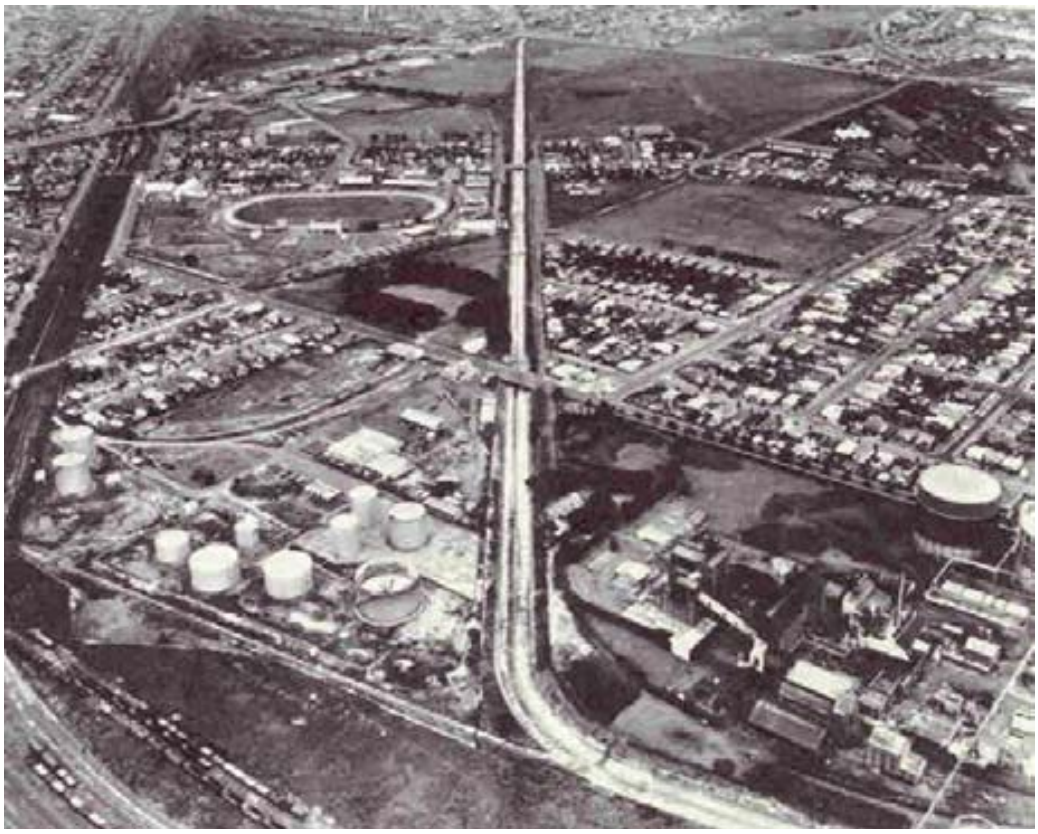


Figure 4-4 The main channel of Throsby Creek originally of earth, was reconstructed with concrete during the Depression. (Source: Armstrong, J., 1967) *in NCC(2005)*

Urban communities were first established in Newcastle in the early 1800s. The urbanisation of the city has continued from those early days to the point that now over 60% of the original landscape has been replaced by houses, commercial and industrial developments, roads and other forms of community infrastructure.

Community comments often include thinking such as “the main drains were built a long time ago and there has been a lot of development since then – so they need to be made bigger to cope with the additional development and stop the flooding”. However, it is important to understand:

- It was not possible for previous generations to confidently calculate how big a drain should be to convey a chosen amount of rainfall and runoff from a catchment with a specific proportion of development. Only simple 'rules of thumb' were used, without a firm scientific basis;
- Even as late as the 1950's, Australian drainage designers were using British rainfall figures, which did not make allowance for the extreme rates of rainfall that occur in Australian climates - but do not occur in Britain; and
- The major drains could never remove major and overwhelming flooding. This is because the built major drains do not follow the natural flood paths. In times of major rainfall nature simply reclaims these natural flow paths. This is illustrated and explained below.

4.2.2 Works Proposed in the Past, but Not Pursued (and why)

Works in this context means proposed physical changes to the natural and human built environments aimed at reducing the impacts of flooding. Most often this equates to ideas aimed at changing the ways floods behave, meaning reducing or stopping flooding in areas where human activity is disadvantaged by inundation. This concept is nothing new. Ideas (and actions) aimed at controlling floods have been proposed in many ancient cultures. Levees have been proposed (and constructed) for example by the ancient Chinese.

Before the physical sciences and engineering were able to estimate in advance how ideas to modify flood behaviours would perform to assess whether or not to go ahead with construction, there were many unexpected and unwanted results, sometimes leading to catastrophic outcomes and the loss of many lives. Fortunately we now have the ability to calculate in advance (using sophisticated and complex mathematical computer simulations) what the physical changes to flooding would likely be for different size and likelihood floods. The advantages, disadvantages and costs can then be assessed. Broader social, economic and environmental factors can also be considered to help make these decisions.

Our predictive abilities now means many proposed works, which may have seemed at first to be good ideas, have been shown to be not worth building, or worse – may have undesirable consequences (such as worsening flooding in other places where this would be unacceptable).

Some examples of flood mitigation works that have been proposed in the Newcastle Local Government Area and subsequently not pursued include:

- **Cutting a bypass channel in the Hunter River at Hexham:** Flood simulations showed there would only be a small reduction in the flood levels – and the cost would be very high;
- **Dredge the Hunter River** (In some events could increase flooding in the lower reaches, high cost – about $90m – and on-going maintenance into perpetuity, as well as environmental impacts. It is noted that dredging in the river is already undertaken from time to time for navigational purposes);
- **Build flood mitigation dams in the Hunter River catchment:** The volumes of storage would be too large – and it is difficult to ensure vacant flood mitigation capacities of dams would be not be used for additional water storage, particularly in the threat of drought. Furthermore, these dams would only potentially address river flooding, whereas flash flooding and ocean flooding tend to represent a greater risk to the Newcastle LGA;

- **Build large detention basins in parks and smaller detention basins in the upper reaches of urbanised catchments to control flash flooding in the suburbs:** The volumes of water are so large – even in flash flood events like the 1988, 1990 and 2007 events – that the differences in flood levels would be small and not worthwhile. In other words, the retarding basin would need to be impractically deep, or the areas much greater than available land. In extremely large floods the additional time afforded to enable people to evacuate would not be helpful – for example only an additional five minutes for Wallsend Commercial Centre. Parks where detention basins have been considered and evaluated include:
  - Aries Way / Taurus St Reserve and Elermore vale Park Elermore Vale;
  - Upper reserve and Wallsend Park Wallsend**;**
  - Wallsend Brickworks Park, Jesmond Park, Heaton Park Jesmond;
  - Park near Henry and Pilkington Streets North Lambton;
  - Lambton Park, District Park, St Pius Oval, Johnson Park, Richley Reserve and Kotara Park – all within the Throsby / Styx Creek catchment;
  - "International Sports Centre" and Trotting Track Broadmeadow; and
  - National Park The Junction.
- **Construct levees near Stormwater Channels:** Generally not feasible since levees would need to be too high, and drainage problems on the upstream side would be created;
- **Widen Stormwater Channels:** The extent needed to prevent flooding would be too great. For example, the existing channel through the Wallsend Commercial Centre would need to be about 5 times its present width. This would be too disruptive to the functioning of the commercial centre itself – notwithstanding the cost;
- **Concrete line open unlined channels:** There would not be a significant and worthwhile reduction in flood levels (for example, downstream of Sandgate Road Birmingham Gardens it was estimated in the 1990's that concrete lining would only achieve about a 1 cm drop in 1% AEP flood levels – because the culvert at Sandgate Rd is the control, along with the flat grades, and the downstream water levels in Hexham Swamp).

Further consideration of some of these past proposals are discussed further in the Options Section of this report (refer Chapter 6).

4.2.3 Buy-Back of Flood Affected Properties

CofN, with significant State and Commonwealth Government financial support, has progressively been purchasing properties exposed to significant flood risk on a voluntary basis. Four residential properties in Croudace Road Elermore Vale were purchased and demolished by CofN – and one additional CofN owned residential property was demolished because of the potential risk to life from flooding in Ironbark Creek in extreme events. One property in Morgan Street Merewether has also been purchased and demolished. The land has been retuned to open space and the land use zoning adjusted to reflect this.

There is anecdotal evidence that these purchases by CofN have reinforced the seriousness of the local flood risks in the surrounding community.

Voluntary purchase is considered a high cost flood management measure, particularly as it targets individual properties only. However, for properties that are exposed to extreme flood risk, voluntary purchase is one of the only ways to remove such significant risks to life.

4.3 Living with Flood Risks

4.3.1 Legal and Planning Controls

The prime responsibility for planning and management of flood prone land in New South Wales rests with local government. Management of existing and future flood risks must be investigated and advanced within a legislative, legal, policy and planning framework.

In New South Wales the primary legislation governing Councils is the *Local Government Act (1993).* A key qualifier of Council's role in floodplain risk management is specifically identified in *s733* of the Local Government Act which specifies that council's do not incur any liability in respect of any advice furnished in good faith by the council relating to the likelihood of any land being flooded or the nature or extent of any such flooding, or anything done or omitted to be done in good faith by the council in so far as it relates to the likelihood of land being flooded or the nature or extent of any such flooding.

Section 733 of the *Local Government Act 199*3 protects councils from liability if they have followed the requirements of the Floodplain Development Manual (2005). The NSW Flood Prone Land Policy and a Floodplain Development Manual (2005) form the basis of floodplain management in New South Wales, as are discussed further below.

4.3.1.1 The NSW Flood Prone Land Policy

The NSW Flood Prone Lands Policy aims to reduce personal and public losses and impacts associated with flooding. The Policy does not attempt to preclude development from the floodplain, but rather, recognises the importance of floodplains for development purposes. The Policy promotes a merit-based approach to floodplain development, wherein all social, economic and ecological consequences are to be considered.

The merit-based approach of the Policy requires a holistic approach by Councils and other consent authorities when prescribing responses and requirements for existing and future development in accordance with the principles of the Floodplain Development Manual (2005). The Manual aims at a fundamental consistency of approach across Councils, and in particular seeks to clarify "the intent … with respect to the determination of Flood Planning Levels and the consideration of rare floods up to the PMF (which) will reduce the potential for inconsistent interpretation by consent authorities".

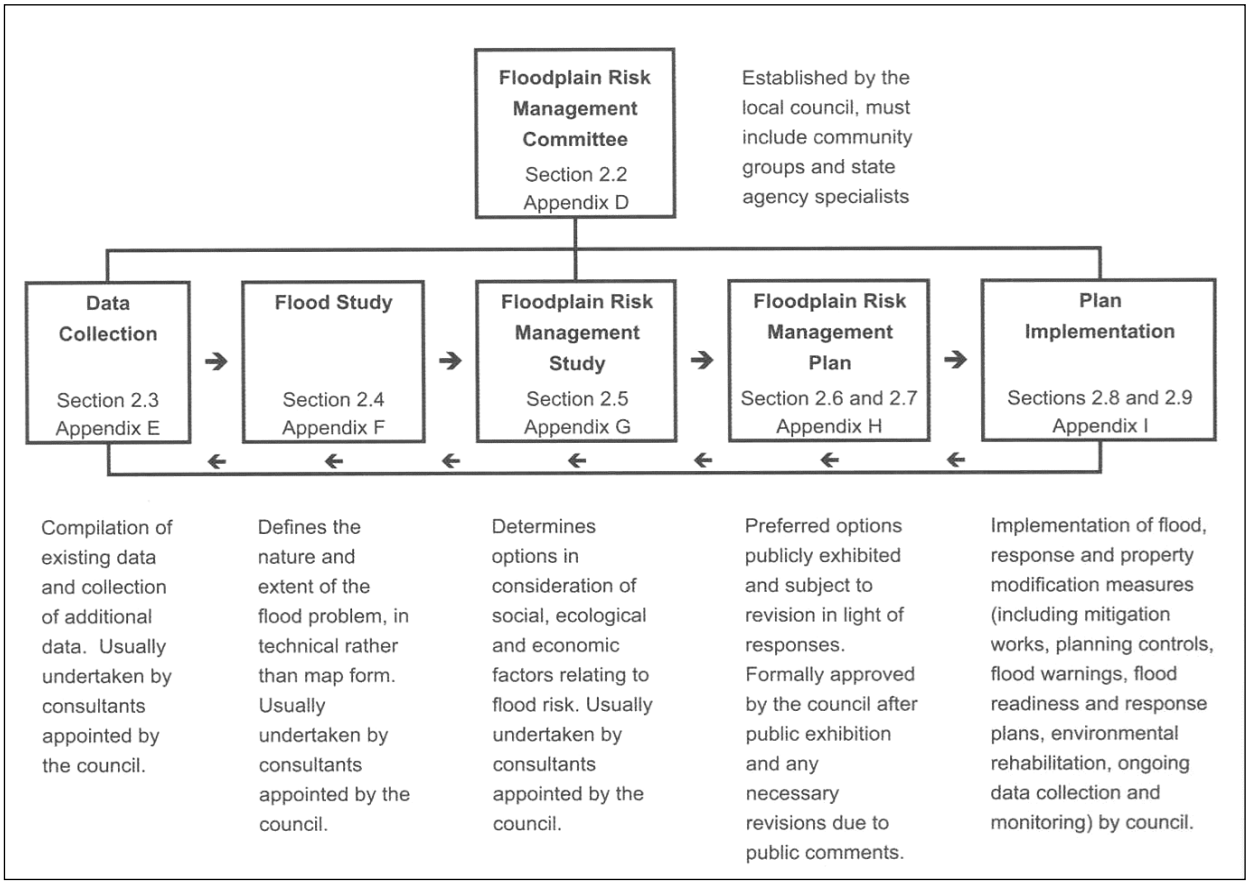
The Policy aims to redress flood risk issues for existing (legacy) development through flood mitigation works and measures, while flood risks for future development should be managed by applying appropriate planning and development controls. Ultimately, the Policy requires that management of flood risks should be based on an integrated mix of management measures that address existing, future, and continuing risk (that is the latent or residual risk that still remains after all tangible management measures are implemented) up to the PMF.

The policy is directed towards providing solutions to existing flooding problems in developed areas and ensuring that new development is compatible with the flood hazard and does not create additional flooding problems in other areas. The Policy and recommendations on how to apply the

principles of the Policy are defined in the NSW Government's Floodplain Development Manual (2005).

4.3.1.2 The NSW Floodplain Development Manual (2005)

The NSW Floodplain Development Manual (2005) presents general principles and a process for flood risk management, to enable councils and associated committees to understand flood behaviour, impacts and risks to communities. The Manual has been prepared to assist councils prepare flood risk plans through a staged floodplain risk management process, as defined in Figure 4-5.



Note: references refer to sections of the Floodplain Development Manual (2005)

Figure 4-5 NSW Government Floodplain Management Process (Source: Floodplain Development Manual, 2005)

The Manual describes current best-practice for management of flood risks, giving consideration to the full spectrum of possible floods, right up to the Probable Maximum Flood (PMF).

The basic stages of floodplain risk management are:

1	Flood Study	Determines the nature and extent of the flood problem
2	Management Study	Evaluates options for the existing and proposed developments

3	Flood Risk Plan	Formal adoption by Council of a plan of management for the floodplain.
4	Implement Plan	Construction works and other actions to protect existing development and people. Modify planning controls to ensure new development is compatible with the hazard, implement community education and emergency management plans and undertake works to private property.

The relationship of flood planning with emergency management planning is provided in Figure 4-6.

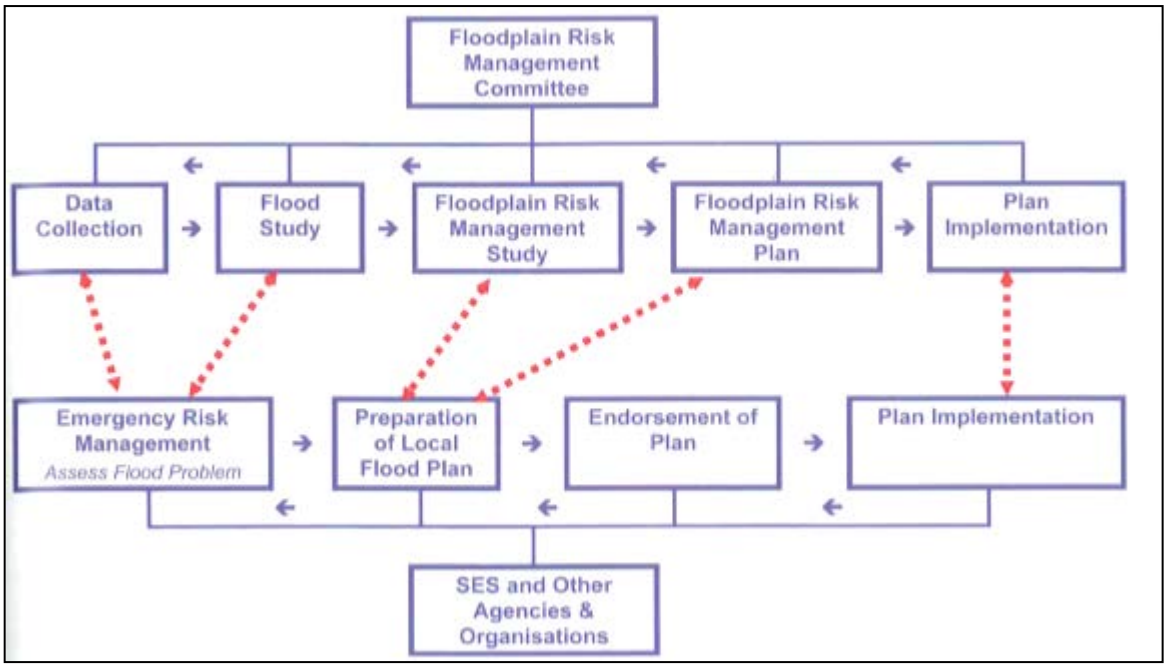


Figure 4-6 Relationship of Floodplain Risk Management Plan to SES's Local Flood Plan

4.3.2 CofN Planning Controls

The principal planning mechanism for managing floodplain within CofN is provided through:

- Newcastle Flood Policy (2004);
- Newcastle Local Environmental Plan (2003), Newcastle City Centre Local Environment Plan (2008), Draft Newcastle Local Environmental Plan (2012);
- Newcastle Development Control Plan (2005), Newcastle Development Control Plan (2011) – adopted but yet be become operational (as of 22/3/12).

Land use planning and development controls are a key mechanism by which CofN can manage future flood risk by legally controlling and directing future development and redevelopment of private and public lands. Because of the incremental nature of development, the benefits of flood planning controls may not be realised for many years. Local Environment Plans (LEP) and Development Control Plans (DCP) can be amended at any stage in the future hence the opportunity always remains to improve flood planning controls as our understanding of flood risks become more refined.

One of the future challenges of CofN will be managing the potential flood risks associated with climate change and sea level rise. Without intervention, certain localities within the LGA will experience gradual changes in flooding frequency, duration and depth as time passes. The LEP and DCP are potentially key mechanisms by which to pre-emptively adapt to this future.

4.3.2.1 Newcastle Flood Policy (2004)

The Newcastle Flood Policy, adopted by CofN on 23 March 2004, has been CofNs principal guiding mechanisms for flood management (in accordance with Appendix C of the Floodplain Development Manual (2005)). The development and adoption of this City-wide Flood Plan will eventually succeed the existing Newcastle Flood Policy.

The Flood Policy aimed to provide a Newcastle context to the more general NSW Flood Prone Lands Policy and set out a framework for reducing the impacts of flooding and flood liability by adopting a merit approach to existing and future development and flood management measures.

Objectives of the policy include:

- To ensure that the use and development of flood prone land (in Newcastle):
  - Has risk consequences that are acceptable to the community;
  - Takes into account the full spectrum of flood risks (i.e. up to the PMF) across all risk dimensions;
  - Recognises the social, economic and environmental values of flood prone land; and
  - Is consistent with the principles contained in the Floodplain (Development) Manual.
- To ensure that flood risk is considered as early as possible in the planning and development process;
- To ensure that planning and development decisions affecting flood prone land take into account the best available information;
- To avoid unnecessary restrictions on the development of flood prone land through consideration of the full range of issues;
- To ensure that the CofN exercises its functions relating to flood risk management with reasonable care and diligence;
- To facilitate the on-going collection of flood information, and the orderly provision of such information to the public; and
- To promote interaction between the CofN's flood risk management activities and provide information to assist emergency management undertaken by the SES and the Newcastle Local Emergency Management Committee (LEMC).

The Policy set out nine general principles to be considered when making decisions for flood prone lands. These principles, which are described in detail within the policy, are:

1. Consideration of the full range of issues (including potential opportunities and losses for utilisation of flood prone land);
2. Strategic assessment (including possible cumulative impacts);

3. Intra- and inter-generational equity (promoting equitable sharing of risk both now and into the future);
4. Conservation of biodiversity and ecological integrity (to protect and maintain the continuity of existing environmental values);
5. Uncertainty (in flood information and understanding) and thus precautionary behaviour (particularly if there are serious or irreversible consequences);
6. Consideration of full flood risk (up to the PMF event, and across all risk dimensions);
7. Adopted risk-to-life principles (with criteria for risk-to-life based on PMF flood conditions);
8. Adopted risk-to-property principles (with criteria of Flood Planning Level corresponding to 1% AEP flood); and
9. Integration with emergency management (to not have adverse consequences for issues such as evacuation and flood warning).

A copy of CofN's Flood Policy is provided in Appendix B.

4.3.2.2 Newcastle Local Environmental Plan

Local Environmental Plans (LEP) are prepared in accordance with Part 3 Division 4 of the *Environmental Planning and Assessment Act 1979*. The intent of the LEP is to define the legal framework for land use and development by 'zoning' all land. The LEP incorporates standard planning provisions, clauses, definitions and zones into the one document. It identifies standard zones and zone objectives and specifies permitted and prohibited uses in zones, and identifies compulsory and optional provisions.

An LEP is essentially a legal document of words and maps which sets out the legal standards or requirements for development to control the use of private and public land. Newcastle is currently in the process of updating the city's Local Environmental Plan in accordance with the NSW Government Standard LEP template, which is intended to provide consistency in planning terminology and structure across the state.

The Minister for Planning, under section 117(2) of the Environmental Planning and Assessment Act 1979 (EP&A Act) issues directions that relevant planning authorities such as local councils must follow when preparing planning proposals for new LEPs. On the 31st January 2007, the Minister released Direction No. 15 – Flood Prone Land to apply when a council prepares a draft LEP that creates, removes or alters a zone or a provision that affects flood prone land. While the Section 117(2) Direction clearly states that the LEP shall be consistent with The 2005 Manual, Planning Circular PS07-003 and Clause 7.3 of the LEP Standard Instrument seem to have abandoned the risk management approach set out in the Floodplain Development Manual (2005) and reverted floodplain risk management back some 20 or 30 years to a standardised flood planning level of the 100 year ARI flood (1% AEP) with no requirement to consider all the possible consequences of flooding. For example, in the Hawkesbury-Nepean floodplain, the flood of record (i.e. a real flood) is more than 2m (i.e. one storey) higher than the 100 year flood.

Clearly there is a risk to life in floods greater than the 100 year flood. CofN recognises risk to life for the full range of flood risks up to and including the PMF. For flash flooding, managing risk to life for

overwhelming flood events is the dominant consideration development consideration. In many cases this means specific consent conditions are required to manage risk to life for floods less likely than the 1% AEP – including for residential development. For example an upper storey refuge above the PMF may be required. These requirements are not possible under the present draft model clauses.

Given the above, Council negotiated with the Department of Planning and Infrastructure to have no flood clause in its draft LEP, and instead rely on the Flood Management provisions of Council's adopted Development Control Plan (2005). These provision have been preserved in Council's companion revised Newcastle Development Control Plan, which will become effective when the Draft LEP is gazetted. At the time of writing Council's draft LEP (with no model flood clause) is in the final stages of review by the NSW Government before Gazettal.

4.3.2.3 Newcastle Development Control Plan (2005)

The Newcastle Development Control Plan 2005 provides guidelines to Development Applications for assessment by CofN. Element 4.3 of CofN's Development Control Plan addresses flood management, and applies to all development on flood prone land, as identified through CofN's flood certificates. The DCP aims to apply elements of the Newcastle Flood Policy in relation to proposed future development. The DCP provides specific guidelines on development within flood prone land. In particular, the DCP provides guidelines on:

- Development within floodways;
- Development within flood storage areas;
- Measures to minimise risks to property (linked to the Flood Planning Level);
- Measures to minimise risks to life (in particular, on site refuge for flash flooding only); and
- Riparian zone management and restoration.

Element 4.3 Flood Management is supported by the Newcastle Flood Management Technical Manual, which is intended to provide technical support and additional information. A copy of the relevant section of CofN's DCP is provided in Appendix B.

The new Newcastle DCP (2011), which will come into force when the draft LEP is adopted, preserves the flood management provisions of the 2005 DCP. This includes provisions associated with maximum building heights, maximum floor space ratios and minimum lot sizes to control future development on certain sites, and are considered to be possible avenues for managing density of development within the floodplain.

4.3.2.4 Newcastle 2030: Community Strategic Plan

In 2009, the NSW State Government introduced the Integrated Planning and Reporting framework. Under this framework, a document hierarchy has been established beginning with Newcastle 2030 (refer Figure 4-7). A long term community vision for Newcastle was established through the Newcastle 2030 Community Strategic Plan. Through consultation, seven strategic directions were established. These were:

- Connected City;
- Protected and Enhanced Environment;

- Vibrant and Activated Public Places;
- Caring and Inclusive Community;
- Liveable and Distinct built Environment;
- Smart and Innovative City; and
- Open and Collaborative Leadership

The City-wide Floodplain Risk Management Plan is identified as one of several major projects that will help the city achieve its future strategic vision and objectives.

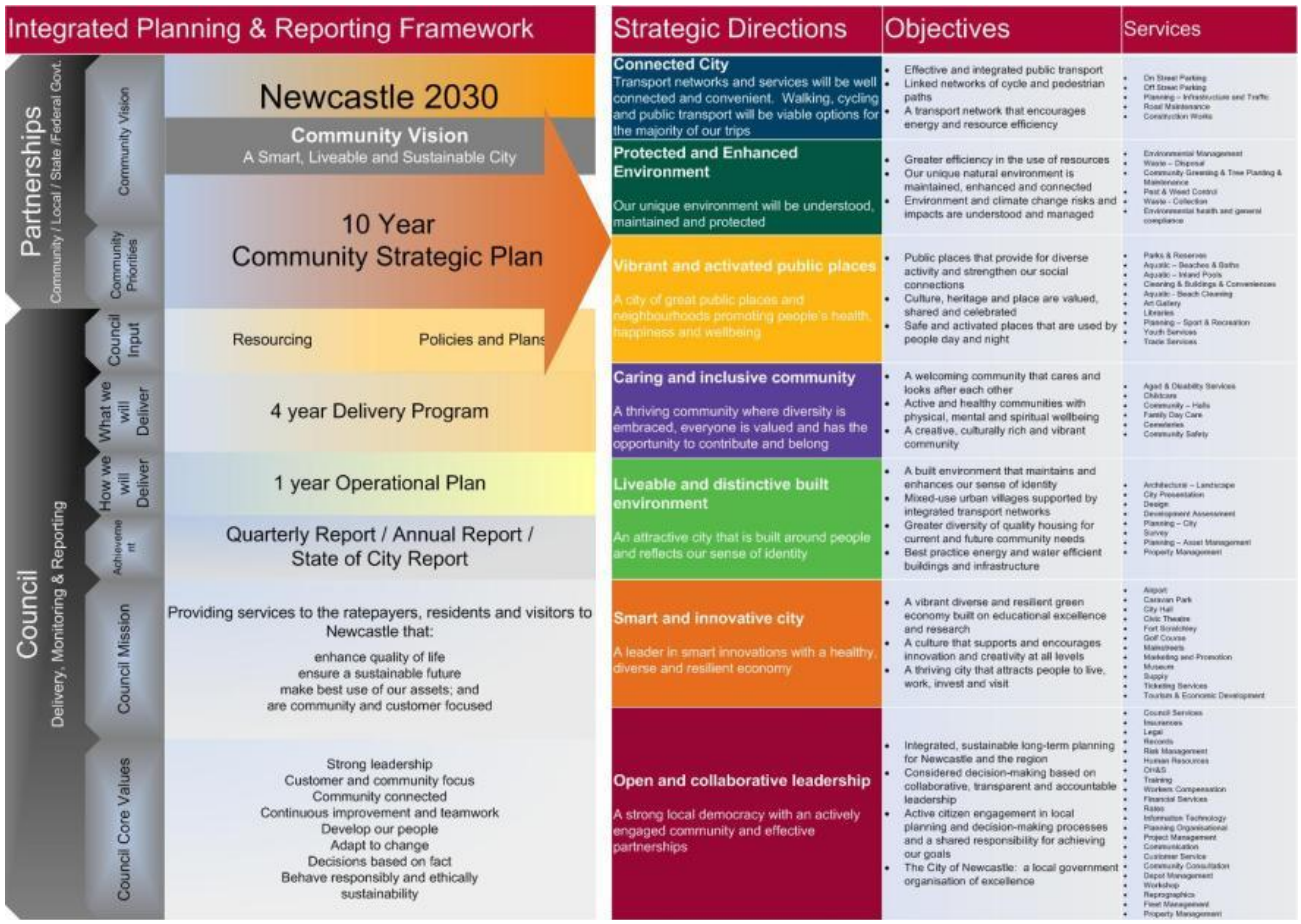


Figure 4-7 Newcastle's Integrated Planning and Reporting Framework

4.3.3 Flood Education Programs

The CofN website www.emergencynewcastle.com.au is the central information tool to educate the community about emergency response in Newcastle. The site contains practical tips and useful contact details to help people who live and work in the city.

There were a large number of flood enquiries made to CofN following the devastating June 2007 storm event. CofN and HWC jointly produced a flood brochure in response to these community concerns and questions to inform people living in the Newcastle LGA. The brochure "Living with

floods in Newcastle" updates a previous version prepared and distributed in 2003. A copy of this brochure is provided in Appendix C.

The NSW SES provides general information about emergency management including flood response but they do not provide specific flood emergency information for the Newcastle region. The SES has recently established a Hunter Regional Community Engagement Officer. There is potential scope for flood education through this position but this is yet to be established.

On a regional scale, the Hunter-Central Rivers Catchment Management Authority has been working in partnership with the SES and the community of Maitland to develop a Community Flood Education Strategy for Maitland and the Hunter Valley. A number of initiatives to improve community flood preparedness within the local community and a number of resources have been developed through the implementation of the strategy.

4.3.4 Signage and Commemorative Markers

CofN received a $25,000 grant to install June 2007 flood level commemorative marker signs as well as "Road Subject to flooding – Indicators show depth" signs and associated indicator poles at key locations across the City.

These markers are intended to help raise awareness regarding flood impacts, and offer some degree of information to motorists and pedestrians during an event in the future to help with more rational decision-making (i.e. preventing people driving into waters of unknown depths).

Locations where these have been installed are:

- King Street Newcastle;
- Steel and Parry Streets Newcastle;
- Queen Street Waratah (near University Drive);
- Minmi Road Wallsend; and
- In and around Wallsend Commercial Centre.

4.4 Emergency Management

4.4.1 SES Flood Plan

The SES Flood Plan needs to recognise the varied flood emergencies that develop from the different types of flooding that affect Newcastle LGA (viz: river flooding, flash flooding, ocean flooding). The SES is responsible for evacuating current populations to flood-free areas (i.e. above the PMF level), ahead of a flood rising as fast as a PMF, based on flood warnings provided by the BoM. It is recognised though that even with an excellent plan and warning system, circumstances can still occur that would prevent all people leaving before flood waters arrive. Should people be unwilling or unable to evacuate, the consequences of failure to evacuate need to be considered when deciding if other floodplain management options need to be implemented to manage this residual life risk.

With regard to river flooding within the Newcastle LGA, investigations showed that current populations should have sufficient time to evacuate by car along existing roads to flood free areas. Should people fail to evacuate by vehicle from areas around the fringes of Hexham Swamp, such as

Birmingham Gardens or Shortland in advance of the floodwaters, the terrain is such that most would be able to walk to flood free land ahead of rising floodwaters. The cluster of properties at Hexham on the other hand can have evacuation routes cut by floodwaters before water is directly threatening properties. In large floods these properties could then be overwhelmed and even destroyed by floodwaters.

Figure 4-8 shows those areas where people could be trapped if they do not evacuate ahead of river flooding and those areas where they would be able to walk to safety if they waited for flood waters to arrive. There are about 2,000 people at risk from river flooding in a PMF, and 200 could be trapped and overwhelmed on islands should they fail to evacuate. Evacuation would not only reduce risks to lives but removal of vehicles and the relocation of some building contents would also reduce risks to property.

These areas have not experienced flooding since 1971 and the scale of flooding that would trigger mass evacuations today has not been seen since 1955. Of the few people from these areas who attended the community meetings held in 2010 and 2011 in relation to this project, most expressed the view that they would not evacuate in the event of a flood. It was therefore concluded that flood warning, evacuation planning and community education are paramount in addressing the significant and potentially life threatening risks associated with riverine flooding.

As discussed further in Section 6.4.3.2, evacuation from areas affected by ocean flooding would be achievable given that ocean flooding would generally be predicted at least a day in advance. However, as populations in Newcastle have never had a need to evacuate due to ocean flooding, there may be reticence to follow directions given by emergency services and combat agencies, possibly until it becomes too late. Figure 4-9 highlights the areas potentially affected by ocean flooding where evacuation routes can be restricted.

Evacuation due to flash flooding is expected to be very difficult to achieve. With little to no warning time, the large population affected by flash flooding across the Newcastle LGA would have minimal opportunity for assistance by emergency services and combat agencies. Although commonsense may prevail in most situations with people simply driving or walking uphill to the closest refuge, it is expected that many people would become trapped with roads and routes considered unsafe for evacuation. Shelter in place would become the priority for personal safety for these individuals facing such circumstances. It is possible that virtually *all* properties within the flash flood PMF extents could have restricted evacuation opportunities (including some 10,000 properties that would be flooded above floor level).

CofN has transferred its City-wide flood modelling results to the SES to assist them in their preparation of the Newcastle Flood Emergency Plan, which for the first time will include flash flooding as well as riverine flooding. The SES-produced Newcastle Flood Emergency Plan will be a separate document and has a different purpose to CofN's development of a City-wide Floodplain Risk Management Plan. The two are complementary, however, the SES document is to be focused on emergency response during and after floods, while CofN's City-wide Flood Plan focuses on documenting flood information and establishing a framework for risk management and all practical measures to manage the flood risks before flooding occurs.

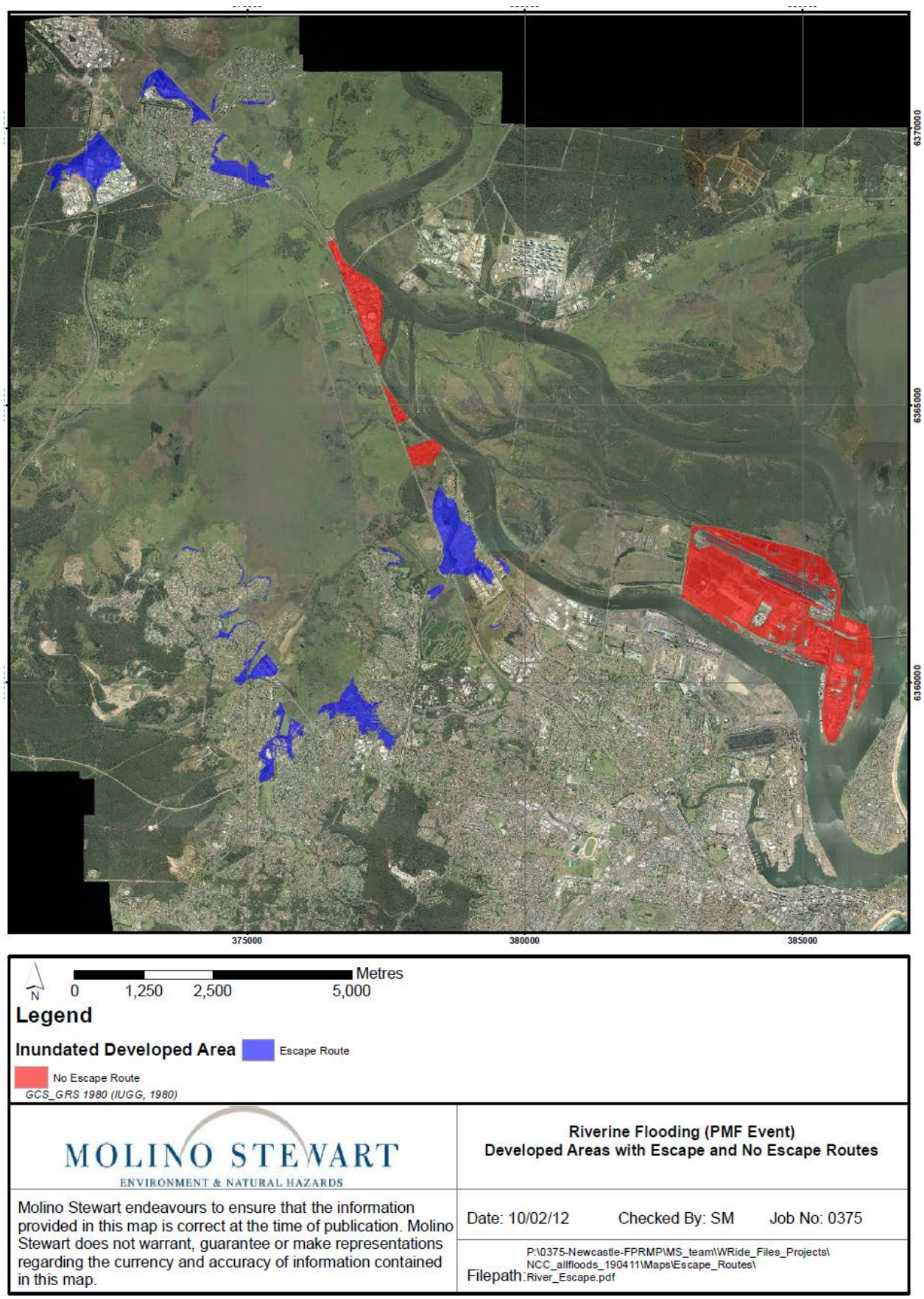
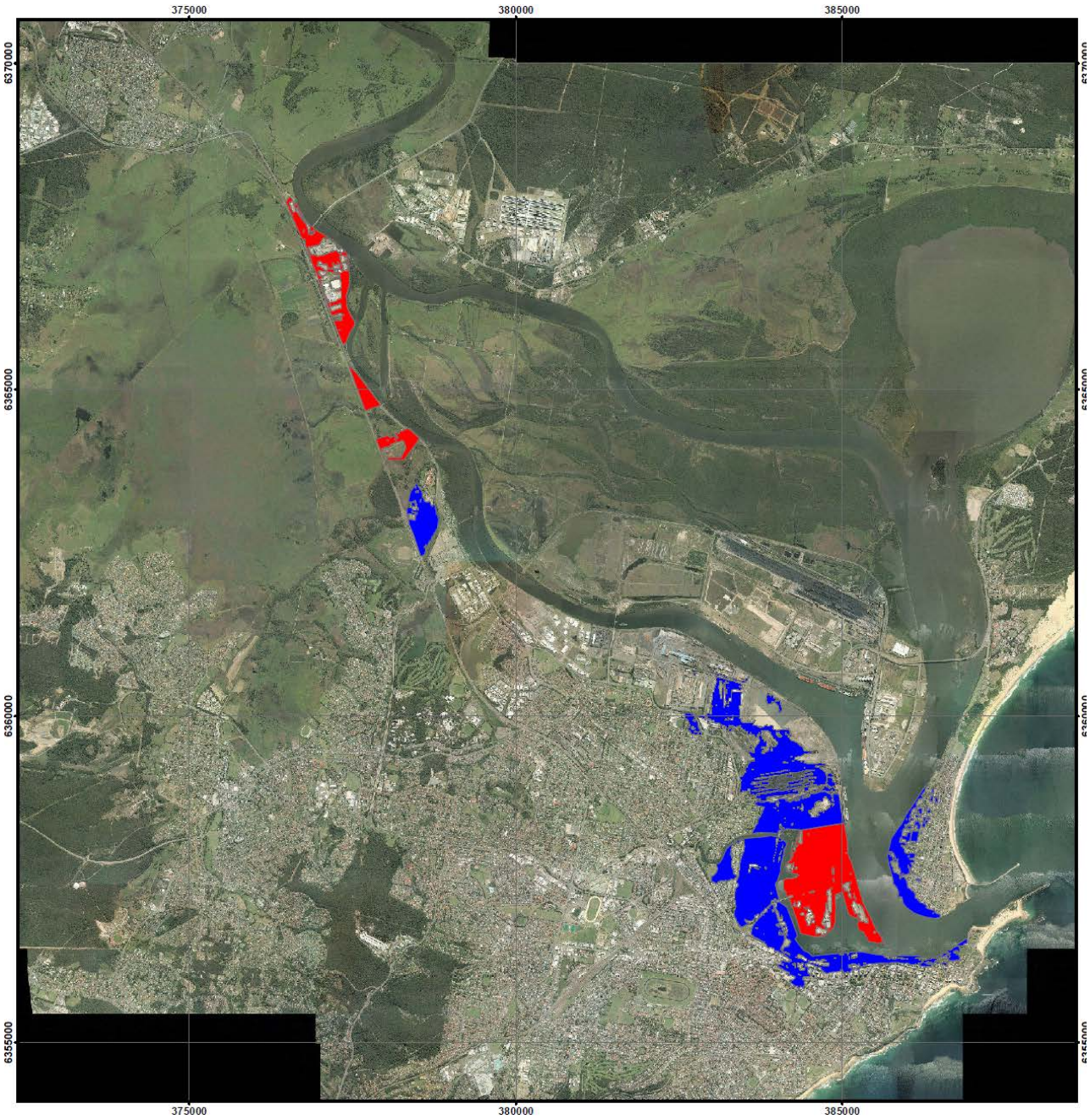


Figure 4-8 Areas affected by River Flooding with and without Escape Routes



N
0 1,250 2,500 5,000 Metres

Legend

Inundated Developed Area Escape Route

No Escape Route

GCS_GRS 1980 (IUGG, 1980)

MOLINO STEWART
ENVIRONMENT & NATURAL HAZARDS

Oceanic Flooding (PMF Event)
Developed Areas with Escape and No Escape Routes

Molino Stewart endeavours to ensure that the information provided in this map is correct at the time of publication. Molino Stewart does not warrant, guarantee or make representations regarding the currency and accuracy of information contained in this map.

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Figure 4-9 Areas affected by Ocean Flooding with and without Escape Routes

An example where this City-wide Flood Plan development will significantly contribute to the SES-produced Newcastle Flood Emergency Plan is enabling the full range of potential flood risks to to be identified – especially the extent and nature of potential risk to life in extreme and overwhelming flash flooding in the suburbs of Newcastle – being more linked to vehicles in transit and the expected impossibility of evacuating people to high ground. The SES will then be enabled to consider these emergency management risks in the preparation of its Newcastle Flood Emergency Plan. The identification of these upper bound limits and challenges by CofN fulfils a key principle of the Floodplain Development Manual (2005).

4.4.2 Flood Evacuation and Emergency Planning

4.4.2.1 Flash Flooding

It would be unrealistic to expect the SES to be able to undertake much in the way of emergency response during a flash flood for several reasons:

- The SES is principally a volunteer organization and the time required to mobilise personnel could exceed the warning time available;
- Many of the principal roads within Newcastle are cut early in flash floods making access difficult for mobilising or responding; and
- There is generally insufficient time to undertake tasks such as sandbagging or evacuation to reduce impacts on property or people.

Given the above, the SES's role in flash flooding is generally to execute rescues and assist with recovery.

4.4.2.2 River Flooding

Consultation contributing to the development of this City-wide Flood Plan revealed emergency management for Hunter River flooding would likely benefit from the opportunity of continued community education and maintenance of the nature of the full range of potential risks and the need to evacuate to high ground. This is especially critical in the area of Hexham because if people do not evacuate in the event of major or more severe flooding, then they will become trapped in life threatening situations – and there would likely be a reluctance to place rescue personnel in danger to attempt their recovery.

At the time of writing, consensus within the SES was that on site shelter in place provision should not be required for new development – nor retro fitted to existing development.

4.4.2.3 Ocean Flooding

Aside from shallow flooding in roads and some property in periods of high tides around some areas close to Newcastle Harbour and the Hunter River in low lying lands, there has not been a history of frequent ocean flooding to first inform and then maintain community awareness. There may therefore be reluctance of affected people to comply with evacuation orders – and more so when the ocean waters are not yet appearing on land or in buildings. It is recommended that the SES consider this potential 'inertia' when it prepares its Newcastle Flood Emergency Plan. The present (and future) possible degrees of the ocean inundation can be supplied by CofN.

4.4.3 Flood Warnings

It should be recognised that a flood warning system or the SES Flood Emergency Plan cannot be relied upon alone to provide an appropriate level of protection, particularly the protection of lives.

4.4.3.1 Flash Flooding

Flash flooding generally occurs with little warning. For catchments like Newcastle, once rainfall intensifies to a level of concern, the opportunity for effective response to warnings has largely elapsed. Warnings for flash floods therefore need to involve real-time collection of information covering localities beyond the immediate area of concern.

CofN has undertaken the installation of a network of telemetered rainfall and water level gauges across the city. Six (6) existing HWC raingauges have been upgraded as part of the works, while an addition four (4) new raingauges have been installed. Two (2) new water level gauges have also been installed at locations upstream of the Wallsend and Kotara Business Districts.

The gauges provide real-time information directly to the BoM to enable them to provide improved flood warnings both to the SES and directly to the community (through their website and media releases). It is envisaged that the real-time data could be interpreted in combination with data from other nearby stations (outside the LGA) as well as the Lemon Tree Passage radar to provide the best warning possible for impending flash floods within the Newcastle metropolitan area.

4.4.3.2 River Flooding

Rivers have large catchments that take an extended time to mobilise and form a flood wave, which then may take days to weeks to travel to the outlet. Generous warning times are possible for riverine floodplains, and predictions can be adjusted during the course of the flood. The technology and practice of flood warnings for larger river systems is relatively well established and reliable.

However, the lower reaches of the Hunter are tidally affected – and the BoM does not currently take this into account in present warnings. In the 2007 floods, CofN's modelling consultant for the Hunter River undertook simulations of tidal influences on the emerging Hunter River flood forecasts further upstream, to provide advice on a trigger water level at the Raymond Terrace gauge on whether or not to evacuate Hexham. The consultant's prediction and trigger proved correct and avoided the unnecessary evacuation of Hexham, which might otherwise have had to be called in the absences of such more specific and accurate capacity to predict flood levels for real floods downstream of Hexham Bridge.

Improvement of the predictive components of warning systems for the tidally affected parts of the Lower Hunter would be expected to increase community confidence and compliance, and assist the SES in its flood planning and emergency response.

4.4.3.3 Ocean Flooding

There are presently no ocean flood warnings issued by the BoM. Coastal warnings are issued, however, these are focused on wind and wave conditions, and do not relate to the potential for inundation of inland waters due to elevated sea levels and storm surge.

It is expected that storm surge levels could be determined relatively easily from barometric conditions, and added to tidal predictions, to give a more accurate estimate of ocean levels and the propensity for ocean flooding.

4.4.3.4 A Future "Systems Approach"

A Flood Warning System must be developed and managed as a whole. A failure of one element can lead to complete failure. Although weather / environmental detection equipment and alarms are key elements, a complete flood warning system comprises:

- Data collection and transmission equipment;
- Communication equipment (public and private) / protocols;
- "Trigger" criteria;
- Response to the "trigger" such as:
  - Monitor closely, OR
  - Issue advice such as:
    - Watch and wait for further advice, OR
    - Prepare (e.g. make sure refuges are accessible) OR
    - Act: (e.g. stay away from car parks and go to upper storey refuges);
- Predetermined, documented likely necessary evasive actions for a range of possible floods (up to the PMF) including definition of roles/responsibilities in addition to the ability to adapt and make decisions "on the fly";
- People who direct others (where and if needed);
- The affected community who need to respond (who therefore need to be aware and educated how to respond before the event);
- Maintenance (equipment, organisation and education); and
- Performance review / improvement where available and warranted.

4.4.3.5 Present Flood Warning Systems

Despite the present of real-time rainfall and water level gauging, there are no complete dedicated Flash Flood Warning Systems in Newcastle

In February 2006 the BoM implemented an enhanced severe thunderstorm warning service in NSW and the ACT which uses graphics to better define the areas under threat when dangerous thunderstorms are occurring. The graphics complement the Bureau's traditional text-based warning service. Using radar based techniques a warning is issued and depicted on maps available on the internet. The maps show the general area of thunderstorm activity and individual cells are tracked at 10 minute intervals where it is judged they may produce a tornado, hail of diameter 2cm or greater, or wind gusts of 90 km/h or greater, or very heavy rain leading to flash flooding. The volatile nature of thunderstorms introduces uncertainty which is described in the Bureau's information about this system.

The Graphical Severe Thunderstorm Warning service does not meet all the flash flood warning needs of Newcastle. For example, flash flooding can be caused by storms that are not thunderstorms, and these will escape detection by this system. Also, the thunderstorms being tracked are shown for reasons in addition to or in combination with the possibility of flash flooding and therefore may not necessarily require a flash flood emergency response. There is no indication of how severe or where any rainfall will be so the severity of the flooding cannot be estimated. Finally, the information provided is only part of a total Flood Warning System (see Section 4.4.3.4 above).

At present it is not possible for a member of the community to find a direct interpretation on the Bureau of Metrology's' web site displaying summary data from the flash flood detection equipment that could be readily and confidently acted on in a flash flood emergency.

4.4.4 LEMC Role and Co-ordination During Emergency Events

The *State Emergency Rescue and Management Act 1989* provides that local government establish and provides support for a Local Emergency Management Committee which is responsible for preparing plans in relation to the prevention of, preparation for, response to and recovery from emergencies in the district for which it is constituted. In the exercise of its functions, any such Committee is responsible to the State Emergency Management Committee.

In our region, a joint Newcastle and Lake Macquarie Local Emergency Management Committee has been established which includes the following membership:

- The City of Newcastle (CofN)
- Lake Macquarie City Council
- NSW Police Service
- NSW Transport Roads and Maritime Services
- Newcastle University
- Hunter-New England Health
- Hospital (various)
- Red Cross
- NSW Rural Fire Service
- NSW Fire and Rescue
- Ambulance Service of NSW
- NSW Department of Trade and Investment
- NSW Department. of Family and Community Services
- NSW Department Industry and Investment - Fisheries
- NSW Department Trade, Infrastructure & Regional Services
- NSW SES
- NSW Department of Community Services
- NSW Department of Health

- NSW Department of Primary Industries
- Telstra
- Newcastle Port Authority
- Royal Coastal Patrol

The Newcastle Local Disaster Plan 2008 (DISPLAN) has been prepared by the Newcastle Local Emergency Management Committee in compliance with the State Emergency and Rescue Management Act, 1989 Section 29 (1). The document sets out the roles and responsibilities of agencies such as the NSW Police, SES and Fire Brigade in controlling and managing emergency situations. In addition to DISPLAN, there are a number of linked documents, such as the Newcastle CBD Emergency Arrangement, which detail special control and coordination arrangements for specific localities or issues and have been prepared as an annex to the DISPLAN.

The NSW SES is currently preparing the Newcastle City Local Flood Emergency Plan which will form one such annex to the DISPLAN. The Newcastle City Local Flood Emergency Plan will cover preparedness measures, the conduct of response operations and the coordination of immediate recovery measures from flooding within the CofN area.

5 ASSESSMENT OF CURRENT FLOOD MANAGEMENT APPROACHES

5.1 Chapter Overview

This chapter aims to define existing risks to life and property, and give an assessment of existing management approaches in trying to minimise these risks.

Fundamentally, the Floodplain Development Manual (2005) aims to:

1) minimise risks to life, and

2) minimise risks to property.

Chapter 2 drew out the key objectives and principles of the Floodplain Development Manual (2005). The key objectives and key principles of the Floodplain Development Manual (2005) are used as the essential flood management criteria in the assessment process. As guided by the Floodplain Development Manual (2005), consideration is given to:

- Existing flood risks, that is, risks to the existing community and associated development;
- Future flood risks, that is, risks that will be faced by development (and redevelopment) that is constructed in the future; and
- Continuing flood risks, that is, risks that remain for rarer events that overwhelm any mitigation works to reduce existing food risks and for rarer events than those used to derive Flood Planning Levels for future development – up to and including the PMF.

The importance of not overlooking continuing flood risks is consistently emphasised in the Floodplain Development Manual (2005), for example in the need to "develop additional management measures … to mitigate danger to personal safety associated with overwhelming flood events. (which will require) a range of management measures … necessary to manage the full range of flood risk." (sG9.2) The Floodplain Development Manual (2005) points out the need to take care not to overlook addressing certain types of risk in both existing and future development areas – including continuing risks for both existing and future development areas (refer sG7 of the Manual).

Risks associated with flooding are more complex than just considering the depths of flooding. Indeed risk to life should consider elements of personal safety during an event, such as effective warning times, and the ability to safely evacuate to higher ground, or, if not, seek shelter with the corresponding need to consider the structural integrity of refuges located within floodprone areas.

The following sections of this chapter reveal that the dominant risks associated with flooding in Newcastle have essentially manifested themselves as a consequence of historical development within flood affected areas, as well as attempts to manipulate flooding behaviour in order to restrict inundation and maximize opportunities for land occupation and utilisation. Therefore, it is shown that managing the already developed floodplains represent the greatest challenge to the City-wide Flood Plan.

The structure of this chapter reflects the categorisation of “Existing”, “Future” and “Continuing” risks as defined in the Floodplain Development Manual (2005), assessing risks to life and to property across these categorisations.

5.2 Existing Risks to Life

5.2.1 Definition

Loss of life is the worst possible consequence in the management of any hazard or risk. Therefore the consideration and management of risks that may result in loss of life become the highest priority for a community and society. Reflecting this, minimising the loss of life due to flooding is the highest priority intent of any Floodplain Risk Management Plan, as defined by the Floodplain Development Manual (2005) (refer Section 4.3.1.2).

There are many factors that potentially influence the vulnerability of particular communities, neighbourhoods and individuals to existing flood risks - especially risks to life. These factors include characteristics associated with the flood behaviour, the land in question, the building structures and the population affected (including the resident population, any temporary population, and importantly, the population in transit).

One of the most important factors in assessing risk to life is the physical flood risk, and in particular, the combination of flood depths and flood velocities. Situations whereby flood depths are shallow, but velocities are high can be just as critical as situations where flood depths are large, but velocities are low. The combination of flood depths and flood velocities (v*d) is defined as the flood hydraulic behaviour. Different values, or thresholds, for flood hydraulic behaviour helps to categorise the risk to life of people exposed to the flood, either directly as pedestrians, or indirectly inside a vehicle, or inside a building / structure. The hydraulic behaviour also aids in the categorisation of risk to property (refer Section 5.3).

The hydraulic behaviour thresholds are described in Table 5-1, which outline associated technical equations in terms of flow depth and velocity, and are presented graphically in Figure 5-1 (these equations are supported by current literature, e.g., Jonkman & Vrijling, 2008). They are not inherently tied to any particular size or likelihood of flood, but rather, they just describe the stability (or otherwise) of a chosen object (e.g. a type of building construction) in water of a particular depth and velocity.

Table 5-1 Hydraulic Behaviour Thresholds for Newcastle LGA

H1	v < 0.5m/s & d < 0.3m	Hydraulically suitable for parked or moving cars.
H2	v < 2m/s, d < 0.8m & v < 3.2 - 4*d	Hydraulically suitable for parked or moving heavy vehicles only, and for wading by able-bodied adults
H3	v < 2m/s, d < 2m, v*d < 1	Hydraulically suitable for light construction (eg timber frame and brick veneer), but not for vehicles or for wading.
H4	v < 2.5m/s, d < 2.5m, v*d < 2.5	Hydraulically suitable for heavy construction (eg steel frame and reinforced concrete) only.
H5	remainder	Generally unsuitable for any construction type.

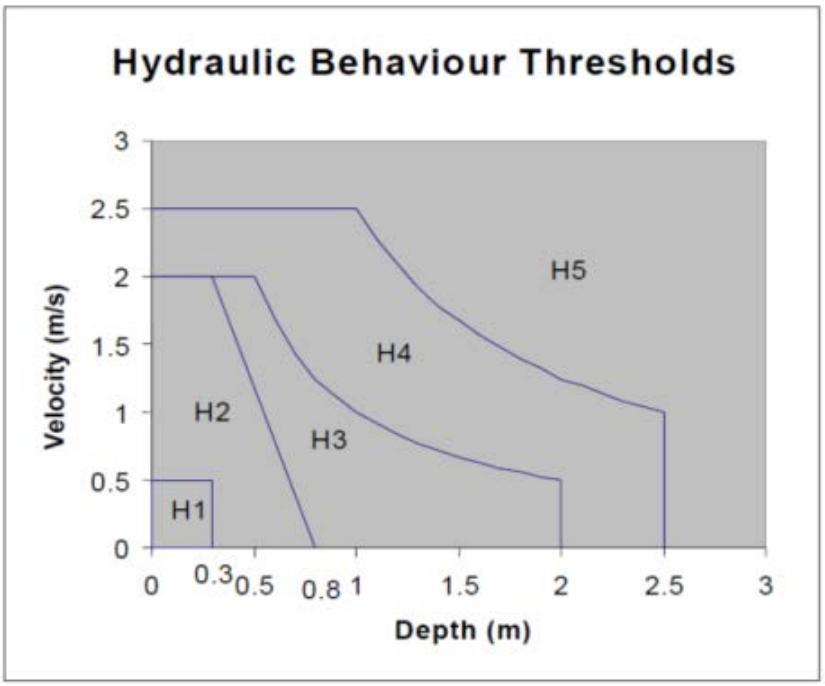


Figure 5-1 Hydraulic Behaviour Thresholds for Newcastle LGA

In addition to hydraulic behaviour, risks to life are influenced by the flooding mechanism (i.e. flash, river or ocean), as well as the availability of an evacuation route. Generally, evacuation can be expected from areas that are under threat from river or ocean flooding. As such, the risks to life in areas affected by river and ocean flooding are considered to be low. Flash flooding, however, can represent a significant risk, as there is generally little time to respond or indeed evacuate. If there is an evacuation route available, which consists of a continuously rising route to flood free land (above the PMF level), then the risks in flash flood situations are less than if no route was available (requiring either shelter-in-place, or perilous evacuation through floodwaters – not recommended).

Risks to life categorisation has therefore been developed taking into account both the availability for evacuation and the hydraulic behaviour, as presented in Table 5-2.

It should be recognised that the classification of areas as L1 based on the availability of time to remove people from flood risk makes the assumption that all affected people can and will evacuate prior to the onset of flooding. Based on feedback during the consultation program undertaken as part of this Plan, it is likely that a large number of residents in Hexham would ignore evacuation orders. It is expected that evacuation due to rising ocean water levels would be similarly met with resistance by the community. Under these circumstances, the L1 areas would still represent a very real risk to life. These issues of evacuation failure are discussed further and addressed as part of the City-wide Flood Plan.

Table 5-2 Risk to Life hazard categories and associated hydraulic behaviour thresholds (adopted at the PMF level)

				Hydraulic Behaviour Threshold				
				H1	H2	H3	H4	H5
Catchment Response Time	Riverine and Ocean Flooding			L1				
	Flash	Escape Route to flood free land	available	L2		L4		L5
			not available	L3				

Where:

L1 Riverine flooding where there is sufficient time to remove people from the risk to their lives by means of formal community evacuation plans. Not relevant to flash flooding scenarios such as the Wallsend Catchment.

L2 Short duration flash flooding with no warning time in circumstances where there is an obvious escape route to flood free land with enclosing waters during the PMF which are suitable for wading or heavy vehicles i.e. hydraulic threshold does not exceed H_2. On site flood refuge not necessary and normal light frame residential building are appropriate.

L3 Short duration flash flooding with no warning time and no obvious escape route to flood free land with enclosing waters during the PMF which are suitable for wading or heavy vehicles i.e. hydraulic threshold does not exceed H_2. On site flood refuge not necessary and normal light frame residential buildings and appropriate.

L4 Short duration flash flooding with no warning time and enclosing waters during the PMF not suitable for wading or heavy vehicles i.e. hydraulic threshold exceeds H_2. On site refuge is necessary and if hydraulic threshold exceeds H_3, heavy frame construction or suitable structural reinforcement required.

L5 Short duration flash flooding with no warning time and enclosing waters during the PMF have too much energy for normal heavy building construction and therefore it is generally not possible to construct a flood refuge i.e. hydraulic threshold is H_5. The risk to life is considered extreme and the site is unsuitable for habitation, either residential or short stay.

Maps 6A to 6D (refer ***Map Series 6*** in accompanying ***Compendium of Maps*** document) show the application of the risk to life criteria (L1 - L5) across the Newcastle LGA for flash flooding, river flooding, and ocean flooding. These Risks to Life criteria are determined based on PMF conditions. These extreme flood conditions are adopted as the Floodplain Development Manual (2005) is explicit in requiring risks to life to be considered and managed over the full range of flood events (i.e. up to the most extreme conditions, or PMF).

5.2.2 Existing Risks to Life on Roads in Newcastle

As discussed in Section 2.4.3, almost half of the flood-related deaths in Australia between 1997 and 2008 have occurred on roads (Fitzgerald *et al*., 2008). Cars can become buoyant when flooded by as little as 30cm, especially under fast flowing waters (Jonkman & Vrijling, 2008). As made evident during the June 2007 flash flood event, people will under-estimate the risks associated with driving and wading through floodwaters. Irrational behaviour and poor judgment put many lives in danger, unnecessarily.

In Newcastle, many of the arterial roads become major flowpaths during infrequent or extreme flash flood events, particularly in the New Lambton area. Unfortunately, it is considered that many people would tragically perish on roads during these significant events well before the first buildings collapse under the force of floodwaters. Roads therefore are the primary concern for risks to life in Newcastle.

Risk to life on roads is considered most critical for flash flooding events as there is little to no warning time for the onset of the flood event. For both river flooding and ocean flooding on the other hand, warning times should be sufficient for emergency services and combat agencies to set-up road closures in areas that are expected to be impacted.

Maps 7A to 7K (refer ***Map Series 7*** in accompanying ***Compendium of Maps*** document) show the existing risk to life on roads across Newcastle affected by flash flooding.

These maps classify the road network into three categories based on their propensity for risk to life. The most severe category, where there is a very high risk of endangering lives, represent those roads that become major flowpaths / floodways and/or are subject to significant flood depths (> 1 metre) during frequent (10% AEP) or infrequent (1% AEP) events. The next category captures those roads where the roads become floodways or have significant flood depths (> 1m), but at the PMF level, which has a low likelihood. The lowest category identified all remaining roads that are potentially subjected to a minimum 0.3m flood depth at the PMF level. As discussed above, only roads subject to flash flooding are included in these figures.

As shown in these maps, a large number of roads are at risk of significant inundation in either the infrequent or extreme flood events. There are many areas throughout Newcastle where channels and local flowpaths cross roads, resulting in small sections of very high risk. In addition, there are more extensive sections of road that are very vulnerable for risk to life, including:

- Merewether: Morgan, Selwyn and Wilton Streets;
- New Lambton: Bridges Rd, Penman Street, Fairfield Avenue;
- Bluegum Road, Jesmond;
- Irving Street, Wallsend; and
- Throughout the Wallsend Commercial Centre.

5.2.3 Existing Risks to Life in Buildings in Newcastle

Buildings afford some degree of protection during flood events. Of significant concern, however, is that people can become trapped within buildings. Should the flood subsequently overwhelm the building, there is a very real risk that the people taking shelter could perish, especially if 1) flood

waters rise higher than the area of refuge within the building or 2) the building suffers structural damage and collapses under the weight and force of the floodwaters. Tragically, many of the lives lost in the Grantham and Lockyer Valley floods in January 2011 were people taking shelter in their homes, which then either collapsed or flooded to roof level or beyond.

Clearly, evacuation from flood liable lands is always the preferred management solution. However, this is not always possible, especially for flash flooding. Indeed, as roads are potentially much more hazardous, attempts to evacuate could become more perilous than taking refuge in buildings, especially as many roads would quickly become congested and generally impassable. Similarly, evacuation on foot during torrential rain may also pose problems, in particular for the elderly and infirm.

The Risk to Life hazard categories (L1 – L5) give consideration to the ability of people to evacuate from buildings, and also the hydraulic behaviour, which considers flood depths and flood velocities. Within these hazard categories, it has been assumed that normal residential building would collapse once floodwaters exceed about 2 metres, purely under hydrostatic pressure loading. In reality, however, the "unsealed" nature of most dwellings would result in floodwaters entering the building, which would relieve some of the hydrostatic loading. In fact, an effective flood management measure is "wet proofing" of building, which permit the inundation of buildings once hydrostatic loads excess of threshold. The purpose of this is to maintain building stability, at the expense of some flood damages. Importantly, however, if people are taking shelter in the building, then providing they can take refuge in an area that is higher than the maximum possible flood level, their risk to life is substantially mitigated.

Maps 8A to 8K (refer ***Map Series 8*** in accompanying ***Compendium of Maps*** document) show Risks to Life in Buildings across Newcastle affected by flash flooding.

Supplemental to the standard Risks to Life categorisation (L1-L5), the figures show a more refined assessment of risks to life in buildings taking into consideration the depths of flooding above floor levels, and the potential for ground floor inundation. It also takes into consideration the potential for on-site refuge above maximum flood levels. As for the risks to life on roads, the risks to life in buildings are only considered to be significant for flash flood environments. For river and ocean flooding, sufficient warning time would allow emergency services and combat agencies to carry out effective evacuation of all affected buildings.

The most severe risk to life in buildings are those buildings that could be structurally affected by a 1% AEP flash flood event (i.e. are located within a 1% AEP floodway), or are single storey and have above floor flooding in excess of 1 metre for the 1% AEP event. The next most severe risks are those buildings that are located within PMF floodways (i.e. may be structurally compromised by flood forces) as well as single storey buildings that have above floor flooding at the PMF level in excess of 2 metres (i.e. there is no realistic opportunity for flood-free refuge during an extreme event). The third and lowest level of risk to life in buildings covers all the single storey buildings that have above floor flooding of more than 1 metre during a PMF event. All remaining flood affected properties are considered to have a minor risk of life in buildings (as they would generally be structurally stable and have adequate refuge, even if it does involve standing on a table or bench). This is not to say that lives cannot be lost in these buildings, but generally this would be the result of more unusual circumstances (including increased susceptibility to loss of life during floods for the very young, old and infirm).

The Maps show that the most significant risks to life in buildings are spread across the City, with particularly high risks located at:

- Merewether: Morgan St – Little Edward Street;
- Hamilton: around Gregson Parks, where flood depths can be very high;
- Isolated properties within the New Lambton floodplains;
- Jesmond Commercial Centre, extending down to Fraser Street;
- Birmingham Gardens, at the bottom end of Dark Creek, particularly along Cunningham St;
- Wallsend: Irving – Dangar Street; and
- Wallsend Commercial Centre.

5.2.4 Management of Existing Risk to Life

Existing risk to life generally represents the legacy of past development, wherein roads, services and buildings were sited and constructed within flood liable lands. Management of existing development is difficult. Attempts have been made at reducing the risks to life through acquisition of high-risk properties, however, broadscale risk reduction is generally not possible given the highly developed nature of the Newcastle floodplains.

Management of existing risk to life therefore is mostly reliant on the effectiveness of the emergency services and combat agencies in helping people to avoid risks, and the knowledge and common-sense of the existing communities in making appropriate decisions regarding management of their own personal safety. While emergency services and combat agencies can be very effective when there is sufficient warning time (e.g. for river and ocean flooding), the situation would be very different for flash flooding. As highlighted by the June 2007 flash flood event, emergency services and combat agencies were unable to access many areas in need, while the scale of the event also stretched the resources of combat agencies beyond that available at very short notice.

In terms of the overall awareness of the community and the suitability of their responses, the vast majority of people applied good common sense and avoided dangerous conditions. Nonetheless, some individuals still persisted on unnecessarily placing lives at danger by trying to drive or wade through floodwaters. While the 2007 flash flood event was significant, it could potentially be dwarfed by the magnitude of a PMF event. It is expected that the existing community, even with the experience of the 2007 event, would be completely unprepared for a PMF-sized event, and many thousands of people would potentially be in danger of perishing (either trapped on roads or trapped in unsafe buildings).

5.2.5 Assessment of Current Management Approaches to Existing Risk to Life

<u>Existing risks to life associated with river flooding and ocean flooding are adequately addressed through emergency management</u>. That is, emergency services and combat agencies such as the SES and Police are capable of removing virtually all significant risk through assisted evacuation. This is possible only because there is sufficient warning time to mobilise resources and co-ordinate suburb-scale evacuation plans. Notwithstanding, there remains risk to life should people choose to ignore warnings in major and overwhelming floods (refer Section 4.4.1, Figure 4-8 and Figure 4-9 for

areas where there would be no safe escape possible if people ignore warnings). Under these circumstances, risks are managed, or at least 'accepted', by the individuals at a personal level (simply providing them with sufficient warning and instructions to evacuate can be deemed as adequate management for these circumstances).

With respect to flash flooding, however, emergency services and combat agencies would have a relatively minor role in management of large scale events. This is because of the rapid onset of the event, and the fact that vehicular access would be cut quickly across the city. Under current arrangements, risks to life during flash flooding would be at the legacy of individuals. It is hoped that where possible people would avoid placing lives at risk, however, there are many situations where floodwaters would rise too fast and personal safety could be compromised.

Under the current arrangements, existing risk to life due to flash flooding is inadequately managed, especially in the continuing risk of overwhelming flood events. It is considered that more can be done to help protect people during these flash flood conditions (both people on roads and people sheltering in buildings), and also to help people make more appropriate decisions, through better signage and extended warning times of approaching flash flood conditions. Better warning times of approaching flash flood events may also benefit emergency services and combat agencies, who could further help direct people away from the most dangerous areas in the floodplain.

The risks to life on roads and risks to life in buildings plots, as presented in **Map Series 7 and 8** (refer accompanying ***Compendium of Maps***) can be used to help identify what areas and what properties require the most attention in terms of managing the full range of risk to life in areas of existing development.

5.3 Existing Risks to Property

5.3.1 Definition

The risk of damage to, or loss of, property is a relatively tangible component of a standard flood risk assessment. Factors that determine the level of risk to properties relate primarily to the characteristics of the property (including floor levels, structural integrity/construction type, purpose) and the specific hazards of the flood (i.e. will the flood just inundate the property or can it cause physical structural damage).

Factors affecting risks to property include:

1 Floor levels;

2 Property type; and

3 Hydraulic behaviour (incorporating flood depths and flood velocities).

5.3.1.1 Floor levels

Damages to property increase dramatically as soon as flood waters exceed floor levels (i.e. damage to floor boards, carpets, walls, cupboards, electricals etc) although property damages can in fact be incurred even before flooding reaches the floor level.

Floor levels for all properties in the Newcastle floodplain have been surveyed by CofN, and have been considered in assessing existing risks to property.

5.3.1.2 Property type

As for risk to life, the property type also has an influence on the risks to property. Roads and open space will have relatively low potential damage, while both residential and non-residential properties can face significant flood damage. Non-residential properties, however, have a greater potential for minimising flood damages due to the particular construction type, materials used etc.

5.3.1.3 Hydraulic behaviour

Hydraulic behaviour corresponds directly with the risk to property hazards. That is, the definition of hydraulic behaviour as provided in Section 5.2.1 for Risks to Life (Figure 5-1) equally apply to Risks to Property. Flood levels are the primary determinant for flood damages, however, the combination of flood levels and flood depths (v*d) also provides insight into the structural integrity of buildings as well as the potential for vehicle damage.

The risks to property and associated property damage are considered at the 1% AEP flood level, as this is the standard advocated within the Floodplain Development Manual (2005) for consideration of property risks and hazards.

Categorisation of Risks to Property has been established as presented in Table 5-3, while **Maps 9A to 9D** (refer ***Map Series 9*** in accompanying ***Compendium of Maps*** document) present maps of the risk to property hazards (at 1% AEP) across the Newcastle LGA.

Table 5-3 Risk to Property hazard categories and associated hydraulic behaviour thresholds

Hydraulic behaviour thresholds (refer Figure 5-1)					
H1	H2	H3	H4	H5	
P1					Parked or moving cars remain stable i.e. equivalent to areas of H1 at the 1% AEP event
	P2				Parked or moving heavy vehicles remain stable i.e. equivalent to areas of H2 at the 1% AEP event
		P3			Suitable for light construction *(e.g. timber frame, masonry and brick veneer)* i.e. equivalent to areas of H3 at the 1% AEP event
			P4		Suitable for heavy construction *(e.g. steel frame, reinforced concrete)* i.e. equivalent to areas of H4 at the 1% AEP event
				P5	Hydraulically unsuitable for normal building construction is equivalent to areas of H5 at the 1% AEP event

5.3.2 Existing Property Damage Estimates

Potential economic losses associated with property damage have been calculated for each of the different flooding mechanisms. A summary of the potential economic losses is provided in Table 5-4.

This table highlights the substantial scale of potential economic losses in Newcastle. For example, a 1% AEP flash flood could potentially result in $170m damages to 560 properties while a PMF flood could impact nearly 10,000 properties with a direct damage bill approaching $1 billion. When combined and annualised, the average annual damage bill associated with flooding across the Newcastle LGA is $21 million (i.e. damages would average out to a total of $21 million per year, when considered over the long term).

Maps 10A to 10L (refer ***Map Series 10*** in accompanying ***Compendium of Maps*** document) show the locations of properties affected by above floor flooding at the 10% AEP, 1% AEP and PMF flood levels, for flash flooding, river flooding, and ocean flooding. The potential damages to property maps also capture properties where buildings (excluding garages) are located within close proximity to an open channel floodway. As experienced during the June 2007 event, minor blockages of channels caused flows to be redirected out of channel and into private property, causing localised but significant damage.

These maps show at the extreme flood, the potential for flood damage is widespread across Newcastle. At the 1% AEP flood, damages tend to be concentrated into pockets, including:

- Small sections of The Junction;
- Small sections of Broadmeadow;
- The whole suburbs of Maryville, Wickham, Carrington and the low parts of Islington;
- Jesmond (Bluegum Road, down to Fraser St);
- Birmingham Gardens around Cunningham St and Wilkinson Avenue;
- Wallsend Commercial Centre;
- Most of Hexham; and
- The river side properties of Stockton.

Damages at the 10% AEP are scattered throughout the City, with notable clustering at:

- Maryville, Wickham and Carrington;
- Hamilton (near Gregson Park); and
- Wallsend Commercial Centre.

Table 5-4 Potential Economic Impacts for Flooding in Newcastle

	Approx number of properties affected by above floor flooding	$ Damages ('000,000) (direct costs only)
Flash Flooding		
10% AEP	220 (140 residential)	$50
1% AEP	560 (380 residential)	$170
PMF	9,660 (8520 residential)	$880
	Average Annual Cost	*$15*
River Flooding		
10% AEP	30 (20 residential)	$2
1% AEP	230 (170 residential)	$20
PMF	990 (790 residential)	$110
	Average Annual Cost	*$1.4*
Ocean Flooding		
10% AEP	0	$1.7
1% AEP	1,460 (1210 residential)	$93
PMF	2,750 (2190 residential)	$280
	Average Annual Cost	*$4.7*
TOTAL		
10% AEP	250 (160 residential)	$53.7
1% AEP	2,240 (1760 residential)	$283
PMF	13,400 (11500 residential)	$1,270
	Average Annual Cost	*$21.1*

Notes

- *The values in this table have been estimated based on surveyed floor levels and property information along with interpretation of computer flood model surfaces. Note that properties were excluded wherein modelled flood depths were less than the height of floor levels above adjacent ground levels;*
- *Little provision has been made for differentiation in property type. Any non-residential property has been assumed as commercial, while commercial properties have not made allowance for multiple occupancies (e.g. shopping centres). Industrial damages are expected to be significantly higher, particularly for large industrial properties located at Hexham;*
- *Property damage starts below floor level, with impacts on foundations, landscaping, out-buildings and general property clean-up; and*
- *No provision has been made for recovery costs, such as short to medium-term accommodation whilst property damages are repaired.*
- *Coincident events comprising more than one flooding mechanism would affect less properties than the Totals provided above, as there are approximately 2,200 properties that can be affected by more than one flooding mechanism at the PMF.*

5.3.3 Management of Existing Risk to Property

As outlined in Section 4.3, risks to existing property are managed to some degree through current and previous development controls. That is, areas that are at greatest risk of property damage have generally been excluded from development in the past. Some areas have therefore evolved into open space recreation and parklands. Notwithstanding, Table 5-4 highlights the magnitude of potential property damage in Newcastle, including some $54 million that would result from frequent flooding (expected to occur about every 10 years, on average).

Existing risks to property can be managed somewhat through pre-flood preparation, subject of course to available flood warning (e.g. raising valuables as high as possible). Ultimately, however, most risk to existing property is managed through personal insurance. This itself presents a number of issues, as traditionally most insurance companies will only cover property for certain 'types' of flooding. Generally, flash flooding would be covered as this can be considered as storm-related. River and ocean flooding, however, may not be covered at it involves inundation from an existing waterway. There are of course exceptions to all circumstances and individuals are strongly encouraged to confirm with their insurance companies what is and is not covered in terms of storm and flood damage, especially since the Federal Government has recently reviewed flood insurance and the insurance industry is changing.

5.3.4 Assessment of Current Management Approaches to Existing Risk to Property

There are some 250 properties within the Newcastle LGA that receive above floor flooding by frequent flood events (150 of which are residential properties). The on-going economic costs of this are large (almost $54 million every 10 years on average).

Whilst for non-residential properties the economic advantage of siting businesses on the floodplain may outweigh the frequent flood damages bills, it is considered that the frequent inundation of residential properties would lead to on-going hardship and degrade personal and societal wellbeing. As such, it is considered that existing risk to property affected by frequent flood events is inadequately managed. The locations of these properties are highlighted in **Maps 10A to 10L** (refer ***Map Series 10*** in accompanying ***Compendium of Maps*** document).

Interestingly, there is not a massive increase in numbers of properties affected at the 1% AEP flood level compared to those affected by the 10% AEP flood. There is, however, almost an order or magnitude increase in terms of properties affected and damages incurred by the PMF event compared to the 1% AEP flood. The very rare probability of a PMF event occurring makes it impractical to manage risks to property to this level of inundation. A 1% AEP event is however more realistic, as there is a 70% chance of such an event occurring during the typical lifetime of a development (taken as 100 years).

For flash flooding, more than half of the properties affected by the 1% AEP event are also affected by the 10% AEP event. Therefore, should those properties affected by more frequent event be more appropriately managed, then the overall risk to property at the 1% AEP level would be much more modest.

Beyond the properties (and especially the residential properties) affected by the 10% AEP flood event, risks to existing property are considered to be appropriately managed through current planning and development controls.

5.4 Future Risks to Life

5.4.1 Management of Future Risks to Life

As outlined in Section 4.3.2.3, the current Newcastle Flood Policy and DCP takes into account the potential for loss of life when permitting future development. The Policy requires that Risks to Life be considered at the PMF event.

The Newcastle DCP 2005 recognises five (5) risk to life hazard categorises (L1 – L5) as set out previously in Table 5-2. These categories reflect an integrated consideration of:

- Size of flood;
- Effective warning time;
- Flood readiness;
- Rate of rise of flood waters
- Hydraulic behaviour thresholds, describing flood velocities and depths (i.e. H1- H5);
- Duration of flooding, evacuation problems;
- Effective flood access; and
- Type of development (refer Table 5-5).

Information on the rationale and derivation of the risk to life and property hazard categories applying the principles of the Manual are contained in CofN's Flood Policy and accompanying technical manual.

Future Risks to Life can be managed by controlling future development within the floodplain through various planning instruments, and through specific response processes.

The Flood Policy and DCP have attempted to meet the needs of the Floodplain Development Manual (2005) by considering Risks to Life up to the PMF level, but at the same time, not unnecessarily sterilising land for future development. Clearly the most risk adverse approach would involve exclusion of all future development from the floodplain (up to the PMF level). This would be impractical, however, given the existing development that has already occurred across the entire floodplain.

Recognising the particular risks to life by flash floods, the DCP requires all new developments in flash flood areas with an "L4" risk to life category to be capable of providing safe refuge in all floods up to the PMF. That is, a flood refuge is required above the PMF flood level, while the building needs to be certified by a structural engineer that it will withstand PMF flood conditions.

For structural certification, applicant's engineers are required to assess whether the floodwaters can enter the buildings or not and what forces are involved. For single storey developments, if the PMF

level is just above the FPL (i.e. 1% AEP + 0.5m), then applicants are required to raise the floor level, or at least a part of the floor space, above the PMF level to meet the refuge requirement.

The provision of refuge areas are confirmed during the development assessment, while the structural certification is included as a condition of consent, to be provided with the construction certificate documentation.

Table 5-5 Risk to Life Hazard Categories (at the PMF) (source: Newcastle DCP 2005)

	HAZARD CLASSIFICATION				
HAZARD FACTOR	L1	L2	L3	L4	L5
Effective Warning	Y	N	N	N	N
Effective capacity to allow evacuation to flood free land	Y	Y	N	N	N
Rate of rise of flood waters	Slow	Flash	Flash	Flash	Flash
Duration of Flooding	Too long for refuge enclosed by floodwaters to be appropriate	Short enough for occupation during the entire flood to be appropriate	Short enough for occupation during the entire flood to be appropriate	Short enough for flood free refuge enclosed by floodwaters to be appropriate	Short enough for flood free refuge enclosed by floodwaters to be appropriate
Escape route	An obvious rising escape route to flood free land outside of the entire flood is available	An obvious rising escape route to flood free land outside of the entire flood is available	There is no obvious rising escape route to flood free land outside of the entire flood	There is no obvious rising escape route to flood free land outside of the entire flood	There is no obvious rising escape route to flood free land outside of the entire flood
Nature of enclosing floodwaters	Flood free land outside of the entire flood can be reached before the flooding affects the site itself	Reaching flood free land outside of the entire flood requires evacuation through enclosing floodwaters and these floodwaters are suitable for wading or heavy vehicles at all times	Enclosing floodwaters are suitable for wading and for medical emergency evacuation by wading or heavy vehicle at all times	Enclosing floodwaters are not suitable for wading or heavy vehicles and require heavy construction for structural stability of buildings (eg. steel frame and concrete)	No form of normal building construction would be feasible to ensure structural stability in enclosing floodwaters
Evacuation need	Required to flood free land outside of the entire flood	Required to flood free land outside of the entire flood	Not required	Required to suitable flood free refuge within the enclosed floodwaters	Normally not possible (therefore normally unsuitable for development)
Evacuation problems	Still need to ensure that any proposed development in these areas will not cause additional burden on emergency response services	Still need to ensure that any proposed development in these areas will not cause additional burden on emergency response services	Nil (for able-bodied adults)	Evacuation shall be self directed and fail safe	Enclosing floodwaters are so hazardous that evacuation by normal means to flood free land outside the entire flood would not be contemplated. The structural stability of an onsite refuge cannot be assured by normally available building types and therefore a refuge enclosed by floodwaters cannot (normally) be provided

5.4.2 Assessment of Current Management Approaches to Future Risk to Life

As outlined in Section 5.2.5, existing Risks to Life from river flooding and ocean flooding are adequately addressed through emergency management. It is considered that future Risks to Life would also be adequately managed through these arrangements providing that the population needing management does not increase significantly (and thus demanding more emergency services resources, which may not necessarily be available).

For flash flooding, CofN has had, since 2005, special requirements for future development to accommodate PMF events, with safe refuge to be provided within all new developments. This is a significant improvement on the existing risk to life wherein many thousands of people taking refuge inside existing buildings could still be a significant risk. <u>It is considered that future risk to life is generally adequately addressed through current planning and development controls</u>.

There would, however, still be some advantage in restricting some critical development types from floodplain areas. These development types may include infrastructure and services that would be critical for emergency management (including flooding or other emergency situations). Notwithstanding, such developments could still be designed to essentially be completely flood-proof (including most if not all of the development located above PMF flood level, along with back-up resources in the event of failure due to flooding).

5.5 Future Risks to Property

5.5.1 Management of Future Risks to Property

The CofN Flood Policy and DCP adopt the P1-P5 property hazard categories as described previously in Section 5.3.1 (refer Table 5-3). The Policy and DCP requires that risks to property be managed at the Flood Planning Level. For Newcastle, this is the 1% AEP flood level plus a freeboard of 0.5 metres to allow for any local effects, such as blockage or turbulence.

5.5.2 Assessment of Current Management Approaches to Future Risk to Property

The 1% AEP flood is a reasonable benchmark for setting controls on future development to limit risks to property, and is suggested as the flood planning standard for residential development in the Floodplain Development Manual (2005). As outlined previously, there is a 70% chance that at least one flood of 1% AEP size or larger would occur within the design life of the development (nominally 100 years).

The June 2007 flash flood provided substantial evidence of the impact of blockage. There were many channels and culverts throughout the city that became blocked with large items such as cars, wheelie bins and even shipping containers. As a result, flood levels in some areas were elevated higher than what they otherwise would have been. Indeed for some areas, such as Newcastle West and Wallsend Commercial Centre, the increase in flood levels was well in excess of the nominal 0.5 metres adopted in Council's Flood Policy and DCP. <u>It is considered that the application of a standard 0.5m freeboard is inadequate to cater for the potential impact of blockages within channels and culverts that are subject to flash flooding.</u>

There is no way of predicting what particular channels or culverts will become blocked during a future flood event in the flash flood catchments, even though in principle it is highly desirable that consideration should to be given to the potential blockage of any channel or culvert. However, the sheer number of possible degrees of blockage, the randomness of the release of debris from the catchments (cars, trees, bins, fences, shipping containers, etc) and the randomness of the impact of blockages make the assessment of potential blockages and the development of specific blockage allowance recommendations for the hundreds of specific locations in the flash flood catchments unachievable at present.

Therefore with the exception of the provision for blockage, it is considered that the current management approaches to future risk to property is adequate, including development controls established for river and ocean flooding. Special consideration regarding future management of potential blockage within channels and culverts is discussed in Section 8.5.1.

5.6 Continuing Risks to Life

5.6.1 Definition

Continuing risk to life is that which remains after all reasonable efforts have been made to mitigate the flooding for areas of existing development, and, in areas of future development or re-development for rarer flood events than that used to set the Flood Planning Level (for risk to property). With time, it is expected the risks to life will be reduced as most of the existing development undergoes some form of redevelopment that needs to comply with the current (and future) planning and development controls (which take into account risk to life for the full continuing risk between the Flood Planning Level all the way to the PMF). This will take a long time, however, as the current stock of development is likely to continue for many more decades without significant need for refurbishment or rebuild (other than to manage flood risk).

Under the existing arrangements, the continuing risks to life for existing development subject to river and ocean flooding are addressed through the provision of emergency management measures (e.g. evacuation – assuming evacuation requests/orders are not ignored!). For flash flooding, however, continuing risk to life can only potentially be addressed through appropriate personal response to the flood emergency. While most people can be expected to make sensible and rational decisions most of the time, the heightened anxiety of an emergency such as flash flooding can lead to irrational behaviour. Irrational behaviour during times of flooding can account for over 80% of flood-related deaths in Australia between 1997 and 2008 (Fitzgerald *et al*., 2008). Remarkably, over a quarter of deaths occurred were the result of purely inappropriate and highly-risky behaviour, such as swimming or surfing in floodwaters (refer Figure 5-2). It must be recognized that for some overwhelming, very rare and extreme flash flood events there will be large numbers of people, measured in the thousands, who cannot safely escape to high ground no matter how well they are trained or rational and calm they are in the event, and as such they will be trapped in life threatening situations.

5.6.2 Assessment of Current Management Approaches to Continuing Risk to Life

Based on the current low awareness and preparedness of the community for very large events in excess of their limited experiential knowledge of flooding, <u>it is considered that current management of continuing risk to life for existing development in flash flood catchments is inadequate</u>. In particular, current management of risks on roads is largely overlooked with instead focus given to buildings where people could potentially take shelter, yet roads represent a much bigger risk to life in flash floods than buildings.

Significant community education would be required to address this shortfall in management of continuing risk to life for existing development in flash floods. Contrary to this, management of continuing risk to life for existing development for river and ocean flooding is adequately managed through current emergency management services.

Continuing risk to life for future development is considered to be well managed by the present CofN Development Control Plan element for Flood Management.

Figure 5-2 Inappropriate and risky behaviour during flooding in Newcastle (image courtesy: B. Gaudry)

5.7 Continuing Risks to Property

5.7.1 Definition

Continuing risk to property is the risk of damage and ongoing economic impacts to existing and future developments that occurs as a result of floods that exceed the flood planning standard, or at least the standard that was in place when the development was built. Unlike historical development, current assessment processes use computer models to provide an estimation of likely inundation probability at certain flood levels. Unfortunately historical development has allowed some 250 properties to be built that are subject to frequent (10% AEP) above floor flooding. This is a high number of properties affected by such a frequent event, compared to the current flood planning standard, which requires all new residential development to be at least 0.5 metres higher than the infrequent (1% AEP) flood level.

Some non-residential developments may be permitted below the 1% AEP standard, since there can be a stronger economic case for allowing non residential developments with lower immunity to above floor flooding, especially if there is some business advantage to the geographic siting of the development. Notwithstanding, the Floodplain Development Manual (2005) points out in these cases that the “overriding consideration should be that the proposed development will not adversely affect

flood behaviour or increase the potential for danger to personal safety, whether public or private (section J2.3 of the Manual) and "personal safety still needs to be addressed … for the full range of flood events" (section K4.4.1 of the Manual).

5.7.2 Assessment of Current Management Approaches to Continuing Risk to Property

There is a chance that new developments built in accordance with the current flood standard will still be impacted and damaged due to flooding. The likelihood of this occurring, however, is considered to be manageable within the design life of the development.

It is considered that the continuing risk to existing and future property at present is adequately addressed by the current management approaches, however, the community would still benefit from education regarding the fact that larger floods can occur, and during such events, significant property damage is expected. The key message to be sold to the community is that flood risks do not stop at the flood planning level.

The Commonwealth Government's National Disaster Insurance Review, which was undertaken in direct response to issues arising from the widespread flooding in Queensland, NSW, Victoria and WA in early 2011, has recommended that all home insurance, home contents insurance and home unit insurance automatically include flood cover for properties affected by flooding. The Review further recommends that discounts apply to premiums to offset any higher costs of insurance, with the Federal Government underwriting claims to cover any shortfall of funds in the reinsurance facility as a result of the premium discounts. Also, the Review recommends that small businesses should automatically be covered for flood insurance, but with the ability to opt-out, rather than having to specifically opt-in as at present. Should these recommendations be adopted by the insurance industry and Government, then the continuing risk to property will be further managed.

Although the present level of continuing risk is considered to be managed adequately, it is expected that future sea level rise and the propensity for future ocean flooding will mean that continuing risk to property will increase substantially. With a sea level rise of about 0.4 metres (projected for the year 2050), it is expected that groundwater levels within the low suburbs of Newcastle will become problematic for roads and services infrastructure, and will make residential living difficult. With a sea level rise of 0.9m (projected for the year 2100), much of the land will be permanently inundated by groundwater-fed swamps (as the mean sea level will be about the same height as ground level). Under these conditions, the continuing risk to property will be inadequately managed.

5.8 Summary of Current Management Approaches

Current flood management approaches have been assessed against the main objectives and principles of the Floodplain Development Manual (2005). In particular, Risks to Life and Risks to Property have been assessed for Existing Risks, Future Risks and Continuing Risks. The outcomes of this assessment are summarised in Table 5-6. From this table it can be seen that by and large, river flooding and ocean flooding is adequately managed through current mechanisms. This is essentially related to the fact that there is generally sufficient warning time available for emergency services and combat agencies to be mobilised and to facilitate and assist in pre-flood preparations, including evacuation of all people at risk.

Current management of flash flooding on the other hand is largely considered to be inadequate. This stems from a general lack of appreciation of extreme flash flooding conditions by the general community, and the very little to no warning time that can be expected for flash flooding. In addition, there is a reasonably large contingent of legacy development that does not meet the current development standards. Until such time that all existing development is refurbished or rebuilt to higher standards, the continuing risk to both life and property is considered to be large. Further, the potential for future sea level rise introduces a very serious and looming threat to property for the more low-lying suburbs at Newcastle.

This summary of adequacy of current management approaches highlights those flood management elements that need to be improved in the future, and as such, are the focus of the remaining chapters of this Plan, being the identification and prioritisation of future management measures and initiatives to manage and reduce flood risks.

Table 5-6 Summary of Assessed Adequacy of Current Management

	Flash Flooding	River Flooding	Ocean Flooding
RISKS TO LIFE			
Existing Risks	**No – especially risks on roads**	yes*	yes*
Future Risks	yes	yes	yes
Continuing Risks	**No – limited appreciation for extreme floods**	yes	yes
RISKS TO PROPERTY			
Existing Risks	**No – many properties affected by frequent flooding**	**No – some properties affected by frequent flooding**	yes
Future Risks	**No – consideration required for blockage of channels and culverts**	yes	yes
Continuing Risks	yes	yes	**No – long term viability of low suburbs is questionable**

** Current management involves providing effective warning and evacuation instructions. The decision to evacuate, or not, is then a personal choice based on an individual's appetite for risk.*

6 POTENTIAL OPTIONS FOR IMPROVING FLOOD MANAGEMENT

6.1 Chapter Overview

This chapter identifies and reviews all reasonable options for addressing the assessed gaps and shortcomings of current flood management within the Newcastle LGA (as discussed in the previous chapter, and summarised in Table 5-6) with respect to existing flood risks, future flood risks, and continuing flood risks.

Options considered for improved flood management can be categorised into:

- Flood modification measures;
- Property modification measures;
- Response modification measures; and
- Other measures.

An initial long list of measures (covering all flood modification, property modification and response modification options) was passed through a 'coarse' filtering process for flash flooding application, river flooding application and ocean flooding application. This established a short list of realistic options to undergo more detailed assessment. A 'fine' filtering process on these short-listed options then produced a final list of most practical options that could potentially be pursued at Newcastle.

Much as the information presented in this Chapter is acknowledged to Molino Stewart, consultant to CofN. As separate document that collates and summarise the findings of Molino Stewart's background assessments, forms a companion to this City-wide Flood Plan (refer Section 12.1).

6.2 Identification of Potential Flood Management Options

A wide selection of flood risk management options/measures were identified and considered for this City-wide Flood Plan. In addition to potential measures identified previously through past floodplain management reports for Newcastle, this Plan has sourced potential options from:

- Suggestions made by the local Newcastle community;
- An extensive national and international literature search;
- Suggestions made by flood management experts at a specially convened workshop held in 2008 during the early stages of the development of this Plan; and
- Various consultants and study team members involved in the preparation of this Plan, who have extensive experience of options adopted for other similar studies, as well as other innovative solutions that are considered to be particularly suited to the needs of Newcastle.

6.2.1 Community Suggestions

As outlined in Section 1.5, extensive community consultation was undertaken as part of the preparation of this City-wide Flood Plan. Community focus groups provided opportunity for community members to offer suggestions for future flood management.

In addition to the focus groups, CofN often receives letters from members of the community requesting works or changes to alleviate local flooding issues. Listed in Table 6-1 is a cross-section of suggestions provided by the community that have been considered as part of this Plan.

Table 6-1 Community suggestions for alleviating flood problems in Newcastle

Suburb	Suggestion
Wallsend	Raise the canal walls to fix flooding in Nelson St Wallsend
Wallsend	Additional drainage pits
Wallsend	Build a large retention/detention tank under Upper Reserve or Wallsend Park
Wallsend	Divert flood flows into mine shafts
Wallsend	Build a tunnel under the commercial centre to divert flood flows
Jesmond	House raising (by 2 metres) in Heaton St, Jesmond to redress local water and flooding issues
New Lambton	Install storm water drain in gutter
New Lambton	Stop large developments that are contributing to the flooding
Lambton	Upgrade of street drainage
Hamilton	Retaining wall causing damming and flooding in Lindsay Street Hamilton and Gregson Park
Merewether	Installation of water tanks and pits to collect the excess water
Merewether	Divert flows from Cottage Creek to Bar Beach
Islington	Encourage residents to sweep their street fronts in order to reduce litter and leaves in the stormwater, and thus reduce potential for blockages in the stormwater pipes and inlets (and associated flooding)
Islington / Maryville	Deepen / dredge the lower reaches of Throsby Creek
Carrington	Replace valves on Lower Throsby Creek to prevent tidal inundation at Hargrave St, Carrington
Hunter River	Divert flows from Fullerton Cove to the ocean
Hunter River	Dredge the North and South Arms of the Hunter River
Generally,	Make open channels deeper and wider to take more flow
Generally,	Build large detention basins to hold back the floodwaters
Lower Throsby	Construct levees around the waterways to keep out sea level rise
Lower Throsby	Use big pumps, like in Holland

6.2.2 National and International Literature Review

6.2.2.1 Australian Perspectives

Flood management in Australia has evolved congruent with the expansion of urban populations since the mid 1900s. Initially, flood management was focussed on engineering works (eg levees, dams

etc) to manipulate flood behaviour. In recent years, however, a more holistic approach has been advocated that incorporates a range of structural and non-structural elements, including education, more appropriate landuse planning and emergency management response.

NSW has an advanced flood management program and an extensive network of professionals experienced in flood management (largely facilitated through the NSW Floodplain Management Authorities). Annual conferences are held to share knowledge amongst professionals and practitioners, and to introduce new concepts and approaches to flood risk management.

The Floodplain Development Manual (2005) (refer Section 4.3.1.2) documents the primary approach to flood risk management in NSW. Other relevant references outlining flood management in Australia include BOM (2007), EMA (1999), Wilson et al (2004) and Wright & Daniell (1998) to name a few. See References (Chapter 12) for a more extensive listing.

6.2.2.2 International Experiences

Flooding is one of the most widespread hazards facing the population across the whole world. But yet it is regarded as the most predictable of natural hazards – although we do not know when a flood will occur, we generally have a good idea of the extent of areas impacted for a range of probabilities up to the maximum conceivable.

It is estimated that more than 200 million people worldwide live on coastal floodplains below a 1% AEP flood level (mostly on deltaic regions within developing countries) (Schwartz, 2005). Evolution of flood risk management in other parts of the world has essentially been comparable to that of Australia, particularly in developed countries where significant funding has been made available for investment in flood management (refer to Floodplain Development Manual (2005) for details).

Flooding in the United Kingdom (UK) is managed at a government level by the UK Environment Agency. Substantial funding has been invested in flood management within the UK for a number of years. Similarly, flood management in the United States is largely facilitated through the Federal Emergency Management Authority (FEMA), although states and counties are generally responsible for individual works programs.

Some examples of international literature include case studies from Central and Eastern Europe (De Roure, 2005; APFM, 2007; Zbigniew & Kundzewicz, 2002; Colombo et al, 2002, Maher, 2000), New Zealand (Handmer, 2002), USA (CADWR, 2008; FEMA, 2004; Harris County; State of Maryland; Montz & Gruntfest, 2002; Simons et al, 1977; SDR, 2008), Asia (Prasad, 2005; Tokar et al, 2006) and South America (Tucci, 2007). See References for details.

6.2.2.3 Associated Programme on Flood Management

The Associated Programme on Flood Management (APFM) is a joint initiative of the United Nation's World Meteorological Organisation and the Global Water Partnership. It aims to promote the concept of Integrated Flood Management, and support countries in the integrated management of floods, within the overall framework of integrated water resources management. Integrated Flood Management (IFM) integrates land and water resourced development across the whole catchment to maximise benefits from floodplain development whilst minimising losses from flooding.

APFM (www.apfm.info) has released several documents outlining concepts, principles and best practice for integrated flood management, including consideration for legal, institutional, social, environmental and economic aspects of flood management. APFM has also documented outcomes from several case study projects (focusing on flood management in developing countries), as well as guidelines for flash flood management.

6.2.2.4 Manufacturers

Proprietary systems are becoming increasingly popular to combat flooding and associated community losses. Drop-in or pop-up barriers, temporary levees, flood-resistant material, pressure equalising flood vents and flood-smart housing designs are available, and indeed can be quite effective at reducing property losses in many circumstances.

The literature review has identified several flood management 'products' that may be suitable for flood management in Newcastle.

6.2.3 Suggestions from Experts Workshop

As discussed in Section 1.5, a workshop of flood management experts was convened by CofN in late 2008 to seek advice and input into the management of flood risks. As part of this workshop, potential management options were considered and discussed. A number of measures were included to the already comprehensive list of options presented at the workshop.

A preliminary level assessment of options was also carried out by participants. It was flagged that many options identified would not be appropriate for Newcastle, given the particular circumstances surrounding local flood risks (e.g., lack of warning time, short duration of flooding, extensive existing development within the floodplain etc).

Input from the Experts Workshop has been incorporated into the discussions below.

6.2.4 Additional Options Developed by Study Team

During the preparation of this document, consideration was given to a number of additional options formulated by the Study Team members. This includes a number of innovative measures that are considered untraditional, but may have merit in the context of Newcastle's specific flood risks. These additional options are also included in discussions below.

6.3 Flood Management Approaches and Initial Coarse Filter

In order to describe the suite of flood management measures, various categories and sub-categories have been developed to group the vast range measures. The primary categories used are as described in the Floodplain Development Manual (2005):

- Flood Modification Measures (Section 6.3.1);
- Property Modification Measures (Section 6.3.2); and
- Response Modification Measures (Section 6.3.3).

In addition, a fourth category has been added to provide a grouping for those measures that do not readily fit into the categories above (mostly relating to flood insurance):

- Other (Section 6.3.4).

The categorisation is designed to assist in identifying practices that may be appropriate in a given location or situation. It is important to recognise that the categories are not important in themselves as these categories vary throughout literature. For example, Simons *et al* (1977) and Colombo *et al.* (2002) use the previously common categories of "Structural" and "Non-Structural".

It should be recognised that best practice flood risk management involves a set of integrated flood mitigation measures that combine together to form an overall strategy (APFM, 2004). Tokar *et al.* (2006) reinforce the importance of having multiple management approaches to overlap and provide management contingency given that state-of-the-art technology and a perfect flood forecast will still not mitigate impacts if the community at risk does not receive a timely warning or does not know what to do when the warning is received. Similarly, an educated and ready community is not able to respond to an inaccurate or poorly timed warning. The components of an integrated flood strategy will vary between locations as what is appropriate in one location is not necessarily appropriate in another.

As well as describing potential options, the following sections also provide a first pass or coarse filter assessment of options by determining if they would be applicable/suitable to the flash flooding, river flooding or ocean flooding environments of Newcastle, along with some general commentary. For those options that were considered applicable/suitable, more detailed (fine filter) assessment was undertaken, as outlined in Sections 6.4, 6.5 and 6.6.

6.3.1 Coarse Filter Assessment of Flood Modification Measures

These measures are designed to modify or manipulate the behaviour of the flood, either by changing its passage or its overall hydrograph (flow versus time relationship). Flood modification measures have been identified and considered based on:

- Excluding floodwaters from vulnerable locations (refer Table 6-2);
- Containing floodwaters to reduce flood peaks downstream (refer Table 6-3); and
- Enhancing conveyance efficiency or diverting floodwaters (refer Table 6-4).

In theory, if floodwaters can be conveyed through local catchments and into the Hunter River more quickly, then less water will spread out over the floodplains. Flood modification measures, such as bigger channels or levee systems, are often expected by some members of the community to be *the* solution to all flood problems. Provision of these measures, however, can result in a false perception of flood security. Most measures have a limited design capacity, meaning that once exceeded, they can still result in potentially devastating impacts (largely to the same degree as if they were not in place at all).

Table 6-2 Flood Modification Options to Exclude Floodwaters

Exclusion of floodwaters	Applicable to Newcastle?			Comments
	FF	RF	OF	
Earthen levee (permanent)	✖	✓	✖	Available space would generally preclude the use of earthen levees within the urban areas that are affected by flash flooding and ocean flooding. Earthen levees are used extensively throughout Hunter Valley, and have been considered previously for areas around Hexham
Wall levee (permanent)	✓	✖	✓	Costs would be prohibitive for river flooding, as the walls would need to be very high to be effective. Levees result in pushing floodwaters elsewhere, so care would be required to ensure other areas are not worse off.
ring levee	✖	✓	✖	Used to encircle a specific area. Hexham would be the only real opportunity for this in Newcastle.
deflector levee	✓	✓	✖	Aims to reduce flood velocities rather than flood levels. Can be applied to help with structural stability of developments, and thus help with risk to life.
dyke / bund	✖	✖	✓	This usually excludes backwater inundation, typically from the ocean. Similar to a levee, and can be earthen or a wall.
temporary tilt-up / pop-up levees	✖	✖	✓	Requires ample warning time in order to raise the levee. Usually suitable for small isolated areas only.
drop-in boards/panels	✖	✓	✓	Requires ample warning time for installation. Isolation of some sections of the floodplain may result in amplification of flood levels elsewhere.
sand bags	✖	✓	✓	As for drop-in boards, is very manual-labour intensive and requires a ready supply of bags and sand.
hinged floodgates	✖	✓	✓	Prevents backwater inundation of floodplains, or low-lying areas subject to ocean inundation. Only suitable for low-level frequent flood events.
one-way flow valves	✖	✓	✓	As per hinged floodgates
automated pop-up barriers	✓	✖	✓	The automated mechanism removed the need to physically install the barrier, however, it is very costly, and would be suitable for isolated areas only, e.g. an undercover carpark.

Table 6-3 Flood Modification Options to Contain Floodwaters

Containment of floodwaters	Applicable to Newcastle?			Comments
	FF	RF	OF	
flood mitigation dam	✖	✓	✖	Only applicable for river flooding. It is unlikely that any new dam would be constructed on the Hunter River.
Flood mitigation capacity within storage dam	✖	✓	✖	Existing storage dams are high in the catchment, and would provide very limited opportunity for flood attenuation.
Large detention / retardation basin	✓	✖	✖	There is limited opportunity for building large flood storage basins in the urban area of Newcastle due to space restrictions. Areas considered suitable are already flood liable (e.g. parklands along Ironbark Creek).

Containment of floodwaters	Applicable to Newcastle?			Comments
	FF	RF	OF	
on site retention/detention	✓	✖	✖	Temporary storage/detention of floodwaters could be achieved through individual on-site basins / pits. While CofN has had a policy of OSD for many years, these are aimed at small floods. Their value in large events would be significantly constrained. There is also a question mark over maintenance of OSD.
increased floodplain storage	✖	✓	✖	Some parts of the natural floodplain have been excluded by historical works. Removal of these works could re-engage natural floodplains. There are limited areas where this would be applicable for river flooding only (such as Hexham Swamp, which is currently excluded from the floodplain for river floods up to about the 10% AEP level.

Table 6-4 Flood Modification Options to Enhance Conveyance or Divert Floodwaters

Diversion of floodwaters	Applicable to Newcastle?			Comments
	FF	RF	OF	
Widen existing channels	✓	✖	✖	Many of the larger channels in Newcastle already have significant flow capacity. The problem is getting the water into the channels (due to the flat ground surrounding the channels). Would be most applicable in the incised catchment of Ironbark and Dark Creeks. Development close to the channels also makes this option difficult.
Deepen existing channels	✓	✖	✖	Tailwater levels control the hydraulic gradient during floods. Making the channels deeper will not necessarily have an impact on flow conveyance, and the bases are also low. Sea level rise will likely negate benefits of deepening channels.
Realign existing channels	✓	✖	✖	Depends on the availability of space. Would target areas where there is significant afflux because of channel constrictions. Limited opportunity in Newcastle, except maybe in Ironbark and Dark Creeks.
River/creek dredging	✓	✓	✖	Hunter River dredging and Lower Throsby Creek dredging have been proposed. As for deepening of channels, dredging is likely to have only a limited impact on flood levels, as hydraulic gradients are controlled by tailwater levels rather than bed levels in the lower reaches.
Highflow bypass channel	✓	✓	✖	Short-cut channels around Hexham have been suggested in the past. Usually very costly options, as land is required to cater for newly created floodways.
Elevated channels (e.g. Los Angeles)	✖	✖	✖	Generally not applicable in Newcastle due to the low hydraulic gradients and distances to the ocean.
Redesign/enlarge bridge openings and other structures, including redesign handrails to reduce blockage potential	✓	✓	✖	Some structures could be targeted, including the Minmi Rd bridge (as per the Wallsend Commercial Centre Flood Plan) and other structures under rail embankments across Newcastle.

Diversion of floodwaters	Applicable to Newcastle?			Comments
	FF	RF	OF	
Blockage barriers	✓	✖	✖	Blockage was a major issue in June 2007. Barriers would target collection and containment of larger items within areas that would not restrict flows. Would require substantial areas adjacent to the channels, which are very limited in Newcastle. Critical culverts or channels could be targeted for limited application of this option.
Removal of flow impediments in floodways and across floodplains (including development)	✓	✓	✖	There are many water and sewerage pipes, cables, fences and other flow impediments that span open channels throughout Newcastle. These can accumulate debris and cause blockage. Some of these could be redesigned to be more elevated over the channel, or indeed buried beneath the channel. In addition, large areas of former wetlands and natural floodways have been filled and buildings erected when suburbs of Newcastle were developed.
Tunnels for storage / conveyance	✓	✖	✖	Tunnels are very expensive to build, however, they can be helpful in conveying and storing floodwaters. They are suited to densely populated areas, like Hong Kong where a $1b stormwater tunnel is currently under construction.
Diversion to mine shafts	✓	✖	✖	Newcastle is littered with relicts from early mining exploitation, including various mine shafts. These shafts could act as a “sink” or at least a temporary “store” for diverted floodwaters, depending on whether they are dry or already full of water.
Pump out of floodwaters	✓	✖	✓	In combination with a levee or dyke, any floodwaters behind the structure could be pumped out. The size of the pumps would need to be compatible with the expected ingress of floodwaters (pumps in New Orleans were completely overwhelmed by flow rates). Pumps are not fail-safe and may only delay inundation, thereby adding time for appropriate emergency response.
Diversion into adjacent catchments	✓	✓	✖	Would require deep tunnelling or open channels to divert flows over ridges and into adjacent catchments. Has been suggested for diverting flows from Cottage Creek directly to Bar Beach. Would be a very costly option. Suggestion also made to divert flood flows from Fullerton Cove to the ocean.
River/stream rehabilitation - slow flood flows	✖	✓	✖	Floods can be attenuated by “slowing” the flows, thereby spreading the peak of the hydrograph. The June 2007 Hunter River flood at Maitland was significantly attenuated by recent regrowth of riparian vegetation between Bolwarra and Greta (pers comm.. Ken Speer, SES).

6.3.2 Coarse Filter Assessment of Property Modification Measures

These measures are designed to reduce the potential risks to life and property by modifying individual properties. Property modification measures have been identified and considered based on whether the measures address existing development or future development, as outlined in Table 6-5 and Table 6-6, respectively.

Table 6-5 Existing Development Property Modification Measures

Existing Development	Applicable to Newcastle?			Comments
	FF	RF	OF	
Voluntary purchase	✓	✓	✓	Target high priority areas only. Can be a very costly option, and will reduce both risks to life and property.
House raising	✓	✓	✓	Applicable to some areas, but may have aesthetic issues. Need to ensure structural stability, and can be used to provide flood free refuge as well as reduce flood damages.
Flood proofing of buildings (walls, floors etc)	✓	✓	✓	Aimed at minimising damages to properties through modifications to buildings. There is probably limited scope for this for existing buildings.
Dry flood proofing (i.e. complete flood exclusion from property)	✖	✖	✓	Would potentially result in significant hydrostatic loading on the external walls. Unless these walls are structurally reinforced, there is a chance the walls will collapse inward.
Wet flood proofing (allow flood ingress to equalise water pressure)	✓	✓	✓	Removes the hydrostatic loading issue by equalising flood pressures inside and outside the building. This would help to make building stable, and thus could assist with provision of shelter-in-place (if flood free refuge areas are available).
Reinforced cladding	✓	✓	✓	Aimed to improve the structural integrity of a building. Would need to be careful to determine the actual structural rating with respect to hydrostatic loading and other flood forces.
Strengthened foundations	✓	✓	✖	Floodwaters can push houses off foundations due to a combination of buoyancy and lateral forces. If just backwater flooding, then less likelihood of foundation damage.
Raise electrical and fixed assets	✓	✓	✓	As per flood proofing. Aims to minimise damages if property is inundated. The level to which electrics is raised would need to consider the probability of the flood.
Temporarily relocate contents	✖	✓	✓	Raising valuable to as high as possible can be effective at limiting some damage, but dependent on having enough time to perform the relocation process.
Sand bags and drop-in boards	✖	✓	✓	In manually intensive and requires ample warning time for installation.
Rainwater tanks	✓	✖	✖	Locally generated flash flooding can be abated somewhat by rainwater tanks, however, it would only be beneficial if the tank was empty at the time of the rain event.
Reduce impervious areas	✓	✖	✖	Locally generated flash flooding could be marginally improved by having a more pervious ground surface, although the rainfall intensity is expected to far exceed infiltration rates for pervious surfaces.
Improve site drainage	✓	✖	✖	Locally generated flash floods could be improved by better local drainage. Greater local drainage may cause amenity issues for non-flood times.
Relocate suburb (e.g. Claymore, QLD), esp. in response to potential SLR	✖	✖	✖	Broadscale relocation of dwellings would be subject to having a suitable alternative location. Within Newcastle, no such alternative and flood-free locations are available. Eventually, areas such as Carrington, Stockton and Maryville may need to be abandoned if sea levels rise

Existing Development	Applicable to Newcastle?			Comments
	FF	RF	OF	
				extensively.
Retrofit upper storey flood free refuge	✓	✖	✓	Can be provided as a second storey to a building, or just access to the roof space in a single storey dwelling, providing that the refuge area is higher than the PMF level, and the building will not collapse during the event. Within the context of Newcastle LGA, the river flooding areas are mostly located within a floodway, and thus the buildings would be considered unsuitable for refuge even if internal access above the PMF level could be provided. The exception to this may be properties located on the periphery of the floodplain (i.e. around Hexham Swamp) within flood fringe areas.

Table 6-6 Future Development Property Modification Measures

Future Development	Applicable to Newcastle?			Comments
	FF	RF	OF	
Zonings to restrict development in critical areas	✓	✓	✓	In particular, certain types of development are considered more suited to development within the floodplain, including developments that contain the elderly or infirm, or developments that are critical to the provision of emergency services and combat agencies.
Time-dependent zoning, for SLR for example, property removal on expiry	✖	✖	✓	Would need to consider triggers for response (e.g. sea level rise gets to *x* cm, or inundation frequency exceeds *x* times per year).
Incentives for redevelopment (e.g. change of zonings)	✓	✓	✓	Current low-density houses of standard construction could be replaced by medium to high-density development that are more structurally robust and would provide greater opportunity for shelter-in-place (and associated structural integrity), albeit at the expense of a greater population affected.
Relate planning levels and conditions to real events (for better comprehension)	✓	✓	✖	Suitable providing there are real events that can be used in this regard. Likely that design conditions will exceed experiential knowledge of flooding.
Development / building controls requiring flood-smart design and structural integrity	✓	✓	✓	The existing DCP requires provision of flood free refuge (above PMF) and structural integrity to PMF level. Controls could also require other mechanisms for minimising flood-related damages, especially in relation to building materials, electrics etc.
Water Sensitive Urban Design	✖	✖	✖	Water Sensitive Urban Design (WSUD) aims to treat normal rainfall events, not floods. If WSUD was designed for flood conditions, the size of measures would be very large.
Property fill	✓	✖	✓	Limited amounts of fill could be used to help raise future development, providing that the development is not located within floodway or flood storage areas. Within Newcastle LGA there may be some small isolated areas that can be filled within the river floodplain, but generally, this would be unsuitable within floodways and flood storage areas.

Future Development	Applicable to Newcastle?			Comments
	FF	RF	OF	
Upper storey flood free refuge	✓	✖	✓	Is a current requirement of the Newcastle Flood DCP. Refuge for river flooding is not recommended, as there would be sufficient time for evacuation, which is the preferred method of emergency management, and existing residential property (at Hexham) is located within a floodway. The exception may be isolated properties around the fringe of the floodplain (although arguably evacuation from these properties should be easiest).
Shelter in place & structural integrity	✓	✖	✓	New development is already required by the DCP to provide flood-free refuge and structural stability to the PMF level.
Adaptive construction - allow for future modifications	✖	✖	✓	Involves construction that will allow for future changes relatively easily in order to better adapt to changing flood conditions (eg progressive raising in response to SLR).

6.3.3 Coarse Filter Assessment of Response Modification Measures

These measures are designed to reduce the potential risks to life and property by modifying the overall response of individuals before, during and after a flood event. These are presented in Table 6-7, Table 6-8 and Table 6-9, respectively.

It is considered that all response modification measures are equally applicable to all flooding mechanisms (flash flooding, river flooding and ocean flooding).

Table 6-7 Pre-Flood Response Modification Measures

Before a Flood	Targeting		Comments
	Comm -unity	Auth- orities	
General education to understand flood risks the community is living with	✓		Key messages regarding what to do and what not to do if caught in a flood
Targeted education (property or neighbourhood specific) to understand specific risks to individuals	✓		Key messages regarding how to manage risks to life and risks to property at an individual property basis, including closest evacuation centres, where roads would likely be flooded, and measures that can be implemented to be better prepared.
Practice drills	✓	✓	For both the community and the emergency services / combat agencies
Periodic updates given new residents and new data (including new events)	✓		As new residents move into communities and as complacency sets in on longer term residents, education is required on a periodic basis – constant updating and renewal.
Local flood plans and pre-		✓	Evacuation centres and emergency responses need to be

Before a Flood	Targeting		Comments
	Comm -unity	Auth- orities	
planned evacuation arrangements			set-up at very short notice, so pre-planning is required. Evacuation centres need to be flood free, and potentially cater for large numbers of affected people.
Disclosing information and sharing knowledge beyond experience (readily available, eg on internet)	✓	✓	Available via S149 certificates, publicly available flood studies and flood plans. Property-scale flood information should be available via the internet.
Review probability based flood maps, and recognise that floods can be bigger than the Flood Planning Level, and anything experienced to date	✓	✓	Community should be encouraged to familiarise themselves with flood maps, including maps of flooding that goes beyond current level of experience.
Share anecdotal and historical information regarding flood behaviour	✓	✓	A portal or forum could be established to focus on community perspectives, experiences etc. This could be in the form of Facebook, twitter etc
Raising access roads to facilitate evacuation and extend effective flood warning times	✓	✓	Example would be raising the Pacific Highway through Hexham to allow for safe evacuation of residents within this area. At present the road becomes inundated relatively early in a flood, especially with high tides and storm surge.

Table 6-8 During-Flood Response Modification Measures

During a Flood	Targeting		Comments
	Comm -unity	Auth- orities	
Evacuation powers - mandatory & willingness to enforce		✓	The Police and SES are often faced with community members unwilling to evacuate, only to require rescue later once floodwaters become perilous.
Inter-agency co-operation and arrangements		✓	Evacuation and other emergency management responses need significant co-ordination between various agencies involved. Clear roles and responsibilities need to be identified during and after an event.
Nowcasting predictions		✓	Nowcasting is forecasting within a 6hr window. Nowcasting is supported by basic level numerical analysis given the short timeframes available.
Flood warning system, based on integrated rainfall and river level gauging, and real-time radar		✓	A total flood warning system can buy extra time for appropriate flood response, if the information can get to the community in time. The system needs to be locally specific and not generic. A system is very acceptable to the community, but can lead to a false sense of security.
Automated voice and text messaging for notification of flood warnings	✓	✓	One possible method of disseminating flood warning information. Multiple methods would be required.
Local flood wardens in hot spot areas	✓		Can be local 'go to' people who know much more about appropriate emergency response than the average community member.

During a Flood	Targeting		Comments
	Comm -unity	Auth- orities	
Temporary advisory signs - flashing flood warning	✓	✓	Large RTA-style signs that can be readily updated to notify road users about flood warnings or road conditions elsewhere. An alternative would be smaller (and significantly cheaper) electronic signals, similar to a flashing school zone sign, which becomes automatically triggered by a water sensor within an adjacent culvert or creek crossing.
Multi-media bulletins for notification of flood warnings	✓		Urgency of disseminating flood warnings is critical to providing the community with as much preparation time as possible. This should extend to all radio and TV channels, not just local ABC Newcastle.
Sirens and public address for notification of flood warnings	✓		Another possible method of disseminating flood warning information. Multiple methods would be required. Community would need to know what to do in the event of a siren of PA alert.
Social media channels, such as twitter and facebook	✓	✓	Much of the flood information that was distributed and accessed during the 2011 floods across Queensland, NSW, Victoria and WA was via social media (facebook, twitter) and internet sites. Emergency services set up direct feeds to these channels with latest updates and information. Community were able to supplement the information with first hand knowledge (thus making sure the information was as current as possible).
flood markers indicating problem areas	✓		Flood markers indicate flood depths, however, there has been confusion over existing markers regarding how to read them. Also, people may be tempted to drive or wade through floodwaters if they know they are shallow, without realising that fast-flowing water can still be very dangerous at shallow depths. Standard RTA flood markers installed in Newcastle after the June 2007 event may need to be altered to reinforce appropriate flood response messages.

Table 6-9 Post-Flood Response Modification Measures

After a Flood	Targeting		Comments
	Comm -unity	Auth- orities	
Inter-agency co-operation and arrangements and recovery plans		✓	Post-flood recovery co-ordination between agencies is required to outline roles and responsibilities, especially as community starts seeking out support and assistance.
State government assistance	✓	✓	Assistance is provided through various schemes set up under the NSW Disaster Assistance Arrangements. Conditions apply
Federal government assistance	✓	✓	Assistance is provided under the Natural Disaster Relief and Recovery Arrangements. Conditions apply
Charity assistance	✓		Assistance provided by charity organisations (food, clothes, shelter, basic needs)
Counselling	✓		To help overcome the trauma associated with flood events

After a Flood	Targeting		Comments
	Comm -unity	Auth- orities	
Clean-up assistance	✓		Assistance with the physical clean-up following flood events. Usually provided by volunteers (note the highly organised Brisbane flood clean-up).

6.3.4 Other Measures

Other measures that do not fall into the basic categories as outlined above generally relate to insurance (refer Table 6-10).

Table 6-10 Other Modification Measures

Insurance	Comments
Property insurance	To cover damages incurred by floods and storms.
Life insurance	To cover loss of life or permanent disability associated with flooding.
Incentivised premiums (e.g. for floodproofing)	Only where damages would be reduced as a result of implementing specific flood management measures.
Improved understanding of flood risks by insurance companies	Work with Insurance Council of Australia to help Insurance Companies understand the risks associated with flooding so they can provide realistic insurance cover, rather than generalised over large areas / regions / states
Improved community understanding of flood insurance	Help the community unravel to detail of insurance cover so they understand what floods are included and what isn't included in individual policies. As discussed previously, the National Disaster Insurance Review provided specific recommendations on flood insurance cover, which if adopted by the insurance industry and Government, would allay much of the current confusion.

6.4 Flash Flooding Options Assessment (Fine Filter)

Based on the initial coarse filter assessment (refer Section 6.3), there are a number of flood modification, property modification and response modification measures that are considered applicable and reasonably practical for the Newcastle flash flood environment.

As outlined in Table 5-6, current management of flash flooding is considered quite inadequate, primarily because risk to life cannot be managed for the full flood risk as required by the Manual. There is simply not enough time to execute a formal evacuation Plan, and many thousands would find themselves in life threatening situations with no means of escape. As such, it is envisaged that much of the City-wide Flood Plan should be dedicated to rectifying this ill-managed situation.

6.4.1 Flood Modification

In the flash flood catchments, four broad flood modification approaches should be considered:

- Detain floodwaters in the upper reaches of catchments;

- Convey floodwaters more quickly out of the floodplains;
- Divert floodwaters or open-up existing constrictions within the floodplain; and
- Mechanical augmentation of stormwater drainage (e.g. pumps).

6.4.1.1 Detention

Flood detention basin

For flood detention to be practical and effective, there needs to be an area available to place a detention basin that is:

- Big enough to hold back a significant amount of water;
- Currently undeveloped;
- Higher up in the catchment than the development which needs protecting;
- Low enough in the catchment that it can intercept sufficient flow to make a difference;
- In or near the flowpath so floodwaters will flow into it; and
- Not currently completely flooded otherwise there will be no space to store the additional floodwaters which are being detained.

Possible land was considered in the Ironbark Creek, Dark Creek, Throsby/Styx Creek and Cottage Creek catchments. A preliminary analysis showed that the area needed was much greater than the area available in each catchment to make a significant difference in a 1% AEP flood. This is illustrated in Table 6-11 for Cottage and Ironbark Creeks, while there is similarly a paucity of unflooded open space in the other catchments that would be suitable.

It was considered that no practical and effective detention basins could be established for flash flood detention in Newcastle, so this option was not investigated further.

Table 6-11 Requirements for Flood Detention: Ironbark and Cottage Creeks

Catchment	Areas targeted for reduction in flood levels	Area needed to keep flows within channel in a 1% AEP flood.	Suitable area available in catchment (ha)
Ironbark Creek	Cowper St	88ha	25ha
Cottage Creek	Mary St	9ha	0ha
	King St	100ha	0ha

A question was put from the Wallsend Commercial Centre business community about whether or not the possibility of having multiple smaller detention basins higher up the Wallsend catchment had been considered. The reason given was that the high cost of CofN's adopted Wallsend Commercial Centre Floodplain Risk Management Plan (over time - $28m for public works and property acquisition to clear the floodway and an estimated $16m in private building strengthening and provision of

refuges). This was seen as unlikely to be funded and therefore focus should shift to less costly measures that may still have some benefit to the Town Centre.

These are very reasonable questions. The following context is needed before exploring a response:

- The objectives and principles of the NSW Government Manual (see Chapter 2) include "Danger to personal safety, economic losses, social and ecological factors should be balanced and should provide best value" that "The PMF (or extreme event) provides an upper limit of flooding and associated consequences … It is used for emergency response planning purposes to address the safety of people" that "There is a need to develop additional management measures such as response modification measures to mitigate the danger to personal safety associated with overwhelming flood events" and also that "Response planning for the consequences of the PMF provides for effective management of smaller events, particularly those rarer than the flood event selected as the basis for the FPL";
- The background research from an expert engaged under the NSW Government Floodplain Management Program was that "In the context of the appalling risk to life, CofN has a duty of care to pursue all the high priority measures of the Plan as a matter of urgency." This included all the measures in CofN's adopted Wallsend Flood Plan (2009)
- Relying on warnings (which cannot always detect the onset of severe flash flooding) is not fail safe, and the provision of refuges above the PMF in stable buildings is still essential.

In response to the community's query then:

- Even a substantial provision of flood storage using the entire Wallsend Park at the bottom of the catchment (just upstream of the Wallsend Commercial Centre) was found to not provide sufficient reduction in flood hazards (either reduced time or delay to allow more time for emergency response). Only five more minutes was provided, which is not material given the number of people at risk on a busy business day would be measured in the thousands;
- Small storages high up in the catchment would not be effective for managing flood risks in the lower parts of the catchments (i.e. the commercial centre) to meet the assessment of management of risk to life based on the objectives and principles of the Floodplain Development Manual (2005). Even using the full capacity of Wallsend Park just upstream of the Wallsend Commercial Centre excavated to a reasonable depth cannot substantially reduce flood damages for major events like occurred in 2007;
- This then left the possibility that small detention basins in the upper reaches of the Wallsend catchment might be able to offer some localised benefits for smaller floods in the risk to property range (1% AEP and smaller). The management actions in CofN's adopted Wallsend Commercial Centre Flood Plain Risk Management Plan would thus still be required. However, even though previous investigations had concluded there would be no benefits of detention in the upper reaches, some further indicative examinations were carried out to further check if any local benefits may be possible; and
- Unfortunately the further indicative investigations found it appears where there is potential for small storage in the upper reaches, there are no buildings immediately downstream – and vice versa.

In conclusion, it is still recommended that during the proposed investigation of amplifying culverts in the upper reaches, at the same time the possibility of constructing small storages to the maximum reasonably possible be investigated using the computer flood model at an appropriate resolution.

On-site Detention

An alternative to providing one or more large detention basins is to provide hundreds or thousands of smaller ones. This can be done through the construction of on-site detention structures on private properties throughout the catchment. This is common practice in many local government areas around Australia. CofN has an on-site detention policy which requires any new development to manage runoff so that downstream drainage systems are not compromised beyond their design criteria. In essence, development is to be designed so that peak runoff from the site for all events from 99% AEP (1 in 1 year) to 1% AEP (1 in 100 year) is not greater than for the 'natural' drainage conditions. For sites of less than 50% impervious area, this can be achieved by providing 12mm of rainfall storage, while for 100% impervious areas, 25mm of rainfall storage is required.

Current on-site detention for an average 20 square house on a block larger than 400m^2 therefore requires about 2m^3 of available detention volume. It should also be noted that this storage volume needs to be empty at the beginning of the rainfall event for it to mitigate flooding, and as such, rainwater tanks or other water supply storages cannot be relied upon for flood mitigation.

It was decided that continuation of the existing on site detention policy be recommended to ensure that flooding does not become worse in frequent floods, however, any change to the policy to incorporate more extreme events would be impractical.

Mine Voids

A suggestion has come from the community to divert flood flows into mine voids thus reducing flooding. This option was considered and the following points noted:

- There are numerous disused underground mines around Newcastle;
- The groundwater table is generally close to the surface, particularly in the lower ends of the catchments, and so the majority of the mine void would likely already be filled with water - the amount of potential flood storage is unknown;
- Works would be necessary to ensure that only excess floodwaters were directed into the void, allowing low to moderate flows to remain in the creeks;
- For the voids to always be available for flood mitigation they would have to be emptied very quickly after a flood. It is expected that floodwaters diverted into the void would actually drain very slowly through recharge of the groundwater table; and
- To ensure viability, the mines voids may need to be manually drained, possibly by pumping, immediately after every flood. The size of pumps and the amount of energy used would be disproportionately large.

Based on the above limitations, this option was not investigated further.

6.4.1.2 Increasing Flood Conveyance

In theory, if floodwaters can be conveyed through the flash flood catchments and into the Hunter River more quickly, then less water will spread out over their floodplains. This was investigated for each flash flood catchment.

Ironbark Creek

Most of the flow in this catchment is conveyed by open channel into Hexham Swamp. Investigations showed that there is a significant constriction to flow as it passes through the Wallsend Commercial District. The Wallsend Commercial Centre Floodplain Risk Management Plan (adopted by the elected Council in 2009) identified that removal of selected commercial buildings and bridges, widening the channel from Wallsend Plaza to Federal Park and increasing the flow capacity under Minmi Rd could make a significant difference to flood conveyance, thus lowering flood levels and reducing potential flood impacts on life and property.

Dark Creek

The Dark Creek catchment is generally drained by open channels which also flow to Hexham Swamp. There are some long sections that are culverted through Jesmond Commercial Centre.

Consideration was given to increasing the open channel downstream of Sandgate Rd within Hexham Swamp (where there are no major impediments to widening the channel). Investigations showed that, at best, a 200mm reduction in level could be achieved for the 1% AEP flood event. Channel widening through the large area of open space between Jesmond Commercial Centre and Birmingham Gardens was also considered. For a 1% AEP flood, floodwaters in this area already spread out to an average width of about 100m at an average overbank depth of about 0.5m. Complete containment of the 1% AEP flow would require increasing the channel from 8m to more than 40 metres. Making the channel this wide along its entire length from Jesmond to Hexham Swamp would require the removal of two sports fields and the demolition of about 10 houses. This is about the same number of houses that would experience above floor flooding. Demolition of this many buildings to benefit the equivalent number when floods occur is not justifiable on social or economic grounds. This was therefore not investigated further.

Throsby Creek

Throsby Creek is generally drained by open channels as well as underground pipe networks, particularly in the upper catchment area. In the middle and lower catchments area there are both open channels and large lengths of underground culverts. Several community members suggested that dredging the bottom end of Throsby Creek or lowering the base of the channel would increase the creek's conveyance and reduce flood levels.

To test this option, the computer flood model was rerun with a 6km section of Throsby Creek lowered by an average of 2.5m along its entire length (refer Figure 6-1). Within this figure, chainage 0m corresponds approximately to the intersection of Northcott Drive with the Railway Embankment in Kotara, chainage 1200m is at Mackie Avenue, chainage 4500m is at Maitland Rd, and chainage 6000m is at Hannell Street.

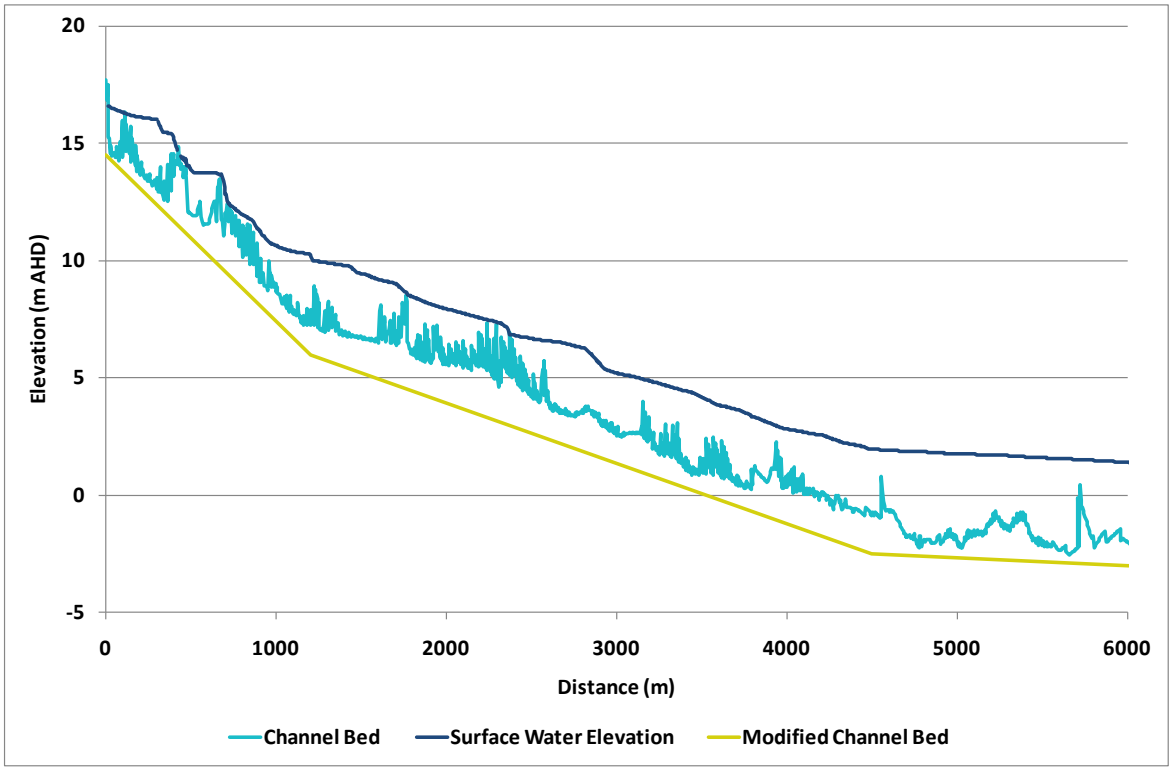


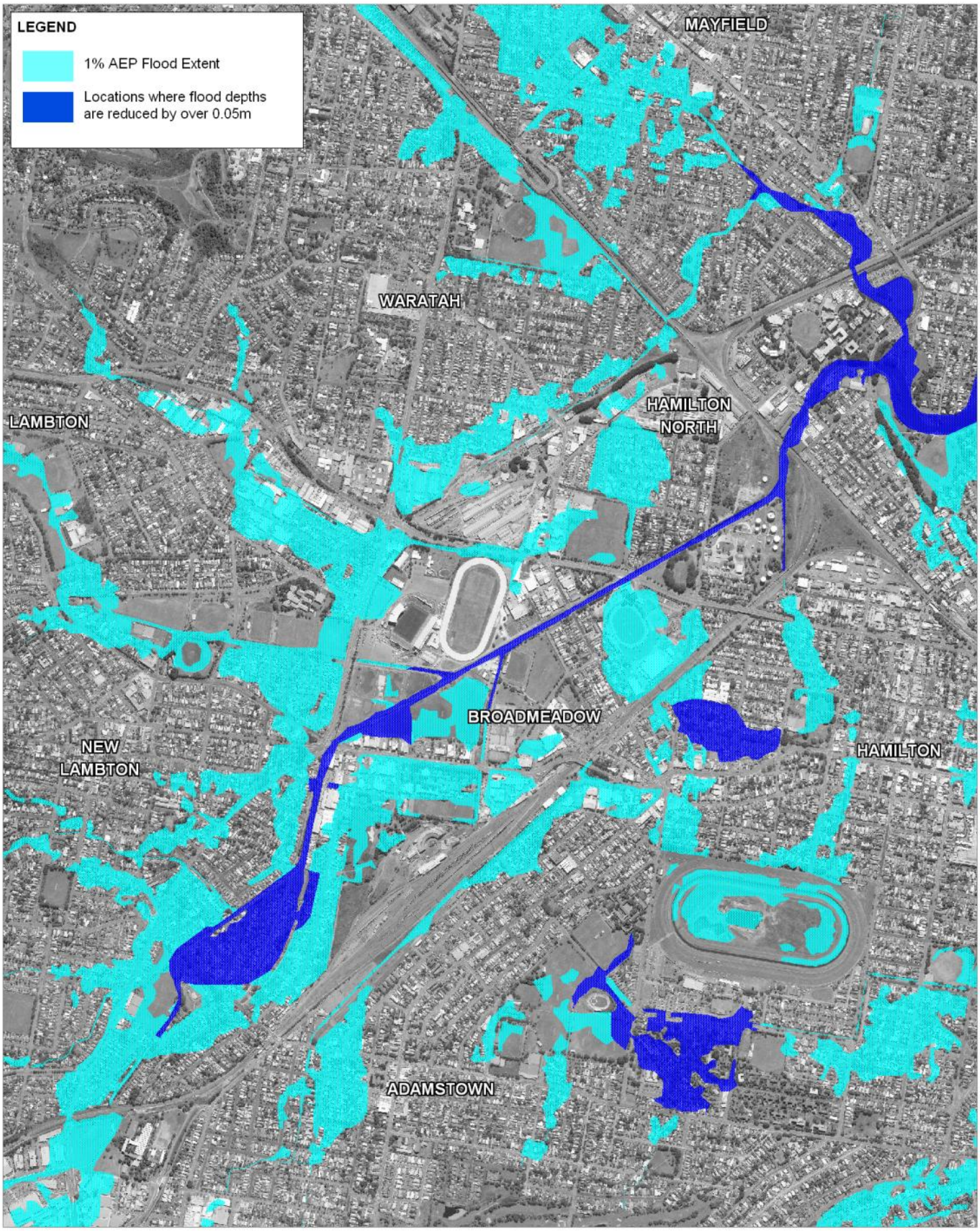
Figure 6-1 Lowered Throsby Channel Profile

The results showed that the majority of overland areas have no change in the flood level, except for an area immediately adjacent to District Park and an area around the velodrome (refer Figure 6-2). For both these areas, the reduction in flood levels was about 0.1m on average. Larger reductions in flood levels were predicted within the channel itself.

Closer inspection of the flood behaviour in the model revealed two reasons for this. At the downstream end, flood levels are controlled by the level of the ocean tailwater. Lowering the channel simply results in water from the Harbour penetrating further up the channel at the same sea level. That is, the level in the creek does not change, but rather the creek simply becomes deeper. Further upstream, the predicted depth of flow does not change with increasing channel depth, as there is no increase in the flow in the channel. This implies that the controlling factor is more related to getting flows into the main channel rather than the conveyance capacity of the channel itself.

This is consistent with observations by the community in the June 2007 flood where it was reported that at the peak of the flood, water levels in the main Styx Channel were still about 1.5m below the top of the channel as it passed through Hamilton North, yet the surrounding areas were flooded to considerable depths. The flat nature of the floodplains surrounding the channels means that no amount of channel or pipe improvements will greatly improve localized flooding, as the issue is the amount of accumulation of water on the floodplain.

A member of the community also suggested that the trash racks within Throsby Creek were obstructions, which have caused flooding upstream. While at low flows these devices may cause a hydraulic jump in the water surface, at high flows they would be overwhelmed by the flooding and have little influence at the peak flood surface. Furthermore, it is clear from the preceding analysis that flooding is occurring around Throsby Creek when the channel is not full and so minor obstructions within the creek itself are not likely to significantly contribute to flooding.



Title:

Impact of Lowering Channel Bed on Flood Levels in Throsby / Styx Creek

Figure: **6-2**

Rev: **A**

N

0 375 750m

Approx. Scale

BMT WBM

www.bmtwbm.com.au

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Cottage Creek

Cottage Creek is also drained by a combination of open channels in the lower sections of the catchment and an underground pipe network in the upper parts of the catchment.

Conveyance of all of the flood flow (up to 1% AEP flow say) within the stormwater system would not be physically possible. For example the peak flows along Morgan Street are four times the capacity of the pipe which runs under the street. Even if it were possible to fit pipes this large within the road reserve, the terrain is such that not all of the flow would still be directed into the pipe.

Further downstream the channel sizes would need to be even larger. At The Junction, the open channel would need to be 6-10 times wider than it currently is, while at Parry St it would need to be 15-20 times wider. But as for Throsby Creek, even with wider channels, the flatness of the surrounding land would inhibit floodwaters getting into the channel, while the tailwater would also be largely controlled by the Harbour levels at the time of the flood.

6.4.1.3 High Priority Areas

An initial list of high priority areas within the flash flood catchments was identified during the previous concept stage of the Plan, which included areas with frequent above floor flooding or significant risk to life in extreme floods. Consideration has also been given to other priority areas defined using the following criteria:

1. Buildings subject to frequent above floor flooding – these are locations where complaints to CofN and/or the modeling of the 10% AEP flood suggests that homes and/or business premises may get floodwaters through them frequently causing damages which result in financial losses, disruption and hardship to those affected;
2. Buildings subject to H3 flooding – these are locations where water depth and velocities can make it unsafe for an able bodied person to wade through so a person exiting these buildings might perish;
3. Residential buildings subject to H4 flooding - this is where water depth and velocity combinations could cause structural failure of residential buildings and people sheltering in such a building might perish;
4. Any building subject to H5 flooding – these are locations where buildings of any construction could fail and people sheltering in such a building might perish;
5. Areas which are sensitive to blockage – these are locations where, should culverts be blocked, the flood hazards increase around nearby buildings; and
6. Any group of houses / buildings located within the 1% AEP floodway.

Although it is recognised that people may occupy areas other than buildings or main roads during a flood, the numbers likely to be affected are expected to be low given the type of weather conditions which prevail. Roads subject to flooding were considered separately.

A map of these high priority sites is presented in Figure 6-3. Evaluation of the high priority areas was carried out in stages. Firstly, the relevant flood model was examined to identify any specific flow constrictions for each of the locations, and to determine whether changes to landform or structure (e.g. a channel bend or narrowing, a bridge or culvert, or a road or rail embankment) would potentially

change flood levels. Only those locations where there was reasonable potential to modify flood behaviour in order to mitigate significant risks to life and/or property were considered further.

On inspection, it was found that at a number of locations that development was so close to the channels that widening or opening-up the channel would require removal of the very buildings that are primarily at risk. In other locations the barrier to flow is the overall landform on which surrounding houses have been built. Again, those houses would have to be demolished in order to modify the landform and remove the flow constriction. Meanwhile, for some other locations, the length of channel that would need to be modified is so long that the works involved would far exceed the benefits that result.

Discussions on the analysis of selected high priority areas undertaken by Molino Stewart are provided below.

Errington St, Mackie Ave, St James Road and Fairfield Ave, New Lambton

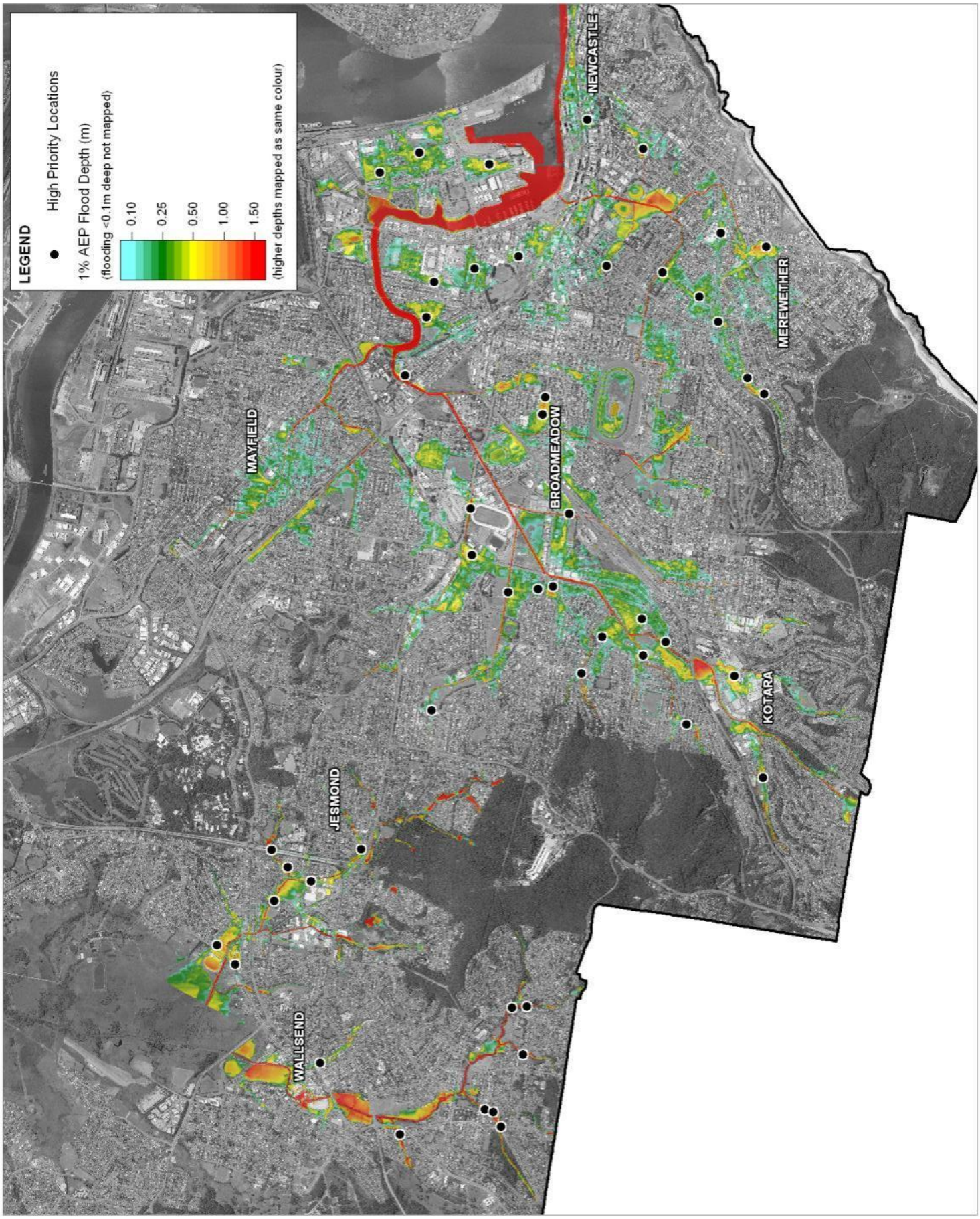
These streets have reported frequent flooding to Council, but flood modeling suggests that a 10% AEP event would not enter the buildings. It is possible that some of the homes in these streets have built extensions at the rear of the houses at a level lower than the rest of the house and therefore lower than the level surveyed by Council. A flood bigger than a 0.5% AEP event would be needed before high hazard flooding occurred around these homes.

A desk top analysis of the model suggested that there may be scope to reduce flood impacts in both the 10% AEP and PMF events by increasing the stormwater channel capacity in this location. While the effectiveness of this option may make it worth considering further, a field inspection showed that there are many properties built close to the channel and houses would need to be acquired and demolished to widen the channel sufficiently in order to potentially reduce flood levels. It was considered that such an option would be neither socially acceptable nor economically viable so this flood modification option was not carried forward for more detailed analysis.

Evescourt Road, New Lambton

A field inspection at this location revealed that the road is about 2 metres higher than two blocks of land on the upstream side of the road but there is no evidence of a surface drainage system. The two houses built on these blocks have raised floors at, or higher than, road level. It would appear that the landform fills in this location to create high hazard flooding during a significant flood event but a flood about this size or bigger would be required before above floor flooding occurred.

While the frequent flooding of the yard and garage is unsatisfactory for these residents, there is no cost effective solution given the natural land topography.



Title:

High Priority Areas in Stormwater System Assessed for Improving Hydraulic Effectiveness

Figure: **6-3**

Rev: **A**

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Approx. Scale

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Hobart Road, New Lambton

There is a stormwater channel running roughly parallel to Hobart Road about 100 metres to the north. This channel is crossed by the remnants of an old railway embankment just upstream of Tyrone Road. The old brick arch culvert under the rail embankment creates a flow restriction and water builds up behind the embankment, flows across to Hobart Road through residential properties and along Hobart Road before cutting back across to the stormwater channel through residential properties. It was considered that this embankment contributes to the above floor flooding of several nearby homes (on Durham Road).

Preliminary analysis suggested that removing a section of the rail embankment would reduce flood risks and damages in a wide range of events from the 10% AEP to the PMF. Modelling of this option was therefore undertaken. The existing historic rail embankment was removed to match the surrounding terrain. When the model was run with the embankment removed (refer Figure 6-4), the flood levels immediately upstream reduced by about a 0.1-0.3 m, while further upstream, there was a 0.05-0.10 m decrease in the flooding depth around the properties bordering Karoola Rd. However, despite the reductions in flood levels, the number of buildings with above floor flooding remained the same. Closer inspection of the modelling revealed that the flooding of these buildings is primarily caused by floodwaters originating from other flow paths upstream and thus is not controlled by the embankment. As removal of the embankment would not reduce above floor flooding, this was not considered further.

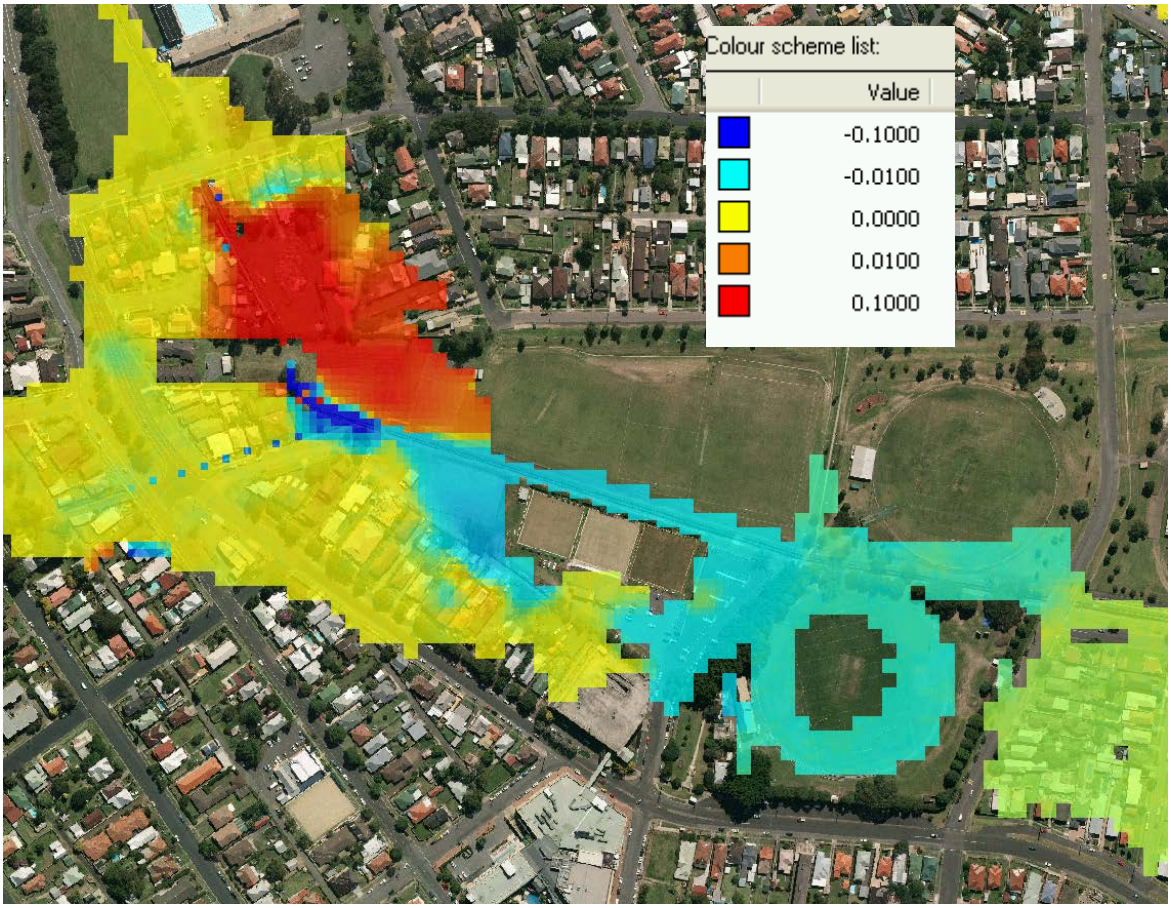


Figure 6-4 Changes in flood levels with removal of embankment at Hobart Road

Howell St, Kotara

A stormwater channel runs through a park on the corner of Howell Street and Park Avenue. The model shows that a constriction at Howell Street is diverting the water into Park Ave and Howell Street and flooding homes. Only one house would experience flooding in at the 10% AEP event.

Increasing the culvert size under Howell St and widening the channel to at least twice its current width may reduce the frequency of flooding of homes in this area. A site inspection revealed that there are two houses built close to the channel and about another 30 properties that would have their backyards reduced in size, and in some instances swimming pools removed, if this option were to be built. It was decided that the social and financial cost of this option could not warrant the potential benefits so it was not investigated further.

Park Ave and Northcott Drive, Kotara

There is a small set of culverts which carry stormwater from a small catchment upstream of Westfield Kotara. In events larger than about a 10% AEP, the culverts reach capacity, water flows overland across a park and into the underground carparking area of the shopping complex (as occurred in 2007, see Figure 6-5). Even if these culverts were converted to an open channel it is unlikely that it would be able to convey more than a 10% AEP event.

Figure 6-5 Flooding in underground carpark Westfield Kotara, June 2007

Further downstream there is a larger open channel which passes under a rail embankment via two culverts. Downstream of the embankment there are several houses susceptible to flooding, while upstream of the culvert is a large park surrounded by commercial development. The embankment tends to impede flows when the channel and culvert capacity is exceeded and the ponded water can back up into the surrounding commercial developments. It was investigated whether the flood

impacts on the downstream properties would be reduced if one of the culverts through the embankment was blocked allowing more detention of the floodwaters in the park.

The results of the modelling (refer Figure 6-6) indicate this would certainly be the case, however, the resulting higher water level in the park would lead to higher water levels along Northcott Drive where it passes under the rail embankment further to the west. In a 1% AEP flood, this would result in the above floor flooding of about the same number of homes as the number which are benefited downstream of the culverts. As there would be no net gain in property damage or intangible benefits it was therefore decided that this option not be considered further.

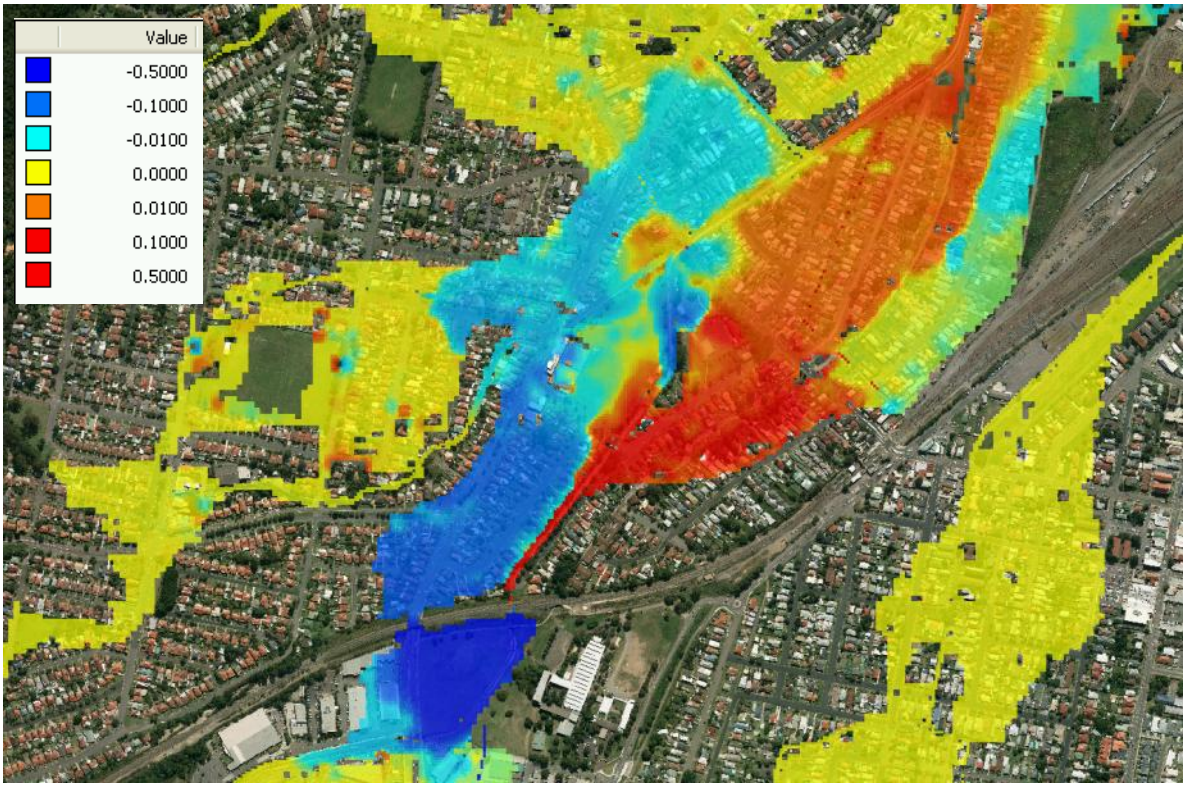


Figure 6-6 Difference in flood levels when one culvert is closed at Northcott Drive

Turton/Womboin Road, Broadmeadow

Houses are flooded at this location flood because there is a constriction in the channel where it passes under Womboin Road and Turton Road. Preliminary analysis of the model outputs suggested that removing the constriction would reduce this flooding for a full range of events.

A site inspection revealed that the stormwater channel passes through a 200m long culvert under Womboin Road, two rows of houses, Turton Road and large automotive businesses before becoming an open channel again. To remove this restriction it would be necessary to open up the channel considerably which would probably mean the removal of two or three houses and part of the automotive business.

Furthermore, in larger events it appears that there are capacity issues with the channel upstream of Womboin Road and to widen the channel in this section would impact about 20 houses and several light industrial businesses built close to the channel. It was therefore decided that it would not be practical or affordable to make these changes to the channel in this location given the magnitude of the potential benefit. This option was not investigated further.

Tara Rd Broadmeadow

There are several light industrial properties in and around Tara Road Broadmeadow which appear to suffer above floor flooding from water building up behind the Lambton Road culvert. The area downstream of Lambton Road is a park, so an increase in flow capacity of this culvert was considered worthwhile investigating, despite major services running along Lambton Road, including telecommunications cabling and a diesel pipeline, which would likely increase the cost of any option here.

The culvert passing under Lambton Rd consists of two rectangular culverts 2.48m wide and 2.25m tall. Doubling the culvert capacity under the road would reduce flood levels by up to 0.5m, while the increase at the downstream side would be less than 0.1 m (refer Figure 6-7). However, despite the reduction in the channel, the reduction in flooding in Tara Road industrial area would be less than 0.1m, and in most cases only approximately 0.03 m, because inundation is mostly from flows originating from overland, rather than coming out of the channel proper.

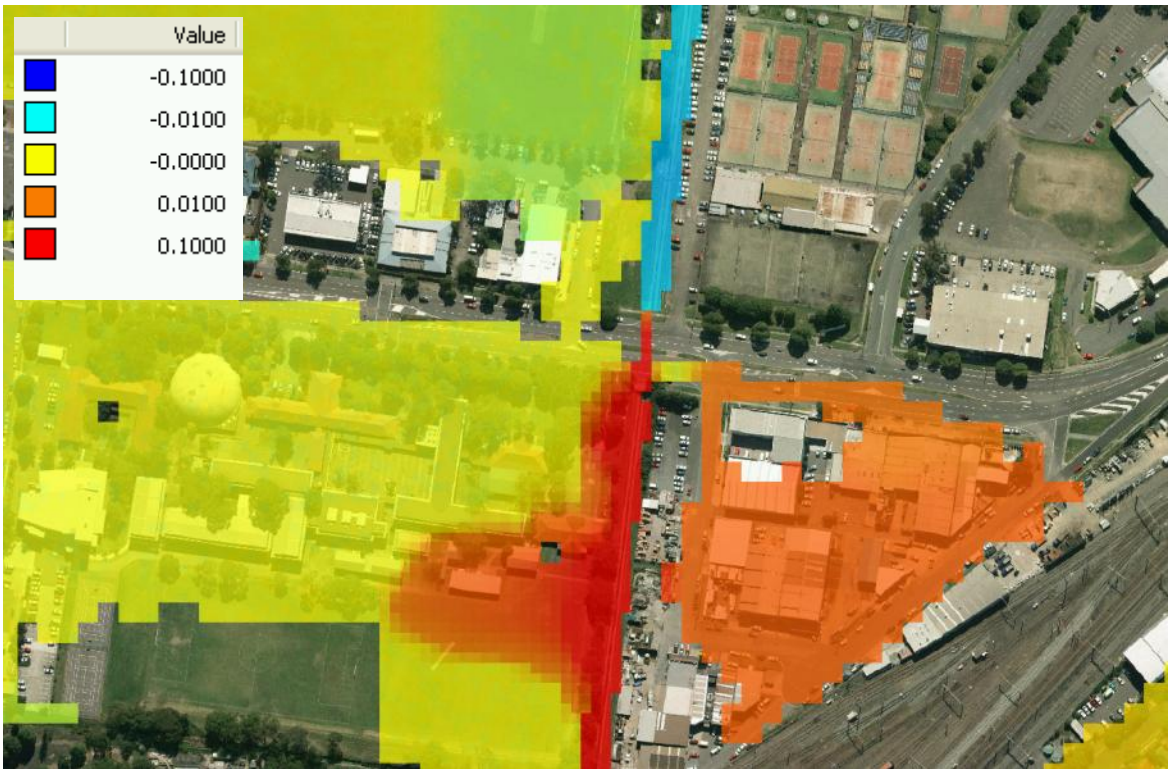


Figure 6-7 Difference in flood levels when increased to three culverts

Samdon St and Tudor St Extended, Broadmeadow

It appears that this whole area is drained by underground drainage pipes and culverts and when flows exceed the capacity of the underground network it fills up the lowest spots on the landscape. These streets happen to be the lowest places in the landscape and fill to hazardous depths sooner than surrounding areas.

It would be neither practical nor affordable to significantly increase the capacity of the drainage network throughout these areas.

John Hooker Road, Islington

Site inspection revealed that there is a single light industrial business close to the canal which has a short steep rise up to John Hooker Road. Flooding at this location may be exacerbated to a small degree by a Jersey Kerb barrier built along the middle of Maitland Road. Removal of the Jersey Kerb may reduce the upstream flood levels but it would also reduce road safety. The kerb was erected after a fatal car accident on this stretch of road. It was decided not to investigate removal of the barrier any further.

Corona Street, Hamilton East

Corona Street forms a natural swale in the landscape, which fills when the underground drainage system cannot cope with stormwater flows. Ponding in Corona Street appears to be exacerbated by a higher road level at the intersection with National Park Street. It is possible that lowering the road level at this intersection may enable overland flows to more easily spill into the nearby stormwater canal running alongside the athletics track.

As the computer model is based on a grid cell of 10m x 10m, the scale of the potential works is too fine for numerical assessment. This is nonetheless expected to be a relatively low cost option to reduce frequent flooding and a detailed survey and finer scale modelling is recommended for further consideration.

King Street and Hunter Street, Newcastle CBD

Several commercial premises in King St are flooded when constrictions in Cottage Creek cause water to overflow from the stormwater channel. Overland flow is along King Street and National Park Street before returning to the channel downstream of Hunter St. Overland flows can also extend along Steel Street between King and Hunter Streets (refer historical image shown in Figure 4-2).

The flow constrictions are numerous in this section of Cottage Creek and the road bridge on King St, a narrowing of the channel downstream of the bridge, piers supporting a building in Hunter St which is built over the channel, the culverts under Hunter St, the rail embankment and Honeysuckle Drive, and a sharp change in channel direction between the rail embankment and Honeysuckle Drive could all influence flood levels at King Street in small and large events.

Of considerable concern is the building over Cottage Creek at 681 Hunter Street. This building completely blocks any overland flow path over Hunter Street at this location. Although the culverts under the building and Hunter Street have a large capacity (broadly capable of accommodating the 1% AEP flow), blockage of this culvert (as occurred in June 2007) or flood in excess of the 1% AEP

event would be constrained by the lack of overland flowpath, and cause backwater inundation upstream. Modelling carried out as part of Stage 1 Flood Planning (BMT WBM, 2009) demonstrated that blockage of the lower reaches of Cottage Creek in a 1% AEP event would cause a significant increase in flood levels upstream, including at least 0.5m afflux across the Marketown commercial precinct, with impacts extending as far upstream as Parkway Avenue. Blockage of the channel also requires the creation of alternative flowpaths along King Street, National Park Street, Steel Street and Hunter Street, in order for floodwaters to be conveyed downstream, with potential damage to properties along the flow routes. Had the building been removed before the 2007 flood event, the damage bill for the Newcastle CBD would have been much lower.

It was therefore considered that demolition of 681 Hunter Street be considered further. It is estimated that demolition of the building would cost in excess of $100,000. The building is a two storey brick building with a shop on the ground floor. It is currently owned by HWC with an existing lease to a third party in place (as of March 2012). It is recommended that HWC retain ownership of the property, but demolish the building in order to provide an overland flowpath for extreme floods, or to cater for blockage of the culverts under Hunter Street. Defining a probability for blockage of the culverts under 681 Hunter Street is impossible, so it is not practical to establish a specific benefit-cost ratio for these works. Nonetheless, good floodplain management practice dictates that such potentially significant overland flowpaths not be fully impeded. Based on conditions experienced in 2007, it is envisaged that much more than $100,000 in damages occurred as a direct result of the blockage of the culverts (with no alternative provision for overland flow).

Honeysuckle Foreshore

Planned revitalization of the Honeysuckle Foreshore provides an opportunity to modify the lower end of Cottage Creek for better floodplain management outcomes. Cottage Creek downstream of the railway comprises a section of over channel (upstream of Honeysuckle Drive) as well as a section of covered culvert (from Honeysuckle Drive to the harbour). Both the culvert and the open channel cause local afflux in flood levels, however, flood levels on Hunter Street and further upstream are primarily controlled by the constraint imposed by the existing railway culverts. It is considered that if channel works within the lower reaches of Cottage Creek were to be managed to improve flooding, then the removal or enlargement of culverts at the railway line would also need to be addressed.

Bluegum Rd and Heaton St, Jesmond

A tributary of Dark Creek runs under Heaton St and Bluegum Road, which could cause nearby houses to flood. Increasing the culvert size under Bluegum Road and widening the channel for 500m or so until it reaches the main channel may reduce local flood levels by about 100 - 200mm. Flood levels in this location would thenceforth be dictated by flood levels in the main Dark Creek channel.

At an estimated cost of more than $500,000 to achieve a 100-200mm lowering of levels in such floods, it was decided not to pursue this option further particularly considering that the affected houses may be suitable for house raising, which may provide greater benefits and lesser cost.

Robert St Jesmond

A 10% AEP event results in above floor flooding in a few houses at the low point in Robert St, while a 2% AEP event would surround the houses with high hazard floodwaters. Initial examination of model

outputs suggested that there was scope to lower flood levels at this location, but a site inspection revealed that significant and costly roadworks would be required for relatively small gain. Flood modification works at this location was therefore not considered warranted.

Sandgate Road and Cunningham Street, Birmingham Gardens

There are many properties at the bottom end of Dark Creek (in the vicinity of Sandgate Road) that experience above floor flooding for 1% AEP floods or less. Modelling indicates that there is a 0.5m afflux across Sandgate Road at the 1% AEP event, suggesting that the restrained conveyance capacity may be contributing to these issues. On closer inspection, however, it is revealed that overland flows leave the Dark Creek channel in the vicinity of Wilkinson Avenue, and follow land topography through the naturally lower swale through Cunningham Street. The lowest point on Sandgate Road is actually adjacent to Cunningham Street, some 80 away from the creek crossing.

Management of flows through this natural overland flowpath would be better addressed through planning controls and house raising.

Culverts in Elermore Vale and Rankin Park

It was recognized in the Wallsend Floodplain Management Study and Plan (Patterson Britton, 2007) that a number of culverts under streets in Elermore Vale and Rankin Park are constricting flows, adversely affecting properties upstream. Patterson Britton (2007) estimated that increasing the size of these culverts would cost between $200,000 and $300,000 each, giving a total cost of about $1.4m. It was noted that increasing the capacity of these culverts may increase flood levels downstream.

Again the scale of the current flood model is too coarse to accurately determine whether increasing these culverts would significantly impact on properties both upstream and downstream. Detailed survey and finer scale modelling is recommended for further consideration.

Irving St, Wallsend

Natural topography dictates that overland flow from Dangar Street flows through a series of private properties before emerging onto Irving Street, where it can then flow within the road reserve towards Ironbark Creek. Velocities and depths within the overland flowpath as it transects the private properties can be high, even for a 1% AEP event. The presence of obstructions, such as solid fences and outhouses, within the flowpath is likely to have various impacts until these structures collapse.

The details of the flowpath are too small for modelling to be carried out specifically, however, it is recommended that a more detailed investigation be undertaken to identify options specifically for opening up this overland flowpath. A stormwater pipe exists along this alignment, so CofN may already have a drainage easement in this area.

Removal of trees from channel banks upstream of Cowper St and Thomas St, Wallsend

Trees play an important role in flood management. While they may increase roughness and trap debris, which may locally increase flood levels, they also help to ‘slow’ flood velocities, which may otherwise have a more destructive influence. Trees also have a stabilisation function on creek banks.

If removed, channels may scour more, bringing more sediment and debris for blockage of road crossings within the Wallsend Commercial Centre.

Any modification to the existing stand of trees would need careful management to ensure less desirable vegetation would simply replace those removed. Habitat values of existing vegetation would also need to be careful assessed.

Channel Maintenance and Blockage Management

The 2007 flood clearly demonstrated the potential for the drainage system to block and increase flood levels significantly. The community has consistently raised the issue of blockage and/or the need to maintain channels so that they can convey flood waters more efficiently.

The waterways which are subject to flash flooding are a mixture or natural or semi-natural unformed channels, concrete lined channels and underground pipes and culverts. Generally, CofN is responsible for maintaining the unformed channels and smaller piped and channel system, while HWC is responsible for maintaining the large lined channels and associated culverts.

Both organisations have maintenance programs for those sections of waterway for which they are responsible. HWC removes silt and debris from its waterways and repairs concrete lining while CofN's program involves weed and rubbish removal and bank stabilisation and revegetation. The combined budget for maintenance of stormwater is approximately $3m. Ongoing maintenance will maximise channel efficiency and minimise the risk of debris causing blockages.

It is recognised that the potential for culverts and bridge openings to block cannot be completely eliminated. Generally, the larger the event, the larger the items and debris washed into waterways. Metal fence panels, garbage bins, cars and even shipping containers can all create significant blockage no matter how well waterways have been maintained beforehand.

There are four ways in which blockages can be managed:

- Reduce the amount of material which can block the channel reaching the channel:
    - Require large items such as shipping containers to be anchored although this would be difficult to enforce;
    - Erect bollards around the perimeter of flood prone car parks or along the top edge of channels to reduce the number of cars entering the waterways. Given the number of roads which flood, this may not be practical across the whole city;
- Place debris interception devices upstream of the potential blockage point. This can simply move the problem upstream or reduce channel efficiency even when there is not enough debris to otherwise cause a blockage;
- Increase the size of openings so they are less likely to block. This can be constrained by the space afforded by the surrounding development; and
- Increase flood planning levels upstream of potential blockage points to account for the probability of a blockage occurring and increasing flood levels.

Initial model runs using a sample of culverts to be blocked suggested that adding an additional freeboard of about 0.5m to the flood planning level may be warranted. While this would not address

existing risks, over time, the additional risks associated with blockage would be reduced through redevelopment. Should a change in flood planning levels be considered worthwhile for addressing blockage risks, then further numerical analysis should be carried out based on more detailed consideration of blockage of culverts, and potential combinations of blockage within upstream and downstream reaches of a channel.

6.4.1.4 Mechanical Augmentation of Stormwater Drainage

For the low-lying suburbs of Wickham, Maryville, Islington and Carrington (as well as a small part of Stockton), locally generated rainfall will result in extensive flooding. These suburbs are essentially "bowl" shaped, with higher ground along the Lower Throsby Creek foreshores preventing escape of floodwaters via normal overland flow. Instead, floodwaters can only be released through drainage via the existing piped stormwater system. When water levels are elevated in the creek/harbour (which is usually the case during severe rain events due to storm set-up), the gravity-based stormwater system is simply incapable affording effective drainage. These suburbs account for about 1/3 of the properties inundated by the 10% AEP flash flood.

The low-lying nature of these suburbs presents a serious long-term planning issue for CofN, as they are densely urbanized at present, thus restricting opportunities for broadscale options such as filling. The potential for sea level rise adds significant complexity to the issue, as these areas are already affected by king tides (see Figure 1-3). As an interim measure, the local stormwater system could be augmented by a series of low head high volume axial propeller pumps. These pumps would effectively drain the suburbs irrespective of the tailwater conditions in the harbour.

Reliance on pumps to augment drainage would introduce a raft of complications, including what happens if the pumps fail, or rainfall exceeds pumping capacity. It is considered that pumping should not be relied upon as the only flood management option for this area, but rather, can be used to maintain access within the streets for longer before they become overwhelmed (given that the streets are the main routes for evacuation, and are typically 0.5 metres lower than house floor levels). Also, flood planning levels should assume pumps are inoperable, meaning that redevelopment of property will slowly reduce existing risks to property in this area. Closer examination of long term land use viability may conclude that continued occupation of these areas is not viable or feasible.

The major pipes and outlets in Maryville, Wickham and Islington are assets of HWC, while the pipes and outlets in Carrington and Stockton are assets of CofN. With a total of about 10 – 12 outlets needing to be pumped, agreement between HWC and CofN on the basis for design, installation and maintenance would be required in order to address the localized flooding of these suburbs. The indicative cost of installing about 10 – 12 low head axial pumps would be in the millions ($0.5 - $1m each, including all ancillary works, power supply, building etc) as the pumps would need to be large enough to convey stormwater / flood flows (in the order of 200m^3/min each). Nonetheless, given the significant potential for reduction of damages in these low lying suburbs, as well as maintaining access along roadways during and after significant rainfall events, it is recommended that further consideration be given to this option.

6.4.2 Property Modification

As outlined in Section 6.3.2, the full range of property modification options is mostly suitable for flash flood catchments.

The preceding sections have shown that there is limited scope for reducing flood hazards in the flash flood catchments, while evacuation is also not reasonably practical in many flash flood situations. Therefore, property modification is important in managing flood risks for both risks to life (up to the PMF event), and for risks to property (to the 1% AEP event at least).

6.4.2.1 Voluntary Purchase

Removing the most at-risk houses would reduce both damage to property and risk to life. There are varying criteria that can be rationalised and adopted for a voluntary purchase scheme, examples of which are provided in Table 6-12.

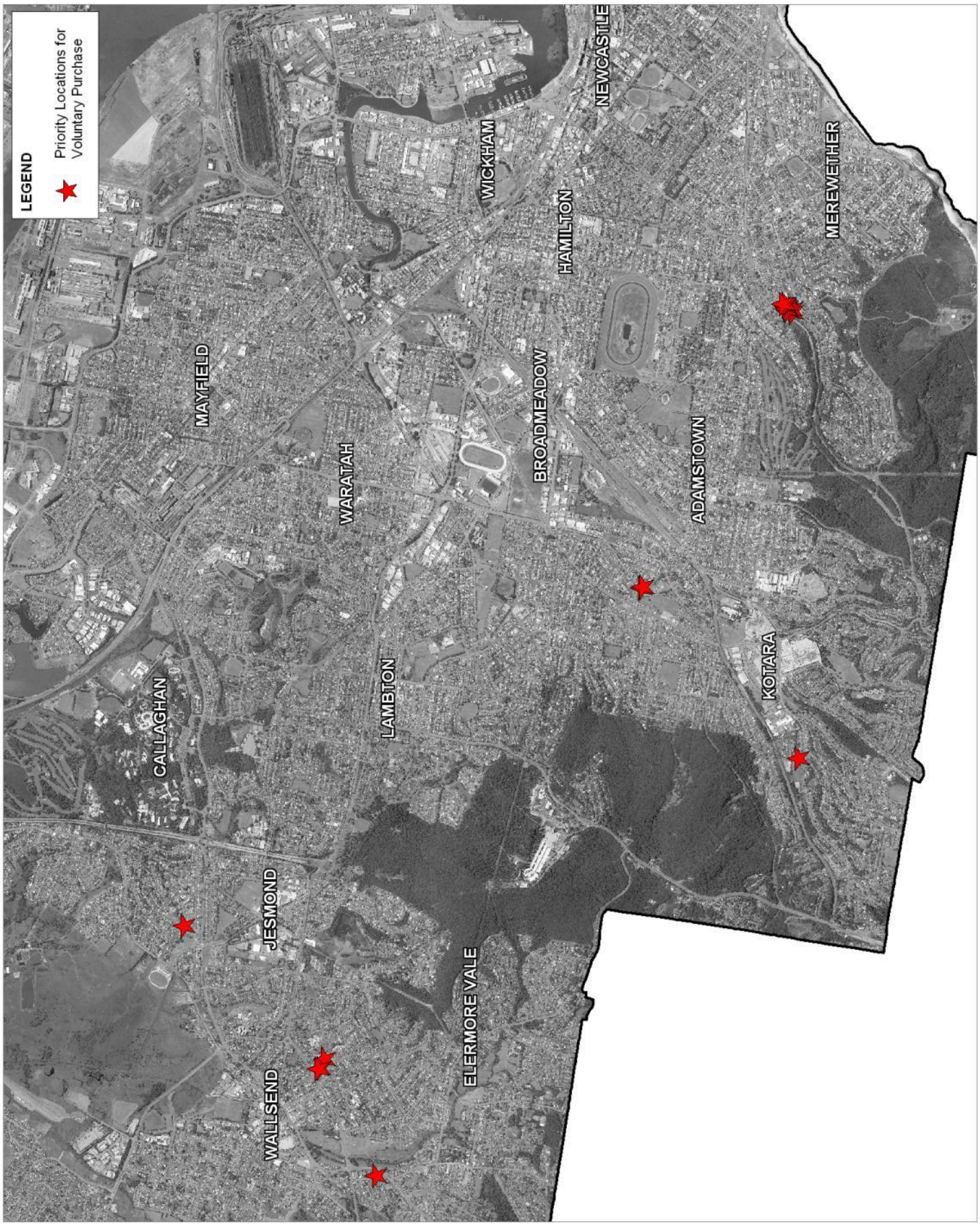
Table 6-12 Examples of criteria that can be used for Voluntary Purchase in Flash Flooding

Criteria	Properties captures	Approximate cost
All houses where the flood hazard equals or exceeds H4 in a PMF as these are houses in which continuing to take refuge would place lives at risk in the most extreme event	Approx. 900 houses	$450m
All houses that are affected by above floor flooding in a 10% AEP event. Although this appears to be driven by risk to property criteria, these houses are generally the same ones which also reach the H4 threshold in the most infrequent floods and therefore represent those houses which pose significant risk to life	Approx. 250 houses	$125m
All houses located within the PMF floodways	Approx. 450 houses	$225m
Priority houses located within the 1% AEP floodways	Approx. 15 houses	$9m

Voluntary acquisition is aimed at reducing the most severe risks to life (reducing property damage is considered secondary, with acquisition not generally justified on economic grounds alone). CofN has already acquired and demolished a number of high risk properties in recent years, including properties on Croudace Road Elermore Vale, and Morgan Street Merewether.

As shown in Figure 6-8, the most high risk properties that would be suitable for voluntary purchase tend to be clustered together in a small number of ‘pockets’ around the city, including:

- Morgan – Selwyn Sts, Merewether;
- Irving – Dangar Sts, Wallsend; and
- Other scattered properties around New Lambton, Kotara, Wallsend and Birmingham Gardens.



Title:

Priority Locations for Possible Voluntary Purchase in Flash Flood Catchments

Figure: **6-8**

Rev: **A**

N

0 0.75 1.5km

Approx. Scale

BMT WBM

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One or more of the properties in the Merewether pocket should be considered for purchase, particularly as the overland floodway from Morgan Street to Little Edward St / Selwyn St has been opened up through the recent demolition of one house (166 Morgan St). For all remaining properties that have a high risk of life in buildings (refer Section 5.2.3), voluntary purchase could also be considered on an opportunity basis. Implementation should be before a flood of sufficient size that would pose significant risk to life. Since such a flood could happen any year (but with a relatively small chance) the implementation should be as soon as practicable in the overall City-wide Plan implementation strategy. However, in the event the properties become damaged by significant flood events (when State and Federal Government grants are more likely for such voluntary purchase schemes) the acquisition of these properties should be actively pursued.

Indeed such a post-flood voluntary purchase scheme could be extended to cover any property substantially destroyed through flooding anywhere across the City (unless the flooding was at the scale of a PMF or similar, wherein a large number of properties are affected). As outlined in Section 6.4.2.6, any future redevelopment of properties within 1% AEP floodways should maintain the existing building footprint (or smaller) and should be designed to withstand PMF conditions in terms of structural stability and flood free refuge.

There are also a number of commercial buildings that could fail structurally in a PMF. These may have more people in them at any one time than the residential buildings but residential buildings are more likely to be occupied by sleeping occupants. Although it is not general practice for commercial buildings to be part of a voluntary purchase scheme, the adopted Floodplain Management Plan for Wallsend Commercial Centre involves the purchase of commercial buildings to not only remove high risk properties from the floodplain but also to provide a wider flow path for floodwaters so that other properties also benefit in a large range of events.

6.4.2.2 Voluntary House Raising

Voluntary house raising generally only provides a benefit in terms of reduced economic damages and although clad, timbered framed houses are most suitable for house raising, some councils provide a subsidy to owners of other forms of houses to rebuild their homes with floors at a higher level.

Eligibility criteria for house raising schemes vary around the country. Fairfield City Council, which arguably operates the largest house raising scheme in the country, pays up to $81,000 to residential property owners with houses with floor levels which are low enough to qualify. They can then choose to invest this subsidy into physically raising the house or into demolishing and rebuilding the house at a higher floor level.

For the purposes of evaluation it was assumed that the scheme would cost $81,000 per eligible house and eligible houses would have their floor level raised to 0.5m above the 1% AEP flood level.

If house raising was to be suited to only clad, timber framed houses on piers that suffered above floor flooding in a 10% AEP flood and which would not be subject to H4 flooding or greater in a PMF, then 110 dwellings could be raised (mostly located in the low suburbs of Carrington, Maryville, Wickham and Islington). This would cost about $9m and would have a benefit cost ratio of about 1.3 making it economically worthwhile.

If the house raising scheme were extended to houses which are flooded by a 1% AEP flood, then up to about 400 houses would qualify at a total cost of more than $30m and with a benefit cost ratio of about 1.0. Again, the vast majority of these properties are located within the low suburbs (refer **Map Series 10** in the accompanying ***Compendium of Maps***).

Notwithstanding, it must be recognised that:

- not all timber framed, clad homes are structurally suitable for raising;
- it changes the appearance of a house;
- this may not be appropriate for houses or streets which have heritage protection; and
- those with mobility restrictions may not be able to easily access the house.

It is considered that house raising could be investigated further in combination with provision of elevated flood-free refuges (refer Section 6.4.2.3) and building strengthening to the PMF (refer Section 6.4.2.4). As the majority of houses suitable for house raising are located within the low suburbs, then the long term viability and management of these suburbs should first be addressed given the looming threat associated with future sea level rise. That is, there would be little value in raising these houses if after 40 years or so these suburbs either become unliveable or are subject to broadscale acquisition and redevelopment.

Excluding properties located within the low suburbs, as discussed above, priority properties that could be considered for house raising within the flash flood catchments are presented in Figure 6-9 and highlights clustering in the following areas:

- Barr St, Merewether;
- Glebe Road, The Junction;
- Corona St, Hamilton East;
- Tudor St Extended, Broadmeadow;
- Samdon Street, Hamilton;
- Bridges Road, New Lambton;
- Hobart Rd, Lambton;
- Robert Street, Jesmond;
- Other scattered properties in Birmingham Gardens, New Lambton, Hamilton, Merewether, Waratah and Mayfield.

6.4.2.3 Elevated Refuges

Upper storey or elevated refuges can provide a safe haven for those trapped in a building by floodwaters. In a house this could take the form of a second storey or a converted roof or attic space, accessible via pull-down stairs. The former provides a more usable space and adds more value to the home but costs substantially more to build. A second storey with four rooms would cost about $150,000 to build, while conversion of a 3m x 3m loft may cost around $20,000. Meanwhile simply installing attic ladders to access the roof space would cost as little as $1,000.

Title:

Priority Locations for Possible House Raising in Flash Flood Catchments

Figure: 6-9

Rev: A

BMT WBM endeavours to ensure that the information provided in this map is correct at the time of publication. BMT WBM does not warrant, guarantee or make representations regarding the currency and accuracy of information contained in this map.

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Approx. Scale

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Upper storey or elevated refuges is primarily about managing risks to life. They would not reduce flood damages, and thus cannot be assessed on a purely economic basis.

There are currently 1,750 single storey buildings that would experience above floor flooding of more than 1 metre in a PMF event (with 1,600 of these being residential houses). It is considered that elevated refuge is only required for properties that have above floor flooding exceeding 1 metre, as refuge up to this level can be accommodated by standing or sitting on tables, benches etc.

Of these 1600 PMF houses, about 100 are located within the PMF floodway or have flood depths above floor levels exceeding 2.5m at the PMF and thus are not recommended for refuge. The 1500 houses that would benefit from an elevated refuge are presented in **Maps 11A to 11K** (refer **Map Series 11** in the accompanying ***Compendium of Maps***). Within these maps, properties are identified which also require structural stability (refer Section 6.4.2.4) as well as those properties that are at an elevated risk and could be considered for other options such as voluntary purchase (Section 6.4.2.1), house raising (Section 6.4.2.2), rezoning (to ensure a lesser risk to life or property) (Section 6.4.2.6) and opening up of flowpaths (Section 6.4.1.3).

As a minimum, if roof space was made accessible for the 1500 properties, the total cost of providing minimum flood-free refuge could be as low as $1,500,000 (excluding any additional structural works that may be required to ensure ability of the refuge under PMF conditions, e.g. under hydrostatic loads – see Section 6.4.2.4). This cost would need to be borne by building owners as there is presently no Federal or State Government Schemes that cover establishment of elevated refuges. It should also be recognised that:

- not all home owners would be able to afford such work;
- not all buildings are structurally suitable for such an addition, or access to roof space (e.g. flat roofed structures);
- not all roof spaces are above the PMF – these may require a more substantial upper storey construction, which would cost substantially more;
- house raising, which would primarily aim to reduce property damage, may also provide sufficient flood-free refuge, depending on how high the structure can be elevated; and
- Design for future homes (and streetscape) in flood affected areas would need to be prepared to ensure the character of an area is not negatively impacted.

These types of works can be encouraged by CofN through community education and planning controls, which do not unnecessarily restrict this type of improvement. Additionally, a concessional bonus height (and/or floor space ratio) could also be considered for properties that need to be raised or where refuges are required.

At the community meetings the concept of local, shared refuges was suggested. To this end, CofN should consider developing a scheme similar to “Neighbourhood Watch” whereby properties that have flood free refuge are identified by a window/letterbox sticker or plaque, potentially providing a more community-wide facility. It must be recognised though that residents of properties with flood free refuges may not always be home, so private refuges cannot necessarily be relied upon to provide safe refuge for the broader community.

The issue of shelter-in-place is somewhat of a dilemma for the SES, as from an emergency management perspective, everyone should evacuate to high ground. Within a highly populated flash flood environment such as Newcastle, however, safe evacuation will simply not be possible for everyone. Therefore, safe shelters located within the floodwaters become essential rather than just a "last resort". The option should be explored further to have SES-endorsed "flash flood safe" refuges, to provide people with more options when faced with flooding (thus potentially making evacuation safer and possible for those who truly have no other alternative).

6.4.2.4 Building Strengthening / Flood Equalisation

Structural integrity of a building can be compromised under flooding conditions by dynamic loading on the external walls (either from the momentum of the water itself, or from the impact of debris carried by the water) or hydrostatic loading, wherein there is a significant pressure differential between the outside and inside water levels. Dynamic loading is considered to be an issue for properties located within a floodway or are located immediately adjacent to a stormwater channel (wherein localised blockage of the channel may lead to redirection of flows into the structure). Hydrostatic loads become significant when outside flood levels exceed building floor levels by more than 2 metres (refer Section 5.2.1). High flood levels on the outside walls of the building, with no or little flooding on inside walls, can result in the building simply imploding under the external water pressure.

There are approximately 170 buildings that have above floor flooding in the PMF of more than 2 metres, about 100 of which are located within the floodway or have flood depths exceeding 2.5 metres. As such, there would be about 70 buildings that would require structural works in order to ensure stability for any pre-existing or proposed elevated refuges.

For existing buildings located within the floodways that are subject to dynamic loading, special bracing and foundation work can be undertaken to provide a higher degree of structural integrity, although each building is different and the means and cost of strengthening them would vary. Some may not be able to be strengthened and for others it might not be appropriate because of their heritage values.

For existing buildings that are at risk of hydrostatic loading, the external water pressures can be alleviated having "flood equalisation" vents, or flood vents, which allow the ingress of floodwaters once outside water pressures rise. Flood vents (e.g. Smart Vent®) are used extensively in the USA, to reduce buoyancy, and thus the risk of structural damage and ultimately building collapse. It is expected that supply and installation of several flood vents in an existing timber clad or masonry building would cost no more than about $4,000. For Newcastle, it is considered that flood vents could be used in combination with access to elevated refuge to provide a safe shelter during floods that would not be susceptible to building collapse. For the 70 buildings that need to be stabilised in order to provide flood-free refuge on-site, the total cost would be about $0.3m. The short duration of flash flooding would limit the time of isolation of people using the shelter during an event.

Of note is the fact that the current Flood DCP (since 2005) requires all new development in Newcastle to have flood free refuge above the PMF level and requires buildings to remain structurally sound during a PMF, as certified by a structural engineer.

6.4.2.5 Flood Resistance / Flood-proofing

Of particular interest to building owners (and insurers) is making changes to building materials to reduce damages during flood. This would include for example replacing composite timber kitchen cupboards with solid timber cupboard, replacing carpet with floor tiles, replacing plasterboard wall lining with fibrous cement etc. These changes can often be done during building renovations, and at a relatively marginal additional cost.

Some business insurance companies currently provide discounts on flood insurance premiums for more flood-compatible buildings. It is expected that insurance companies would also be exploring this option for residential insurance cover.

6.4.2.6 Redevelopment

<u>DCP controls for floodprone lands</u>

In flash flood areas, the current DCP, which came into effect in 2005, requires:

- Floor levels of new building to be constructed 0.5m above the 1% AEP flood level;
- Building materials and design to be able to withstand the forces of floodwaters and debris up to the 1% AEP flood level;
- Various controls on parking and ancillary development;
- Provision of a place of refuge on site for developments more than 40m from the boundary of the PMF which can be subject to H3 or H4 flooding; and
- Restrictions on development, including buildings, fill and fencing, within floodways and flood storages.

Most of these controls are consistent with current practice in many local government areas around Australia as well as the Section 117 directive issued by the Minister for Planning in 2007. The exception is the provision of a place of refuge. Not only is this less common in planning instruments but is contrary to the Minister's Section 117 directive which specifically requires that no building controls be placed on residential buildings above the 1% AEP flood level other than in exceptional circumstances. At this stage, exceptional circumstances status has not been applied for by CofN pending completion of this Plan. This is because of legal advice that CofN received shortly after the introduction of the s117 directive, that CofN should continue its prior refuge requirements for residential development, and any request for exceptional circumstances would only be required in the event CofN proposed significant changes to such requirements. The present Newcastle DCP 2011 (which has been publicly exhibited) notes that the controls have not been changed.

It was considered that the continuation of these planning controls is largely appropriate given the risk to property from all floods and the potential risk to life in the PMF, although this should be confirmed through a detailed review of strategic planning and compatibility against flood risk. The provision of on-site refuge is an important requirement when taking into account that none of the other flood risk management options considered, other than building removal, can be relied upon to significantly reduce risk to life.

While the provision of a PMF refuge is mandated by the DCP, all developments are encouraged to have a private flood response plan, with evacuation as the first choice where this is practical and safe. Private flood plans are not considered to be necessary conditions of consent, but rather, are aimed at increasing awareness of flood risks, and encouraging appropriate self-directed responses by individuals during a flood event. It must also be recognised that many existing buildings and therefore their future replacements will be in locations where remaining in the building is safer than attempting evacuation due to dangerous conditions on local roads.

A suggested change to current planning controls would involve restrictions on vehicular parking within floodways, and particularly within 1% AEP floodways. The reason for this is that:

- People may take unnecessary risks to try and move their cars, which are otherwise positioned in very dangerous flood locations; and
- Vehicles, once buoyant, can be swept downstream where they can cause blockages and thus potentially increase impacts of flooding upstream.

Redevelopment within a 1% AEP floodway should discouraged (with existing properties earmarked for possible future voluntary purchase), while redevelopment within a PMF floodway should be restricted to the footprint of the current building (or smaller). Similarly, redevelopment within 1% AEP flood storage areas should be limited to not increase the current building footprint by more than 20% (subject to site specific confirmation).

Over time redevelopment will result in buildings which have a more acceptable risk to property damage and provision for a refuge up to the PMF. Nevertheless, these buildings will still be in less than desirable locations from a flood risk management point of view and unless all flood prone buildings are redeveloped there will remain those with an unacceptable risk to life and property.

Future Zonings

Development controls under existing zonings ensures that flood risks are reduced over time by requiring better buildings even if they are in a location which is inappropriate for that form of development from a flooding point of view. Rezoning of land on the other hand provides an opportunity to change future landuses to those which are more compatible with the flood risks.

There are currently a number of planning studies which could result in changes of landuse within Newcastle:

- Department of Planning Lower Hunter Regional Strategy – which has identified areas for future employment lands and growth corridors along main roads;
- Newcastle Urban Strategy – which is guiding proposed rezoning for residential high density and medium development;
- Department of Planning - City Centre Revitalisation State Environmental Planning Policy; and
- City of Newcastle (CofN) – City Centre Revitalisation Project.

Potential conflicts with some of the landuses proposed in these studies and the flood risks have already been flagged. Further work is required in integrating the flood risks into the town planning studies so that:

- New development is not proposed in areas that are floodways;
- New development is not proposed to impede flood storages beyond an acceptable or tolerable level;
- Redevelopment removes existing development from floodways or other areas that have unacceptable flood risks; and
- Redevelopment replaces existing development with development that is commensurate with the flood risks.

With regard to removing existing development from areas where the flood risks are unacceptable, both the Regional Strategy and the Urban Strategy propose rezoning of land for higher value uses. This provides the opportunity for some of the value adding created by redevelopment to be used to purchase the most high risk land for open space. For example, where a current urban block is to be rezoned and redeveloped to medium or high density residential development, it may be possible to turn the properties which currently have unacceptable flood risks on that block into a local park to serves the new community.

Such changes would require CofN to create developer contributions plans which would fund the purchase of the high risk properties and conversion to open space by CofN. Alternatively, where a developer undertakes large scale redevelopment, the development could be conditioned on the provision of open space or the restriction of the development to the lowest flood risk part of the precinct. Removing high risk development from the floodplain in this way would reduce the number of buildings that would otherwise be potentially included in a voluntary purchase scheme. Implementation of this concept would require details to be worked through first, and may require legal advice considering the specific legislative and legal framework at that time.

Redevelopment using buildings that are more compatible with the flood risk can be complicated. For example it would be possible to replace an existing low-level and flood-liable cottage with a solid high density residential development, build on columns above the flood planning level (and thus remain structurally sound even in a PMF). The downside, however, is that it can increase the number of people in that part of the floodplain. If this takes places in a location where evacuation is not practical or safe then the building must also provide flood-free refuge above the PMF level. The reality is likely to be that newer developments would tend to provide a neighbourhood-wide facility for local flood refuge providing it has flood-free common areas that can be readily accessed from the street.

Rezoning therefore provides both a potential risk of making flood risks worse and an opportunity for making them better. It is considered that flood risks need to be fully integrated into future planning strategies and rezonings across the City, which would be an outcome from a recommended comprehensive strategic planning review.

Figure 6-10 shows indicative areas where the Draft LEP zonings 2011 (before Parliamentary Counsel at time of writing) could require changing to suit the flood environment taking into account many of the above considerations. For example:

- Floodways (where there should typically be no development), and flood storages (where the density of development is restricted);
- Recommended growth centres and increased residential densities in areas where flood hazards are inappropriately high;

- Areas where flood hazards are too high regardless of density – dominantly in residential areas; and
- Areas subject to significant future Sea Level Rise where continued occupation at some time would be problematic.

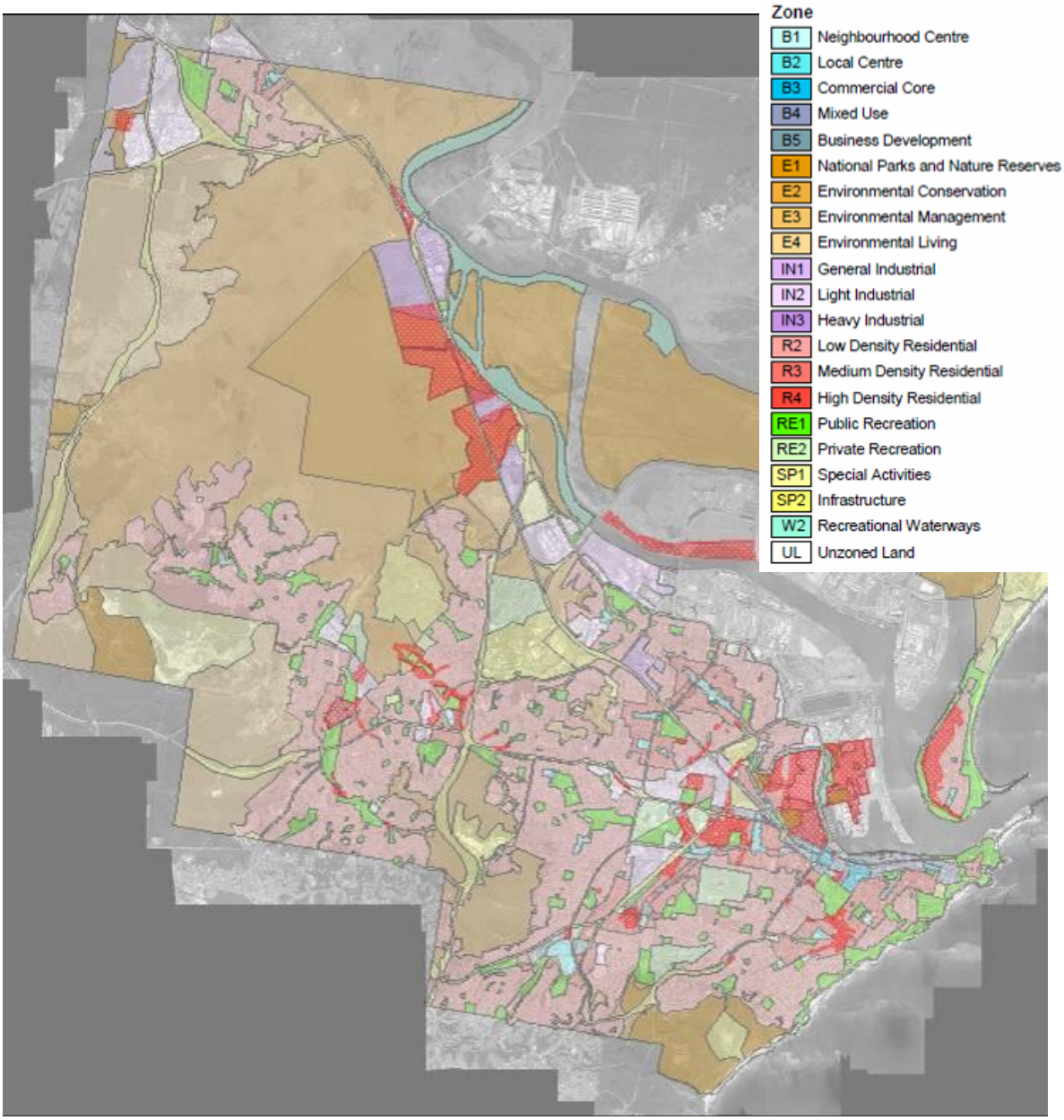


Figure 6-10 Indicative preliminary assessment of where land use zonings are potentially in conflict with flood risks (shown in red cross-hatch)

A hierarchy of permissible landuses and development controls should be established based on an increasing level of flood risk. For example, it may be established through the strategic planning review that all significant future development should be prohibited from the mapped 1% AEP floodways, with existing properties earmarked for future voluntary purchase (although minor renovations to existing buildings may still be permitted providing there is no increase in building

footprint). For properties that are outside the 1% AEP floodway, but within the PMF floodway, some future developments may be permitted but subject to development controls. This may include for example restricting the types of future development to only those that can provide elevated safe refuge, can be constructed in a manner that will not be compromised under PMF conditions (e.g. commercial or industrial developments) and does not increase the impediment to flood flows. Areas outside of floodways may allow for a greater range of permissible landuses, but may still be subject to various development controls, including for example limits on 'filling' within the 1% AEP flood storage area, and limits on intensification of population within areas that may be difficult for evacuation or emergency access during flood conditions.

CofN already has a hierarchy of flood risks within their Flood Policy via the H1 to H5, L1 to L5 and P1 to P5 categories. A strategic planning review should revisit these flood risk categories, along with the additional mapping of flood impacts categories (i.e. PMF and 1% AEP floodways, flood storages and flood fringes) provided in this Study and Plan and reconsider the compatibility of landuses and appropriateness of development controls for each area.

Figure 6-11 to Figure 6-13 present three different types of circumstances that will require different landuse zoning and/or development control approaches to manage future flood risks. Figure 6-11 shows Wallsend, where the 1% AEP floodway captures some existing development that is largely flagged for removal as part of the adopted Wallsend Floodplain Risk Management Plan. Areas beyond this that are within the PMF floodway are also at substantial risk during extreme floods, however, this risk may be managed through appropriate development controls, including the provision for evacuation to high ground or refuge such as the nearby Wallsend Library. Note that this City-wide Flood Plan incorporates refinement to the floodplain categorisation within the Wallsend Commercial Centre. City-wide review of strategic planning instruments should also include the Wallsend Commercial Centre, which is also subject to a separate and adopted Flood Plan (2009).

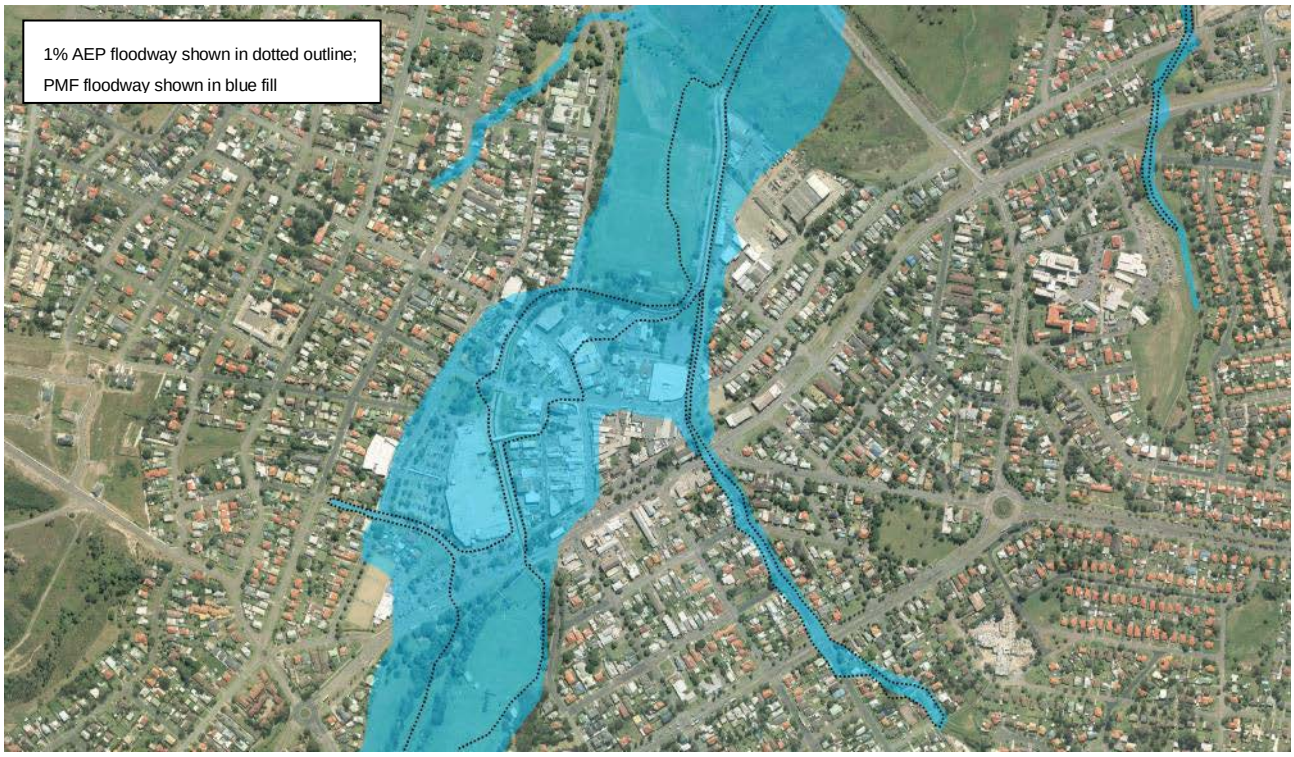


Figure 6-11 1% AEP and PMF Floodways in Wallsend Business District

Figure 6-12 1% AEP and PMF Floodways in Morgan – Selwyn Streets, Merewether

Figure 6-13 1% AEP and PMF Floodways in Hamilton

Figure 6-12 shows possibly the greatest risk to private residential properties in Newcastle, that being the Morgan Street – Selwyn Street floodway. This figure shows that there is no significant difference in the floodway extents between the 1% AEP and the PMF conditions. Private properties within this floodway should ideally be removed, through rezoning, development controls and voluntary purchase.

Figure 6-13 displays the critical flood conditions in Hamilton in the vicinity of Gregson Park. In a 1% AEP, the area is largely flood storage, however, during a PMF event it becomes a floodway. Total exclusion of development from the PMF floodway may not be practical, even in the long term. Development controls for this area therefore should ensure that future buildings will not collapse under PMF conditions. This may require a change in landuse type to facilitate the construction of more flood-compatible buildings.

Flood Planning Levels

Blockages of channels and culverts can cause significant elevation of flood levels beyond standard design conditions. There are hundreds, if not thousands, of locations within the piped and open channel stormwater system across Newcastle that can become blocked during flood events. There is no way of determining where blockages will occur in the future, so a standardised provision is required to take account of the potential higher flood levels.

In the absence of better flood modelling information, an increase to the standard 0.5m freeboard could be considered, however, it is recommended that more numerical analysis be undertake to confirm the validity of such a figure. Indeed it is expected that blockage in areas of broad flat floodplains would have only a minor impact on flood levels, whereas blockage within steeply incised floodplains would potentially have more significant impacts.

It is noted that design rainfall conditions across Australia, as defined in the Australian Rainfall and Runoff (AR&R) are currently under review. New design conditions are expected within the next couple of years, at which time there may be a need to revise modelling carried out to date. Similarly, there is still a degree of uncertainty surrounding projections to future climate variables (and in particular, changes to rainfall conditions). Until further information is at hand, it is considered unwarranted to modify existing flood planning levels on the basis of anticipated future design conditions or changes to the climate.

For the time being, FPL's will be based on a 1% AEP design flood event for existing conditions and a constant 0.5m freeboard for the Hunter River and flash flooding environments. Similarly, in the interim a 1% AEP ocean design flood event with projected sea level rise of 0.9 metre (i.e. year 2100) added, and a reduced freeboard of 0.3m in view of the long time of the planning horizon, will give a uniform FPL for ocean flooding of RL 2.5m AHD. However, it is recommended that when the First 5 Years implementation actions reach a conclusion on the whether or not there should be continued occupation of low lying sea level rise affected suburbs, these FPL's be amended if required. There is no reason to continue with FPL's that assume continued occupation if planned retreat is adopted.

6.4.3 Response Modification

The nature of flash flooding is such that warning times are short. It is generally caused by either severe thunderstorms which are quite localised or intense rainfall bursts within prolonged rainfall

events caused by an intense low pressure system. The latter was the nature of the June 2007 flash floods in Newcastle.

The lack of warning time means that there is only a limited amount of assistance that can be provided during the event. In reality, most people would be largely self-reliant during a flash flood. Agencies can, however, help people make more appropriate decisions during these floods through giving as much warning as possible (via an integrated flash flood warning system), and through flash flood emergency planning provisions. Education and flood preparedness before the event would also greatly improve the resilience of the community to flash flooding.

6.4.3.1 Flash Flood Warning System

Throughout the community engagement phases of this project the community expressed a desire for the existing flash flood detection equipment to be supplemented to create a complete integrated flash flood warning system. The equipment was installed after the June 2007 floods by CofN through State Government grant funding.

Critical to the success of a flash flood warning system would be an accompanying community education plan so that people know how to respond when they receive a warning.

At present, the only warnings available are generic, and automatically generated by the BoM in response to severe weather warnings. Unlike river flooding, it is difficult to know which particular catchment will experience flash flooding until close to the event, and it is not possible to provide a forecast of how high the flooding is likely to reach. Furthermore, the time from the onset of rain to the point at which floodwaters become hazardous can be less than an hour in some locations, particularly in the more extreme events. This means that any realistic warnings would need to be disseminated to a large number of people very rapidly.

The recently installed rainfall and flood level equipment provides real time data (via telemetry) to the BoM and the SES, but until recently, there was no means by which a warning based on this information could be issued directly to those at risk. Following the 2009 Victorian bushfires, a national telephone based warning system was created called Emergency Alert and privacy laws were changed to permit emergency service agencies to send unsolicited warning messages to telephone subscribers. Recent improvements to Emergency Alert now allows emergency service agencies to preload high risk areas into the system and, when a warning needs to be issued, a recorded telephone message or SMS can be sent to all telephones with a billing address within the identified area. Research is currently being undertaken by Telstra to improve the system's capabilities so that it can also send an SMS to all mobile telephones physically within the identified warning area at the time that the warning is issued.

CofN has recently provided the NSW SES with electronic mapping of the areas at risk of small, large and extreme flash floods so that they would be able to use Emergency Alert to issue a flash flood warning message directly to those at risk as part of an improved Flash Flood Warning System.

While these developments are significant, there are still important limitations to this system which need to be acknowledged:

- There will be little certainty about the location and severity of flash flooding until it is actually occurring (although it is hoped that future integration of radar mapping into the warning system will provide a better estimate of storm trajectories and anticipated rainfall intensities);
- The system depends on a functioning telephone system which cannot be guaranteed as evidenced by the events of June 2007;
- Many modern telephones (cordless, PABX, T-box etc) also rely upon a functioning electricity system, which also cannot be guaranteed during severe weather likely to cause flash flooding;
- The roll out of the National Broadband Network will eventually replace copper cabling with fibre optic cables, which will make all landlines dependent on a functioning electricity system; and
- Research suggests that Emergency Alert only reaches about 60% of intended recipients (although this is still much more than the alternative of relying on local radio to broadcast warnings).

Emergency Alert can send out messages at a rate of up to 1,000 voice messages per minute depending on the amount of other telephone traffic on lines. It would take at least 15 minutes to dial every telephone in the area at risk of flash flooding and about 15 minutes to go through the process of initiating the warning. The SES may be faced with the choice of sending out a general flash flood warning before it is certain that flash flooding will occur or where it will occur, or waiting for greater certainty but significantly reducing people's limited response time.

6.4.3.2 Flash Flood Emergency Planning

It would not be realistic to expect the SES to be able to undertake much in the way of emergency response during a flash flood for several reasons:

- The SES is principally a volunteer organization and the time required to mobilise personnel could exceed the warning time available;
- Many of the principal roads within Newcastle are cut early in flash floods making access difficult for mobilizing or responding; and
- There is generally insufficient time to undertake tasks such as sandbagging or evacuation to reduce impacts on property or people.

As outlined in 4.4.2.1, the SES's role in flash flooding will generally be limited to executing rescues and assisting with recovery after the event.

That is not to say that the flood warning system or the SES Flood Emergency Plan will not in some measure mitigate the impacts of flash flooding. What it does mean is that they cannot be relied upon alone to provide an appropriate level of protection, particularly the protection of lives. In a flash flood, individuals and groups of people must essentially take appropriate actions to protect themselves.

Nationally, emergency service organisations are developing a position paper on flash flooding. It is likely that this will recommend evacuation to a location outside of the floodplain as the preferable means of protecting lives in a flash flood. For this to work in flash floods in Newcastle people need to be able to respond quickly, know where to go and have the means of getting there without passing through floodwater. All of this would need to be part of a personal response plan which also needs to recognise that flash flooding could happen at night.

While the NSW SES does not encourage people to stay inside flooding buildings, it acknowledges that a number of circumstances can prevent evacuation in some situations, and once trapped in a building, it is generally safer to stay inside than to exit into high hazard floodwaters.

In light of the above discussion it was acknowledged that occupants of business, government and residential premises should be encouraged to have private flash flood emergency response plans which have evacuation as the preferred initial response if that is practical. While private flood plans are no substitute for good floodplain management planning, they are very useful as education tools in helping to manage *existing* flood risks. Should evacuation not be possible before floodwaters cut off evacuation routes then remaining in the building should be the next best alternative. Shelter-in-place is much less risky if the building has a refuge above the PMF level, and is assured of structural integrity up to the PMF level. These property management aspects of floodplain management were discussed in Section 6.4.2. From an emergency management perspective, it is important for SES to know the locations of these 'safe' refuges.

CofN currently requires any business which submits a development application for a location which is flood prone to accompany the application with a flood emergency plan specific to that enterprise. This should be continued but should not be relied upon as a sufficient means alone of managing flood risks.

6.4.4 Summary of Practical Flash Flooding Options

There is significant risk to life and property associated with flash flooding. Because of the potential rapid onset of flash flooding there may not be enough time for people to evacuate safely to high ground. As such, many people will become trapped in buildings, some of which do not have flood free refuge, and cannot be assured of structural integrity up to the PMF event. But it is the people in transit on roads that potentially represent the biggest risk to life in flash floods, because in Newcastle many of the arterial roads become floodways as flood levels rise. If people are using these roads to evacuate, or are simply using the roads for normal purposes, they could face extremely dangerous conditions, as was the case in June 2007 (which could be dwarfed by larger flash flood events that are physically possible).

In light of the preceding discussion, the following actions have been considered for further inclusion as part of this Plan:

- Investigate culvert enlargement at selected locations in the upper reaches of the Ironbark Creek Catchment, taking into consideration the potential to increase flood impacts downstream;
- CofN and HWC to continue regular maintenance of stormwater channels under their respective care and control, as well as weed and vegetation management as appropriate;
- Ensure that flood risks for the full range of flood events are considered in rezoning and city revitalisation plans for Newcastle;
- Investigate funding mechanisms which would facilitate the conversion of currently developed high risk areas into open space through the redevelopment process;
- Maintain current planning controls to ensure compatibility of landuses, buildings and infrastructure with the flood risk. This includes the mandatory provision of free refuges and certification on structural stability in the PMF event;

- Further research and then assign flood planning levels upstream of blockages which correspond to the 1% AEP level should the drainage structure be blocked;
- Establish a limited voluntary purchase scheme for the residential properties with the greatest risk to life and which will not be removed through redevelopment;
- Establish a voluntary house raising scheme for those properties which are most frequently flooded in areas which will remain zoned for residential purposes and which are not likely to fail in any flood event;
- Encourage owners of single storey residential and non-residential buildings to create elevated refuges at their own expenses if their property is at risk of above floor flooding by more than 1 metre;
- Investigate the practicality of adopting a scheme for certified flash-flood safe refuges, in consultation with the community and SES, which could be similar to Neighbourhood Watch, with certified buildings providing a local facility for neighbouring residents as needed;
- Encourage building owners to renovate buildings with more flood resistant materials and designs;
- Improve flash flood predictions through nowcasting techniques;
- Develop and implement a City-wide Flash Flood Warning System, which encompasses effective broadcasting of warning information, including multi media and social media channels, as well as integration with active road signage around Newcastle;
- Request that the BoM and SES use Emergency Alert and other means to disseminate flash flood warning messages directly to those at risk of flash flooding;
- Request that the SES update its Flood Emergency Plan to include information from this plan regarding flash flood risks;
- Work with the SES to develop a community education plan for flash flooding, and provide dedicated resources to deliver the education program; and
- Install flood hazard warning signs at selected low spots along main roads, with some of these possibly being electronic (with an independent power source).

6.5 River Flooding Options Assessment (Fine Filter)

Based on the initial coarse filter assessment (refer Section 6.3), there are a number of flood modification, property modification and response modification measures that are considered applicable and reasonably practical for the Newcastle river flood environment.

The area of Newcastle LGA that is affected by river flooding is generally limited to Hexham and the fringes of Hexham Swamp, such as Birmingham Gardens and Wallsend.

As outlined in Table 5-6, current management of river flooding is considered mostly adequate, with the exception of existing flood risks, wherein a number of existing properties are flooded by frequent (10% AEP) floods. For completeness, the fine filter assessment has considered risks beyond just the existing risks, however, particularly where there is still opportunity to improve current adequate practice.

6.5.1 Flood Modification

Section 6.3.1 outlines various ways, in principle, that river flood behaviour can be modified for flood management, including levees, upstream flood retardation, dredging, highflow bypass channels, flow diversions to adjacent catchments and revegetation of riparian areas.

Flood modelling carried out as part of the Lower Hunter Floodplain Management Study (Patterson Britton, 2002) considered and assessed a number of these options in an effort to lower flood levels at Hexham and elsewhere.

6.5.1.1 Flood Detention

With regard to detaining floodwaters within the existing dams (Chichester, Lostock, Glennies Creek and Glenbawn Dams) within the Hunter River catchment, the following observations are made:

- The River has a catchment areas of more than 21,000 km^2 upstream of Hexham Bridge;
- The 1% AEP peak flow rate is 21,000 ML per hour at Hexham Bridge. That is the equivalent of about 150 Olympic swimming pools every minute;
- The existing dams have a combined catchment area of less than 10% of the total catchment upstream of the bridge; and
- Rain varies significantly across the catchment. Unless the rainfall is concentrated over the catchments of the dams then they will make little, if any, contribution to flood mitigation.

Based on this, and the fact that any new dams within the catchment would be highly unlikely, it is considered that upstream flood detention is not viable.

6.5.1.2 Hunter River Dredging

Some flood mitigation benefits could be obtained by dredging the North Arm of the Hunter River. As determined through the Lower Hunter Floodplain Management Study (Patterson Britton, 2002), numerical modelling showed that a 200 metre wide channel dredged down to -11.0 m AHD between Hexham Bridge and Stockton Bridge would likely to have a measurable impact on flood levels. In the more frequent events the dredging could potentially reduce flood levels along the river by about 0.4m between Hexham Bridge to Tomago, while in a 1% AEP flood it would reduce flood levels in the vicinity of Sandgate and Tomago by about 0.5m (but would have minimal impact at Hexham). In fact in a PMF event it would actually increase flood levels at Hexham by about 0.5m while reducing levels at Sandgate by about the same amount. Sandgate and Hexham are where the majority of residential and commercial properties are which suffer above floor flooding in the floods up to the 1% AEP year event. In 2002 it was estimated that such an option would cost in the order of $90m initially, but significant maintenance dredging would also be required, particularly following a flood. In 2011 dollars it could cost around $115m. By reducing flood levels by about 0.5m it would reduce average annual damages by up to $2.9m which, over a 50 year period equates to a net present value of about $40m. As such, this option is not viable on purely economic grounds, while the dredging would also undoubtedly have significant environmental and ecological concerns.

6.5.1.3 High Flow Bypass

Options for creating high flow bypasses around Hexham Bridge and through Tomago were examined through numerical modelling as part of the Lower Hunter Floodplain Management Study (Patterson Britton, 2002). The results of the modelling indicate that flood levels at Hexham would be marginally reduced (by about 13cm only), and thus could not justify the expense of this option.

6.5.1.4 Levees

The Hunter River floodplain already has an extensive network of levees and diversion banks, aimed at minimising overbank impacts within the floodplain. The Lower Hunter Floodplain Management Study (Patterson Britton, 2002) investigated the option of lowering all rural levees by 1 metre, in an effort to increase floodplain storage upstream. The results of the analysis showed negligible change to flood levels at Hexham.

6.5.1.5 Flow Diversion

Suggestions were offered during community consultation to connect Fullerton Cove to the sea (either directly or via Tilligerry Creek to Port Stephens), thereby potentially reducing flood levels in the river (albeit at a massive environmental, economic and social cost). This connection would be well downstream of where flood levels need to be reduced at Hexham and Sandgate and this option was therefore considered to be less effective than dredging the North Arm of the Hunter River (and probably at a similar or higher cost). Any such connection would be susceptible to siltation on the river side and shoaling on the ocean side, thus demanding significant maintenance costs.

6.5.1.6 Revegetation

The Lower Hunter Floodplain Management Study (Patterson Britton, 2002) also investigated the option of revegetating Kooragang Island. The results of the investigation were that flood levels increased significantly at Hexham, upstream of Kooragang Island, due to retardation of the flood flow. This option clearly would be of no benefit for mitigating flood impacts at Hexham and Sandgate.

6.5.2 Property Modification

A number of property modification measures for existing or future buildings are physically possible and could potentially reduce risks from riverine flooding, as discussed below.

6.5.2.1 Voluntary Purchase

This would involve removing the most at-risk houses affected by river flooding, and would reduce both risks to property and risk to life.

A number of different qualifying criteria were examined for a voluntary purchase scheme. They included:

- All houses where the flood hazard equals or exceeds H4 in a PMF as homes would potentially collapse in a PMF event, rendering them ineffective for flood refuge;
- All houses where the flood hazard equals or exceeds H4 in a 1% AEP flood as these would have a much greater chance of being affected; and

- All houses that are affected by above floor flooding in a 10% AEP event. Although this appears to be driven by risk to property criteria, these homes are essentially the ones which also reach the H4 threshold in the more frequent floods and therefore represent those homes which still pose the greatest risk to life.

Median house prices for 2011 for the suburbs which the homes were in were used to estimate the costs of the purchase schemes. Table 6-13 summarises the analysis of the options.

Table 6-13 Voluntary Purchase Options for River Flooding

Criteria	Number of home which qualify	Cost of purchases	Economic benefit	Benefit cost ratio
H4 or more in PMF	425	$122m	$24m	0.2
H4 or more in 1% AEP event	76	$19m	$12m	0.6
Above Floor Flooding (AFF) in 10% AEP event	22	$6m	$4m	0.7

Purchasing all of the houses which would qualify in a PMF event is not economically justifiable (based on damages) nor is it likely to be affordable. For most cases, risks to life should be manageable through evacuation.

For a threshold set at the 1% AEP event, the costs become more affordable, but are still very expensive. More than 90% of these properties are in the Hexham area. Due to the isolation of Hexham, if people fail to evacuate, then the risks to life are high. For a threshold set at above floor flooding in a 10% AEP event, the costs are lower again, and give a benefit cost ratio of 0.7. On purely economic grounds it is still not feasible, however, there would be risk to life benefits if people within these properties would otherwise fail to evacuate. Feedback from community consultation sessions conducted as part of this study indicates that many residents of Hexham may be hesitant to evacuate (until it is too late), suggesting that reliance on evacuation to mitigate flood risk may be problematic.

When considering the increased potential for damage due to future climate change, the economic analysis can be revised to yield benefit cost ratios in excess of 1 for both the 10% AEP and 1% AEP criteria. Clearly other issues would also need to be considered in making decisions regarding voluntary purchase for properties affected by river flooding, including the availability of funds for acquisition.

Also, some parts of Hexham are earmarked for future employment lands. Therefore redevelopment of existing residential properties to commercial or industrial lands is a viable alternative to acquisition. Until then, these properties should be supported by an SES-led evacuation plan, flood warnings and community education to ensure that they have every opportunity to safely evacuate in the event of a flood.

Funding for voluntary purchase and voluntary house raising is available (at a $2:$1 contribution by State:Council) under the NSW Government's Floodplain Management Program. The Voluntary Purchase/Voluntary House Raising Pool is approved annually for nominated projects on a competitive basis. Around $1.75m is available state wide for these purposes in 2011/12.

It is acknowledged that Hexham residents, through the community meetings, expressed a desire to remain living in Hexham and for residential land not to be redeveloped for commercial or industrial purposes. Notwithstanding these concerns, this City-wide Flood Plan has shown that:

- some of the Hexham residential properties are located within a floodway;
- most of those homes have floor levels which are contrary to best practice floodplain management; and
- there is a significant risk to life for a range of floods smaller than the PMF.

Independent of the needs from a floodplain risk management perspective, CofN's Strategic Plan has shown that for town planning reasons, Hexham is better suited to employment landuses than residential landuses. As such, voluntary purchase of these residential properties should be pursued as funding and opportunity becomes available.

6.5.2.2 House Raising

Voluntary house raising generally only provides a benefit in terms of reduced economic damages although it can also provide a flood refuge depending on the extent of the raising the PMF flood levels. Clad, timbered framed houses which are constructed on piers are most suitable for house raising although houses built of brick have been raised in the past.

Based on the house raising scheme costs operated by Fairfield City Council (refer Section 6.4.2.2), for the purposes of evaluation it was assumed that the scheme would cost $81,000 per eligible house and eligible houses would have their floor level raised to 0.5m above the 1% AEP flood level.

A scheme which sets the 10% AEP flood as the eligibility criterion would benefit about 15 houses, cost about $1.2m and have a benefit cost ratio of around 2.2, while extending the scheme to include any houses up the 1% AEP flood to qualify would result in up to 164 homes being eligible, costing up to $13m, with a benefit cost ratio of less than 1.0. The economic benefit, however, would increase substantial if flooding was to become more frequent in the future as a result of climate change and sea level rise.

About half of the houses with floors below the 1% AEP are within Hexham and it is proposed that in the long term these homes be removed or replaced by commercial development. As such, there would be no value in raising these houses.

The broader impacts of house raising should not be overlooked, as it will potentially change the visual character of a house and possibly the street / suburb, may not be appropriate if the building or streetscape has heritage listing, and will result in a property that has restricted accessibility, and thus may not be appropriate for people with limited mobility.

House raising was therefore considered to be potentially viable for properties that are of suitable construction, are frequently flooded and which are not planned to be removed because of future development, floodway clearing or their high hazard in extreme floods.

6.5.2.3 Upper Storey Refuges

There should be ample time for people to evacuate ahead of river flooding and, with the exception of Hexham, no one should be trapped in their homes by floodwaters as they should simply be able to

walk up-slope to safety. Within Hexham, houses are more suited to be removed or replaced with industrial and commercial development, and therefore there is little benefit in investing in upper storey refuges for these properties.

Similarly, it is not considered necessary for commercial and industrial properties to provide on-site refuge as it should be possible to evacuate from these buildings in advance of arriving floodwaters.

Upper storey refuges are therefore not proposed as a management measure for river flood risks. This would not prevent people from adding upper storeys to their homes with CofN approval if they chose to do so.

6.5.2.4 Redevelopment

Redevelopment provides the opportunity to ensure that future developments, buildings and infrastructure are compatible with the known flood risk.

Zoning delineates areas suitable for particular types of development or redevelopment taking into consideration the flood risk, while the development control plan provide details on how development should be undertaken in a way which is compatible with the flood risk.

As discussed in Section 4.3.1.2, the Floodplain Development Manual (2005) requirement that floodprone lands are not unnecessarily sterilised, but at the same time, flood risks are minimised.

A review of strategic planning is recommended to provide direction for changes to the LEP, DCP and other strategic policies is respect to compatibility with flood risks. With respect to river flooding, longer warning times help to manage risks to life through more effective evacuation, however, properties still remain at significant risk. The review should consider the appropriateness of existing zonings and formulate development controls that are commensurate with the risks posed. For example, the strategic planning review should give consideration to the following specific issues of concern to river flooding:

- New buildings or substantial alterations to existing buildings or filling within floodways (either the 1% AEP or PMF floodways);
- Non-floodways in Hexham could be rezoned for employment landuses only
- New residential development should not be permitted on land which can be isolated by river flooding;
- Restrictions should be maintained on fencing within floodways;
- Vehicle parking and storage of non-buoyant, non-polluting materials that are not susceptible to water damage (e.g., concrete products) may be permitted in areas below the riverine 1% AEP flood level;
- All buildings should have minimum floor levels at or above the current planning level; and
- New energy and communications infrastructure should be constructed above the planning level and critical infrastructure, including major energy and communications infrastructure components, should be above the PMF level.

6.5.3 Response Modification

6.5.3.1 Evacuation

Evacuation planning will be critical to minimising risk to life from river flooding but its effectiveness will be compromised if it is not supported by timely, accurate and relevant warnings and a community education plan which helps people respond appropriately to a flood warning and evacuation order. Successful evacuation would not only reduce risks to lives but also removal of vehicles and the relocation of some building contents would reduce risks to property.

There are about 2,000 people at risk from river flooding in a PMF and 200 could be trapped and overwhelmed on islands should they fail to evacuate. Areas along the Hunter River have not flooded since 1971 and the sort of flooding which would trigger mass evacuations today has not occurred since 1955.

With regard to river flooding, investigations showed that the current population should have sufficient time to evacuate by car along existing roads to areas above the PMF level, ahead of a flood rising as fast as a PMF. Nonetheless, should people fail to follow evacuation instructions, they can become isolated early with evacuation routes cut. There is a genuine risk that people will not evacuate from Hexham because 1) consultation with residents in this area indicated their strong reluctance to do so, and 2) there would be little signs of overbank flooding when the evacuation orders go out, however, if the evacuation orders are delayed, then the low-lying roads would already be cut and evacuation from Hexham properties would not be possible. In large floods these properties could then be overwhelmed and possibly even destroyed by floodwaters with little chance of survival for anyone taking refuge inside.

The SES is responsible for developing an evacuation plan based on flood warnings provided by the BoM. Should people be unwilling or unable to evacuate, the consequences of failure to evacuate need to be considered when deciding if other floodplain management options should be implemented in order to manage this residual life risk.

Should people fail to evacuate by vehicle from areas around the fringes of Hexham Swamp such as Birmingham Gardens or Shortland in advance of the floodwaters, the terrain is such that most would be able to walk to flood free land. Hexham on the other hand can have its evacuation routes cut by floodwaters early in the flood hydrograph. An option to help address this risk would be to raise the level of the Pacific Highway. The raised carriageway would provide more time for residents to evacuate from this very dangerous part of the floodplain. Ultimately, however, these properties should be removed from the floodplain. Initial indications suggest that raising the Pacific Highway would cost in the order of $33 million. Given that there are only about 40 residential properties adjacent to the Pacific Highway, and another 30 or so residential/business dwellings on Old Maitland Road, it may indeed be cheaper to acquire these properties, which was discussed in Section 6.5.2.1.

Another trigger for considering raising Pacific Highway in the Hexham area would be sea level rise. Based on current projections, this could happen within the next few decades. The latest projected sea level rise estimates and Government Policy should be examined at the review of the Plan. It is possible additional sea level rise estimated will be revised within the First 5 Years of implementation of the Plan.

6.5.3.2 Flood Warnings

In recent riverine floods the NSW SES has used the new national telephone warning system Emergency Alert to issue flood warnings and evacuation orders in addition to traditional methods such as media broadcasts, internet postings and door knocking. During floods in NSW, Victoria and Queensland in 2011, social media emerged as a significant flood warning dissemination tool. Many unofficial sites issued flood warning information and Queensland Police set up a facebook page and twitter account to feed official information into these spaces and counteract misleading information which was being disseminated and these official spaces became well subscribed. The use of social media to enhance other warning dissemination channels should therefore be considered further.

6.5.3.3 Community Education

There is currently no riverine flood education plan for Newcastle nor any locality specific education materials. Recently the SES has appointed a community engagement co-ordinator for the Hunter whose responsibilities will include Newcastle. The Hunter Central Rivers CMA, which is responsible for managing flood mitigation works as far downstream as Hexham Swamp, also has a flood education officer and, and in conjunction with the SES, has developed a community flood education plan for Maitland which includes a Maitland Floodsafe Guide, DVDs and other educational materials, interpretive tours and commemorative events.

The SES has developed the Floodsafe education program which it implements across NSW. This includes:

- generic Floodsafe guides for riverine flooding;
- home and business Floodsafe toolkits to assist in the development of personal flood response plans;
- community education officers; and
- location specific Floodsafe guides to be used in locally tailored flood education plans.

6.5.4 Summary of Practical River Flooding Options

There is significant risk to property from river flooding. In light of the preceding discussion, the following actions have been considered for further inclusion as part of this Plan:

- Rezone the River's floodways to prevent future development and discourage redevelopment;
- Rezone the developable part of Hexham as employment lands only;
- Establish a voluntary purchase scheme for residential properties in Hexham which are not within the new industrial areas (i.e. in floodway area);
- Investigate whether raising the Pacific Highway would be a feasible and economic alternative to voluntary purchase for critical properties along Hexham, recognising there may be other advantages of raising the highway, particularly in relation to sea level rise adaptation of this very critical arterial road route to and from Newcastle;
- Investigate establishing a voluntary house raising scheme for those properties that are most frequently flooded in areas which will remain zoned for residential purposes (non-Hexham area);

- Modify existing planning controls to broaden the types of landuses compatible with river flooding and to ensure infrastructure development is compatible with risk;
- Maintain a watching brief of climate change forecasts to see whether flood planning levels need to be revised;
- The BoM to extend flood forecasting to Hexham Bridge;
- The SES to update its Flood Emergency Plan to include evacuation of areas at risk of river flooding consistent with the areas identified in this plan; and
- Work with the SES to develop a community education plan for river flooding.

6.6 Ocean Flooding Options Assessment (Fine Filter)

Based on the initial coarse filter assessment (refer Section 6.3), there are a number of flood modification, property modification and response modification measures that are considered applicable and reasonably practical for the Newcastle ocean flood environment.

As summarised in Table 5-6, the current management measures are generally considered adequate for managing ocean flooding in Newcastle. For completeness, however, an initial review of additional options targeting management of ocean flooding has been carried out and is described below.

6.6.1 Flood Modification

There are really only two ways of modifying ocean flood behaviour:

- Fill land to above the ocean flood level; and
- Create a barrier to exclude floodwaters for certain parts of the land.

Both of these have been adopted in the development of Newcastle in the past with much of the foreshore areas being built on fill and Carrington and Maryville being protected by low levees along the banks of Lower Throsby Creek.

Filling can only be done when redevelopment takes place, while levees can be built to protect existing developments. Filling has the further limitation that it is really only practical where an entire area is to be developed or redeveloped. Filling lot by lot does not work, particularly if roads and utilities remain at former levels. Furthermore, should sea level continue to rise, the on-going filling of broadscale areas would be required, whereas “topping up” of a levee is not without its challenges but it is more manageable.

Barriers could include permanent or temporary levees, dykes or other formal pop-up structures that inhibit the ingress of ocean waters. The value of barriers in protecting properties from sea level rise depends on the number and value of properties being protected, as well as the total cost of construction and maintenance, the practicality of undertaking the works, the longevity of the option, the impacts on other types of flooding and the environmental and social impacts.

The construction of barriers around Hexham and Birmingham Gardens to protect against future ocean inundation and sea level rise is likely to impact on river and/or flash flooding, as these areas are within floodways. Areas such as Stockton, Carrington, Maryville and Wickham, however, may be able to be protected without adversely impacting on flood levels elsewhere.

With respect to direct ocean flooding (ignoring flash flooding of the same areas), a 1% AEP ocean flood combined with a sea level rise of 0.9m would result in above floor inundation of some 1400 properties, while PMF ocean flooding would inundate about 2,700 properties.

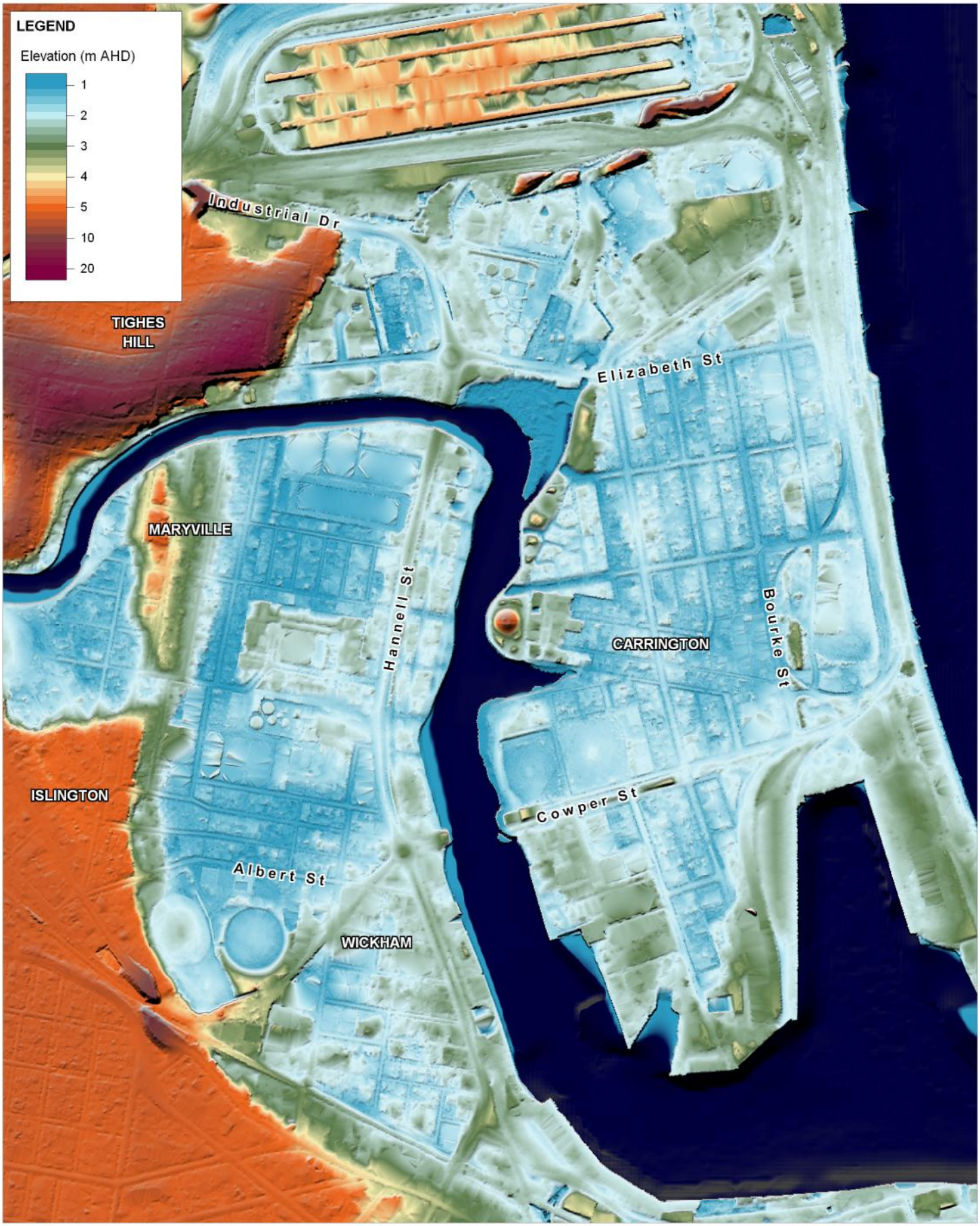
As sea levels rise, the propensity for low lying suburbs to drain via existing gravity-based stormwater systems will reduce significantly. Given that these suburbs already suffer from poor drainage, the need to augment the stormwater system with pumps or similar will increase in the future commensurate with sea level rise irrespective of if barriers are installed or increased around the waterway edges. In addition to poor drainage, areas located behind levees will be subject to increased groundwater levels, broadly commensurate with sea level rise. Thus, for areas that are already low lying, the construction of a levee for protection from sea inundation will be futile, as the inundation will literally come up through the ground.

In the longer term, it is expected that a strategic plan will be required to decide the long term management of the low-lying suburbs potentially affected by ocean flooding. With streets currently at a level of about 1m AHD, these suburbs may become unlivable with a sea level rise of a metre or so (i.e. the street level would be the same level as mean sea level, while groundwater level would likely be at the surface, making the suburbs permanently wet). Indeed a sea level rise of just 0.4m (as projected for 2050) would still create significant groundwater and drainage issues for these suburbs (unless augmented by pumps or similar). A land relief map of Maryville, Wickham, Islington and Carrington is shown in Figure 6-14, highlighting the low ground levels compared to surrounding topography and indeed filled levels and constructed levees along the banks of Lower Throsby Creek.

A management plan for these suburbs may involve broadscale filling, which would require (compulsory) acquisition of many hundreds of properties, plus finding a suitable source of fill material (volume of fill required would be about 2 – 3 million cubic metres). Clearly the costs of this rescue plan would be enormous, but depending on the final developable land options, the plan could still be economically viable (subject to available up front financing). The alternative is to rezone and retreat from these suburbs, with no future development and allow the area to change to swampland. This would result in an economic loss in excess of $1 billion of existing property value. Whilst such a decision does not need to be made immediately, CofN should be bracing itself for such an ultimatum in the near future (within the next 10 years or so, or as the realities of sea level rise start to manifest). Further, CofN should be considerate of these long term objectives in reviewing zonings and development controls in these areas in the future.

6.6.2 Property Modification

Where it is not possible to justify protection of existing buildings by means of a barrier, a choice will be required in the future between allowing it to be flooded by the ocean periodically (maybe with varying degrees of flood proofing, such as a change of building materials or even house raising), or abandonment of the property. That decision is likely to be governed by the frequency and severity of flooding, but is unlikely to be made until sea level rise begins to manifest and create a tangible problem. In the interim, landowners should be able to continue to develop properties, subject to existing and future planning and development controls (including the provision of flood free refuge and structural stability in a PMF event).



Title:

Land Relief Map of Maryville, Wickham, Islington and Carrington

Figure: **6-14**

Rev: **A**

N

0 250 500m

Approx. Scale

BMT WBM

www.bmtwbm.com.au

Filepath : K:\N2246_Newcastle_FRMS_Stage2\Mapinfo\workspaces\DRG_005_111221_Land_Relief.WOR

CofN will nonetheless need to make property owners aware of the potential for properties to be flooded by the ocean and how that would change with increases in sea level so that owners can make informed decisions about future development options. Ocean flooding is fundamentally different to river and flash flooding in that it involves saltwater rather than freshwater. Saltwater inundation is more damaging that freshwater, particularly if it occurs on a regular basis. It also has the potential to impact on soil quality, which ultimately may limit the usability of the land, irrespective of any structural provision made for refuge and minimising property damage.

6.6.3 Response Modification

Ocean flooding will generally be caused by meteorological events that can be forecast some days in advance. Should sea level rise in the future, then tidal fluctuations would also cause inundation, although these too would be able to be forecast well in advance.

The NSW SES Evacuation Timeline Model (Opper, 2004) was used to analyse the areas that could be subject to ocean flooding. This showed that the most number of vehicles evacuating along a single route would be from Maryville and that it would take about 6 hours after being warned for all residents to evacuate. Other areas would have small numbers of evacuees and would be able to use a range of different evacuation routes. Ocean flooding can currently be forecast at least a day in advance and therefore there is ample time for orderly vehicular evacuation in advance of the flood.

Evacuation would not only reduce risks to lives but the removal of vehicles and the relocation of some building contents would also reduce risks to property. Failure to evacuate would mean that lives and property remain at risk, particularly in Maryville and Carrington, which are currently protected by low levees. Overtopping of these levees could see a sudden rise in water levels and limited options for people to evacuate with a sudden inundation of ocean floodwaters. At other locations there is more scope for people to evacuate ahead of the rising floodwaters although in Hexham evacuation routes can be cut by rising floodwaters thus potentially isolating people on their properties.

As people in Newcastle have not previously had to evacuate in advance of ocean flooding, and people are generally reluctant to evacuate until their properties are directly under threat, community education about ocean flood risks will be necessary for evacuation to be effective in the future.

Flood warning, evacuation and education are likely to be the most cost effective means of addressing risk to life in areas affected by ocean flooding. The BoM's current forecasting products can provide sufficient advanced warning of these areas of flooding. A new experimental product, which it has been trialling, should be able to model ocean levels more accurately and provide these forecasts more than a few days in advance. The SES is currently updating its Flood Emergency Response Plan which should include evacuation for ocean flooding and appropriate trigger levels.

6.6.4 Summary of Practical Ocean Flooding Options

In light of the preceding discussion, the following actions have been considered for further inclusion as part of this Plan:

- Confirm ocean flooding impacts on the lowest lying properties in Stockton and Hexham;
- Consider the opportunities for minor works (e.g. drain outlet floodgates and one-way flow valves) to reduce the chance of such flooding;

- Further technical investigations and feasibility assessments of permanent or temporary barriers to protect Carrington, Wickham, Maryville and Newcastle West;
- Undertake investigations to establish a Strategic Position to decide between abandoning or rescuing low-lying areas / suburbs in the long-term (50+ yrs);
- The BoM and the SES to develop ocean flood warning arrangements for Newcastle;
- The SES to update its Flood Emergency Response Plan to include evacuation of areas at risk of ocean flooding consistent with the areas identified in this plan; and
- The SES and CofN develop a community education plan addressing ocean flooding risks.

6.7 Summary of What's Not Suitable for Newcastle

An exhaustive process was followed in determining which possible floodplain management actions could be adopted in Newcastle and included in the City-wide Flood Plan. This process included:

- A world wide search of possible flood management actions;
- Convening a panel of experts drawn from government and practicing consultants to canvass and review possible options early;
- Consultation with the community and key stakeholders (inside and outside of CofN); and
- Input from CofN's City-wide Floodplain Risk Management Working Party (which has representatives from the elected Council, the community and commerce and government agencies).

The following list of options were initially flagged as possible options by the community, stakeholders or the Study Team, but on closer inspection proved to be impractical or ineffective for the specific application at Newcastle:

- Purpose built flood mitigation dams in Hunter River catchment;
- Hunter River bypass channel through Tomago;
- Hunter River bypass channel at Hexham;
- Dredge North and South Arms of the Hunter River;
- Increase (or decrease) Hunter River flood levees;
- Large detention basins in upper, middle and lower areas of suburban catchments;
- Levees beside stormwater channels;
- Bypass tunnel to the ocean at Bar Beach;
- Dredge downstream end of Throsby Creek;
- Draining floodwaters into underground mine voids;
- Moratorium on all future development in the floodplain;
- Requiring a minimum % pervious areas for new development;
- Relocating whole suburbs to flood-free land;
- Immediate and broadscale retrospective rezoning (backzoning);

- Filling within floodways and flood storages; and
- Relying on emergency services and combat agencies and flash flood warnings only.

With the exception of the Wallsend Commercial Centre, which is covered in the already adopted Wallsend Commercial Centre Flood Management Plan (2009), the following options have also been determined to be unsuitable in remaining areas across Newcastle:

- Larger / deeper stormwater channels and bigger underground pipes / culverts. Note that more than 40 locations examined as part of this Study to determine if these works would be appropriate, with no obvious winners; and
- Large scale buy back to allow for a larger drainage system that follows original floodpaths.

It is also recognised that the options recommended in this Plan cannot necessarily be implemented within the immediate timeframe. As such, a ranking and prioritisation process has been carried out that identifies which options provide the best outcomes for the least financial and resource demands. The ranking and prioritisation and ranking process is described in the next Chapter.

7 RECOMMENDED FLOOD MANAGEMENT STRATEGY

7.1 Overview of Chapter

The assessment and review of possible flood management options described in Chapter 6 provides a short-list of works and actions that can be implemented to improve current floodplain management practices. As presented in Table 5-6, current management practices are considered to be largely inadequate for flash flooding environments, while existing risks in river flood environments are also poorly managed, as are continuing risks for ocean flooding.

Table 7-1 provides a summary listing of the most suited actions for improving flood management in Newcastle in terms of risks to life and property for existing risks, future risks and continuing risks, and thereby redressing the shortcoming of existing management arrangements.

Table 7-1 Summary of Most Suited Actions for Improving Flood Management

	Flash Flooding	River Flooding	Ocean Flooding
RISKS TO LIFE			
Existing Risks	• Investigate, and pursue if warranted, opening flowpath at Irving St, Wallsend • Investigate, and pursue if warranted, voluntary purchase within Morgan – Selwyn floodway, Merewether • Improved predictions of flooding (nowcasting) • Develop and operate Flash Flood Warning System, including effective broadcasting through media and social media channels • Community education • Install passive and active road signage	• Investigate, and pursue if warranted, voluntary purchase of residential properties in floodway • Investigate, and pursue if warranted, raising Pacific Highway • BoM to provide flood forecasting for Hexham Bridge • Develop and operate River Flood Warning System, including effective broadcasting through media and social media channels • Community education • Install passive and active road signage	• Improved predictions of ocean flooding • Develop and operate Ocean Flood Warning System, including effective broadcasting through media and social media channels • Community education • Install passive and active road signage
Future Risks	• Continue existing development controls for PMF refuge and structural stability needs • Investigate, and pursue if warranted, rezoning and changes to development controls to promote more flood-compatible development • Review controls on development within PMF and 1% AEP floodways and storages, clarifying locations of applicability through further modelling, as required	• Investigate, and pursue if warranted, rezoning and changes to development controls to promote more flood-compatible development (particularly at Hexham) • Reinforce controls on building footprints in PMF and 1% AEP floodways and storages, clarifying locations of applicability through further modelling, as required	• Investigations required to develop Strategic Plan to formulate a future management approach for low-lying areas / suburbs in the long-term (50+ yrs)
Continuing Risks	• Provide elevated flood-free refuge, in combination with flood vents where required to minimise pressure loading on buildings • Provide an advisory and certification scheme for "flash flood free" refuge • SES to update Flood Emergency Plan to include flash flood risks and issues • Community education and flood liaison officer	• SES to update Flood Emergency Plan to include river flood risks and issues • Community education and flood liaison officer	• SES to update Flood Emergency Plan to include ocean flood risks and issues • Community education and flood liaison officer

	Flash Flooding	River Flooding	Ocean Flooding
RISKS TO PROPERTY			
Existing Risks	• Investigate, and pursue if warranted, lowering Corona St / National Pk St intersection, Hamilton East • Investigate, and pursue if warranted, larger culverts in Elermore Vale / Rankin Park • Demolish 681 Hunter St building over Cottage Creek • Investigate, and pursue if warranted, house raising for most susceptible and suitable properties • Investigate, and pursue if warranted, voluntary purchase within Morgan – Selwyn floodway, Merewether • Investigate, and pursue if warranted, voluntary purchase of properties that become substantially damaged by flooding • Investigate, and pursue if warranted, augmentation of existing stormwater system with pumps in Wickham, Maryville, Islington and Carrington	• Investigate, and pursue if warranted, voluntary purchase of residential properties in floodway • Investigate, and pursue if warranted, house raising for most susceptible and suitable properties not to be rezoned • BoM to provide flood forecasting for Hexham Bridge • Develop and operate River Flood Warning System, including effective broadcasting through media and social media channels	• Investigate, and pursue if warranted, raising existing levees around Lower Throsby Creek, with backflow prevention on stormwater outlets • Investigate, and pursue if warranted, augmentation of existing stormwater system with pumps in Wickham, Maryville, Islington and Carrington
Future Risks	• Encourage redevelopment and renovations with more flood resilient materials and design • Clarify Controls on floatables and car-parking in floodways and/or hazardous areas • Review controls on development within PMF and 1% AEP floodways and storages, clarifying locations of applicability through further modelling, as required • Investigate revising FPLs to cater for blockages • Investigate revising FPLs when climate change impacts occur	• Encourage redevelopment and renovations with more flood resilient materials and design • Investigate, and pursue if warranted, revising planning controls to broaden landuse types compatible with river flooding • Investigate revising FPLs when climate change impacts occur	• Encourage redevelopment and renovations with more flood resilient materials and design • Investigate revising FPLs when climate change impacts occur
Continuing Risks	• Continue maintenance of stormwater system • Community education and flood liaison officer	• Community education and flood liaison officer	• Investigations required to develop Strategic Plan to formulate a future management approach for low-lying areas / suburbs in the long-term (50+ yrs) • Community education and flood liaison officer

Note: Shaded cells represent risks considered to be inadequately managed under existing arrangements (refer Table 5-6).

This Chapter presents the prioritisation and ranking of these most suited floodplain management options to establish a strategy of action comprising both short term works that can be implemented within the next 5 years, as well as longer term initiatives that should be pursued, subject to initial feasibility investigations.

The flood management strategy represents the "package" of actions that are considered in their totality as an integrated suite of measures (including both short term actions for immediate implementation, as well as longer term works and initiatives that are as yet unfunded). The whole "package" of actions needs to address the objectives of the Floodplain Development Manual (2005), and needs to be consistent with the principles of sound flood management practice, as discussed previously in Chapter 2.

7.2 Rapid Analysis of Recommended Actions

7.2.1 Purpose

A simple tool has been developed to assess the positive and negative benefits and costs of the recommended actions. The criteria are based on a "traffic light" colour system to clearly display if an aspect of an option should be cause to "stop" and reconsider, "slow" to proceed with caution or "go" with few trade-offs expected.

The assessment has been conducted for each recommended floodplain management action as determined to be practical from the coarse and fine filtering process described in Chapter 6.

The aim of the rapid analysis is to provide a straightforward overview of the various actions applicable at Newcastle, presenting quickly and clearly to community the benefits and trade-offs of a particular action, to assist in the prioritising and ordering of works within the immediate, medium and longer terms.

7.2.2 Criteria for Analysis

The criteria used for the rapid analysis is described below and summarised in Table 7-2.

No Regrets

The "No Regrets" criterion identifies those actions that, in essence, should be done anyway as part of good governance irrespective of the specific demands of a new Floodplain Risk Management Plan. "No Regrets" actions also provide for activities that will improve resilience and preparedness for future flooding.

The result for *No Regrets* is either YES or NO.

Meet Gaps

Chapter 5 describes the adequacy of current management measures. The outcome of Chapter 5 is summarised in Table 5-6, and highlights the current gaps, or inadequacies, in the current flood management arrangements for Newcastle. The gaps include:

- Managing Risk to Life for Existing Development affected by Flash Flooding;
- Managing Risk to Life for Continuing Risks affected by Flash Flooding;

- Managing Risks to Property for Existing Development affected by Flash Flooding;
- Managing Risks to Property for Existing Development affected by River Flooding;
- Managing Risks to Property for Future Development affected by Flash Flooding; and
- Managing Risks to Property for Continuing Risks affected by Ocean Flooding.

The "Meet Gaps" criterion identified those actions that specifically address these gaps in the current management arrangements. It is considered that the final list of recommended strategies should meet all of the current gaps and deficiencies associated with existing management.

The result for *Meet Gaps* is either YES or NO.

Performance

The performance criterion considers how well the action would actually address the risks it is specifically targeting. The performance criterion also factors whether the action provides a long term solution, or is just a short term fix.

The criterion for Performance is based on a scale from high to low, where high performance represents effectiveness of the action in addressing flood risks, and low performance represents low performance or uncertainty in the outcomes.

The result for *Performance* is presented in Table 7-2, as a traffic light assessment for ease of interpretation.

Practicality

The practicality criterion considers how easy and practical the action will be to implement. If the action can be considered standard process for CofN or other agencies with minimal delays and hurdles, then the practicality would be high. If there are some barriers or delays to the option being implemented, then the practicality would be lower. With reducing practicality, it is expected that the effort (and costs) required to implement the action would increase.

The result for *Practicality* is presented in Table 7-2, as a traffic light assessment for ease of interpretation.

Community Acceptance

The community acceptance criterion aims to reflect the general support for the action by the community as a whole. It is recognised that some actions may have a small section of the community that is most affected (e.g. landholders subject to voluntary purchase or house raising), however, it is the expected opinions of community at large that have been captured by this criterion.

The result for *Community Acceptance* is presented in Table 7-2, as a traffic light assessment for ease of interpretation.

Costs / Resource Needs

Floodplain Risk Management actions can be inherently costly, especially when dealing with engineered works or property modifications. Planning controls are the exception to this, although these can still require significant effort from CofN and others.

The Costs / Resource Needs criterion represents a rating wherein a High Rating reflects the lowest costs, while a Low Rating reflects the highest costs. This has been adopted for consistency with the other criteria.

The result for *Costs / Resource Needs* is presented in Table 7-2, as a traffic light assessment for ease of interpretation.

Table 7-2 Rapid Analysis (Traffic Light Assessment) Criteria

	Performance	Practicality	Community Acceptability	Costs / Resources
LOW **(STOP / reassess)**	Action is not particularly effective over the short or longer terms	Acton would be difficult to implement through existing constraints, approvals required etc. Would be very demanding to successfully implement.	Unlikely to be acceptable to the majority of the community and politically unpalatable. Significant championing required by CofN and State.	Very Expensive (more than $1,000,000) and/or very high (unmanageable) resource demands on authorities
MEDIUM **(SLOW)**	Action provides only a short-term fix, or is only partly effective over the long term	Action would have some hurdles for implementation, which may take longer and demand more effort to overcome.	Would be palatable to some, not to others. Briefing by Councillors, GM and community education required	Moderately expensive (e.g. $100,000 - $1,000,000) and/or high resource demands on authorities
HIGH **(GO)**	Action provides an effective long term solution to the risks identified	Action is straightforward to implement with few barriers or uncertainties.	Is very politically palatable, acceptable to community. Minimal education required	Manageable costs (< $100,000) and manageable resource demands on authorities

7.2.3 Analysis of Results

The results of the Rapid Analysis are presented in Table 7-3. This table also gives a Total Score for each action. The score is calculated based on the following points system:

- All HIGH (go) criteria have a score of +1
- All MEDIUM (slow) criteria have a score of 0
- All LOW (stop and reassess) criteria have a score of -1.

Additional points are given if the *No Regrets* and the *Meet Gaps* criteria are met. The maximum possible score therefore is +6. A score of +3 or above is considered to have good benefit cost outcomes, while a score of +2 would be the next level down and have also have reasonable outcomes.

Table 7-3 Rapid Analysis (Traffic Light Assessment) Results for Recommended Actions

Recommended Action	Mechan-ism			Life or Property		Risk Type			No Regrets	Meet Gaps	Performance	Practicality	Community Acceptance	Costs / Resources	Total Score
	Flash	River	Ocean	Risk 2 Life	Risk 2 Ppty	Existing	Future	Continuing							
Education Initiatives															
• Undertake community education, facilitated through a dedicated flood liaison officer	✓	✓	✓	✓	✓			✓	YES	YES	HIGH	HIGH	HIGH	LOW	**+4**
Flood predictions and warnings															
• Provide river flood forecasting for location(s) in Newcastle LGA		✓		✓		✓			YES		HIGH	MED	HIGH	HIGH	**+3**
• Develop and operate a complete Flood Warning System for Newcastle (covering Flash, River and Ocean Flooding), including effective broadcasting of warning and relevant information through multi media and social media channels	✓	✓	✓	✓		✓			YES	YES	HIGH	MED	HIGH	MED	**+4**
• Install passive and active road signage to relay warnings, advise of flooded roads, and provide other emergency information	✓	✓	✓	✓	✓	✓			YES	YES	MED	HIGH	HIGH	MED	**+4**
• Improved predictions of flash flooding (using integrated modelling and interpretive radar mapping: “nowcasting”)	✓			✓		✓				YES	MED	LOW	HIGH	MED	+1
• Improved predictions of ocean flooding through integrated barometric forecasting and tidal predictions			✓	✓		✓					LOW	MED	HIGH	HIGH	+1
Additional Planning Controls															
• Clarify Controls on floatables and car-parking in floodways and/or hazardous areas	✓				✓		✓		YES	YES	HIGH	MED	MED	HIGH	**+4**
• Encourage redevelopment and building renovations with more flood resilient materials and design	✓	✓	✓		✓		✓		YES	YES	MED	HIGH	HIGH	HIGH	**+5**
• Undertake appropriate technical, social and economic investigations to develop a Strategic Position that will decide	✓		✓	✓	✓		✓		YES	YES	HIGH	MED	HIGH	MED	**+4**

Recommended Action	Mechan-ism			Life or Property		Risk Type			No Regrets	Meet Gaps	Performance	Practicality	Community Acceptance	Costs / Resources	Total Score
	Flash	River	Ocean	Risk 2 Life	Risk 2 Ppty	Existing	Future	Continuing							
future management of low-lying areas / suburbs in the long-term (within a 50 yr horizon)															
• Investigate rezoning (up-zoning) to promote more flood-compatible development, and adopt if determined to be appropriate	✓			✓	✓		✓			YES	MED	LOW	MED	HIGH	+1
• Investigate rezoning (up-zoning) of non-floodways to employment lands at Hexham, and adopt if determined to be appropriate		✓		✓			✓				MED	MED	MED	HIGH	+1
• Investigate rezoning (down-zoning) of hazardous floodways along Hunter River, and adopt if determined to be appropriate		✓		✓	✓		✓				HIGH	LOW	MED	HIGH	+1
• Investigate revising planning controls to broaden landuse types compatible with river flooding, and adopt if determined to be appropriate		✓			✓		✓				MED	MED	MED	HIGH	+1
• Investigate revising FPLs to cater for blockages, and adopt if determined to be appropriate	✓				✓		✓			YES	MED	MED	LOW	HIGH	+1
• Investigate revising FPLs, triggered when climate change impacts start to manifest	✓	✓	✓		✓		✓			YES	MED	MED	LOW	HIGH	+1
Emergency Management															
• Update and implement as required the SES Flood Emergency Plan for Newcastle / Lower Hunter to include flash, river and ocean flood risks and issues	✓	✓	✓	✓				✓	YES	YES	HIGH	HIGH	HIGH	HIGH	**+6**
Governance Initiatives															
• Provide an advisory and certification scheme for “flash flood free” refuges	✓			✓				✓		YES	HIGH	MED	HIGH	MED	**+3**

Recommended Action	Mechan-ism			Life or Property		Risk Type			No Regrets	Meet Gaps	Performance	Practicality	Community Acceptance	Costs / Resources	Total Score
	Flash	River	Ocean	Risk 2 Life	Risk 2 Ppty	Existing	Future	Continuing							
Property Works															
• Provide elevated flood-free refuge, in combination with flood vents where required to minimise pressure loading on buildings (1,500 required in total across Newcastle to fully meet risks)	✓			✓				✓		YES	HIGH	MED	MED	HIGH	**+3**
• Demolish 681 Hunter St building over Cottage Creek	✓				✓	✓			YES	YES	LOW	HIGH	HIGH	HIGH	**+3**
• Investigate voluntary purchase of one or more properties within Morgan – Selwyn floodway, Merewether, and pursue if determined to be appropriate, subject to availability of funding	✓			✓	✓	✓				YES	HIGH	HIGH	MED	MED	**+3**
• Investigate voluntary purchase of all existing residential properties in hazardous Hunter River floodways, and pursue if determined to be appropriate, subject to availability of funding		✓		✓	✓	✓				YES	HIGH	HIGH	MED	LOW	+2
• Investigate voluntary purchase of any properties that become substantially structurally damaged by flooding, subject to availability of funding	✓	✓	✓		✓	✓				YES	HIGH	HIGH	MED	LOW	+2
• Investigate house raising for properties affected by frequent flash flooding, and pursue if determined to be appropriate	✓				✓	✓				YES	MED	HIGH	MED	MED	+2
• Investigate house raising for properties on Sandgate Road Birmingham Gardens, affected by frequent river flooding, and pursue if determined to be appropriate	✓	✓			✓	✓				YES	MED	HIGH	MED	MED	+2
Continue Existing Initiatives															
• Continue existing development controls for PMF refuge and structural stability needs	✓			✓	✓		✓		YES	YES	HIGH	HIGH	MED	HIGH	**+5**
• Reinforce controls on building footprints in floodways and flood storages	✓				✓		✓		YES	YES	HIGH	HIGH	MED	HIGH	**+5**

Recommended Action	Mechan-ism			Life or Property		Risk Type			No Regrets	Meet Gaps	Performance	Practicality	Community Acceptance	Costs / Resources	Total Score
	Flash	River	Ocean	Risk 2 Life	Risk 2 Ppty	Existing	Future	Continuing							
• Continue maintenance of constructed stormwater system to meet design capacities	✓				✓			✓	YES		MED	HIGH	HIGH	HIGH	**+4**
• Refine the existing flood models to provide more accurate flood maps, to test the validity of structural options and to give a better appreciation of flood behaviour, including calibration to 2007 flash flood event	✓	✓	✓	✓	✓	✓	✓	✓		YES	MED	HIGH	MED	MED	+2
Structural and Physical Works															
• Investigate opening flowpath at Irving St, Wallsend, and secure easements and design and construct works if appropriate.	✓			✓	✓	✓				YES	HIGH	MED	MED	MED	+2
• Investigate and confirm benefits and costs of larger culverts and small local detention basins in Elermore Vale / Rankin Park, and if suited, construct works	✓				✓	✓				YES	MED	MED	HIGH	MED	+2
• Investigate options for augmentation of existing stormwater system with pumps in Wickham, Maryville, and Carrington, and parts of Islington and Stockton. Identify appropriate trigger for implementing works, and source funding for construction. Undertake works when triggered.	✓		✓		✓	✓				YES	MED	MED	HIGH	MED	+2
• Investigate raising existing levees around Lower Throsby Creek, with backflow prevention on stormwater outlets. Undertake design and identify appropriate trigger for implementation, then undertake works when triggered.			✓		✓	✓					MED	MED	HIGH	MED	+1
• Investigate lowering Corona St / National Pk St intersection, Hamilton East, and design and construct if determined to be worthwhile and appropriate.	✓				✓	✓				YES	LOW	MED	MED	MED	0
• Investigate raising the Pacific Highway at Hexham as an alternative to voluntary purchase, recognising the benefits of the raising that extend beyond local evacuation enhancement		✓		✓		✓					MED	LOW	HIGH	LOW	-1

7.3 First 5 Years Package

The "First 5 Years" of this Newcastle City-wide Floodplain Risk Management Plan should contain a range of measures (a "package") that will make positive steps towards redressing the current short-comings of flood risk management across the City. In the short term, there should be an emphasis on managing "continuing risks". In the longer term, existing and future risks can be addressed, which would then minimise the residual (continuing) risk, requiring fewer demands on services such as emergency management and response.

A First 5 Years package has been developed largely on the basis of the outcomes of the rapid analysis presented in Section 7.2. The First 5 Years package includes some of the high scoring actions in their totality, as well as the initial investigative steps in some other higher scoring actions that would take considerable time, resources and potentially funding to implement further, if considered warranted. The First 5 Years package also includes some further strategic planning works given that these can be undertaken as part of the day-to-day affairs of CofN, and can help to address the continuing risk (a consolidation of various rezoning actions put forward in Table 7-3).

The First 5 Years package is outlined in Table 7-4. Actions that would be considered after completion of this First 5 Years package are discussed in Section 7.4.

Table 7-4 Initiatives and Works Package for the First 5 Years

	Recommended Action	Suggested Lead Responsibilities	Indicative Costs
Education Initiatives			
Ed.1	Undertake community education, facilitated through a flood liaison officer	CofN SES HCRCMA	$1.2 million over 5 years (incl. $300,000 in salary & on-costs)
Flood Predictions and Warning			
Wa.1	Provide river flood forecasting for location(s) in Newcastle LGA	BoM	$50,000
Wa.2	Develop and operate a complete Flood Warning System for Newcastle (covering Flash, River and Ocean Flooding), including effective broadcasting of warnings and relevant information through multi media and social media channels	CofN BoM SES (lead to be confirmed)	$350,000 development $25,000 per year for on-going maintenance and control
Wa.3	Install passive and active road signage to relay warnings, advise of flooded roads, and provide other emergency information	CofN RTA SES	$100,000 for passive $250,000 for local active signs $900,000 for large active signs (boards)
Planning Controls			
Pl.1	In concert with existing planning reviews, clarify and implement controls on floatables and car-parking in floodways and/or hazardous areas	CofN	minimal
Pl.2	Encourage redevelopment and renovations with more flood resilient materials and design	CofN	$10,000 for brochures and promotion

	Recommended Action	Suggested Lead Responsibilities	Indicative Costs
Pl.3	As a first step towards possible strategic landuse changes, undertake appropriate investigations to develop a Strategic Position that will decide the future management of low-lying areas / suburbs in the long-term (within a 50 yr horizon)	CofN	$500,000 for initial environmental, social, planning and economic feasibility assessments
Pl.4	Undertake a strategic planning review of all floodplain areas, with recommendations for changes to the LEP, DCP and other guiding policies and plans as appropriate.	CofN	Minimal
Governance Initiatives			
Go.1	Provide an advisory and certification scheme for "flash flood free" refuge	CofN SES	$10,000 for materials, promotions etc
Property Works			
Pr.1	Provide elevated flood-free refuge, in combination with flood vents where required to minimise pressure loading on buildings (1,500 required in total across Newcastle to fully meet needs – aim for 200 over first 5 years)	Landholders	$1,000 per property. ($200,000 for first 5yrs) Assume no structural needs in first 200.
Pr.2	Demolish 681 Hunter St building over Cottage Creek to allow relief for overland flow – especially in the event of blockage to the waterway under Hunter Street.	By agreement between HWC and CofN	$100,000
Pr.3	Investigate voluntary purchase of one or more properties within Morgan – Selwyn floodway, Merewether, and pursue if determined to be appropriate, subject to availability of funding	CofN	Market value of properties, plus assessments and legal expenses Assume $1m for First 5 Years
Emergency Management			
Em.1	Update and implement as required the SES Flood Emergency Plan for Newcastle / Lower Hunter to include flash, river and ocean flood risks and issues	SES	Minimal
Continue Existing Initiatives			
Ex.1	Continue existing development controls for PMF refuge and structural stability needs	CofN	Minimal
Ex.2	Reinforce controls on building footprints within floodways and flood storages	CofN	$100,000 for investigative modelling
Ex.3	Continue maintenance of constructed stormwater system to meet design capacities	By agreement between HWC and CofN	Maintain existing spend (as a minimum). Est. $3m/yr
	TOTAL ESTIMSTED COST FOR FIRST 5 YEARS (excluding continuation of existing maintenance costs)		**$4.7 million**

As outlined above, it is imperative that the First 5 Years Package can make solid progress in addressing the current gaps and deficiencies in the needs for flood management in Newcastle. Previously, Table 5-6 outlined those gaps with respect to Risk to Life and Risks to Property for Existing, Future and Continuing Risks. Table 7-5 replicates that same table, but this time outlining which gaps each of the First 5 Years strategies addresses. As shown in Table 7-5, all of the critical

gaps are met by the proposed package or works and initiatives, however, it is considered that the proposed strategies to address existing risks to property affected by river flooding are somewhat limited in their ability to make significant different to this risk (that is, it is reliant on the fact that improved warning will allow residents to better prepare themselves to reduce damages, such as elevate personal possessions and move vehicles to high ground). Similarly, whilst education can have a positive effect, the overwhelming potential increase in continuing risk to property due to future sea level rise will necessitate a more pro-active approach to management in the future. It is therefore recommended that other strategies that can address these particular gaps are given a greater level of priority when considering the Next Steps after the First 5 Years (refer Section 7.4).

Table 7-5 First 5 Years Strategies that Meet the Gaps in Current Management

	Flash Flooding	River Flooding	Ocean Flooding
RISKS TO LIFE			
Existing Risks	**Wa.2** **Wa.3** **Ed.1** **Pr.3**	Wa.1 Wa.2 Wa.3 Ed.1	Qa.2 Wa.3 Ed.1
Future Risks	Ex.1 Ex.2 Pl.4	Ex.2 Pl.4	Pl.4
Continuing Risks	**Pr.1** **Em.1** **Ed.1** **Go.1**	Em.1 Ed.1	Em.1 Ed.1
RISKS TO PROPERTY			
Existing Risks	**Pr.2** **Pr.3**	**Wa.1** **Wa.2**	Wa.2
Future Risks	**Ex.2** **Pl.1** **Pl.2** **Pl.4**	Ex.2 Pl.2 Pl.4	Pl.2 Pl.4
Continuing Risks	Ex.3 Ed.1 Pl.3	Ed.1	**Ed.1** **Pl.3**

Descriptions of the individual actions, works and initiatives included within the First 5 Years Package are provided below.

7.3.1 Education Initiatives

Ed.1 Undertake community education, facilitated through a flood liaison officer

Community education is being given the highest priority in this Floodplain Risk Management Plan for several reasons:

- Education is required to build a flood-resilient community. A resilient community is not only prepared for flooding and able to respond to and recover from actual floods but also learns from the flood experience to become even more resilient to future floods. Despite the events of 2007, the people of Newcastle still have limited flood experience across the full range of flood frequencies and flood types;
- This Plan is underpinned by the concept of shared responsibility where government, business, community groups and individuals all have a role to play in building resilience, preparedness, response and recovery. Community education will be important in helping people understand the risks and how they can be managed and equipping themselves to fulfil their role;
- Without community education, other elements of the plan such as flood warning, evacuation planning, personal response plans, road warning signage, rezoning, development control, voluntary purchase schemes, voluntary house raising schemes, flood refuges and flood proofing would be less effective;
- Because of their dependence on technology and human action, flood warnings and emergency response cannot be considered as failsafe, particularly in the flash flood catchments, so it is critical that the community knows how to self-respond to an actual flood without assistance from combat agencies such as SES or Police. As an example, heavy rain (especially the torrential rains associated with a PMF event) will make driving very difficult, if not impossible, which will lead to rapid traffic congestion. Within a very short period of time, many roads in Newcastle will become floodways placing all vehicle occupants at peril. Only through education and preparedness would occupants abandon their vehicles during torrential rain to seek shelter elsewhere – yet this action may be absolutely necessary in order to save lives;
- It will take time for many elements of the plan to be implemented, particularly those that will gradually remove development from the most hazardous parts of the floodplain. In the interim, community flood response will be the only effective way to manage risks to life and property in these areas;
- Even if all other elements of the plan are fully implemented, there will still be a residual or continuing risk that needs to be managed by appropriate community flood responses; and
- There are few planning or administrative barriers that would delay the development and implementation of a community education plan. Education should be a key role for combat agencies such as the SES. Community-specific education is also required to 174aximize effectiveness, and as such, CofN has a key supporting role to play in assisting SES with the technical elements of flood characteristics across Newcastle.

Being the centre piece of the Plan, it is recommended that significant financial investment be made in community education. To be truly effective, a significant and serious effort is required. In this regard, rather than providing top-down generic education campaigns, flood communications need to be contextually placed relative to the lives and environments (e.g. homes, communities and landscapes)

of people at risk, with local people being part of novel and interactive mechanisms for raising awareness (Burningham *et al*., 2008). Local perspectives of flooding are crucial to building shared societal knowledge and awareness, as well as suitable local responses.

It should be recognised, however, that education is also not a fail-safe management approach. Experience from the Environment Agency (EA) in the UK suggests that flood awareness is actually very difficult to achieve, especially if there is little to no experiential knowledge of flooding (Burningham *et al.*, 2008). Post-flood, many UK residents complain of a lack of flood information, yet many continue to deny they actually live on floodplains, even after flood evacuations and direct instructions from EA.

In the past few years, a new approach to community education has emerged and been successfully used by emergency managers and local councils around Australia and elsewhere in the world. It deviates markedly from the 'traditional' education approach of only distributing information to communities in the hope of raising awareness and thus they will be better prepared to respond appropriately to a flood. Extensive research has shown that although this may lead to increased awareness, it will not by itself change preparedness and response behaviours.

For the new approach, Dufty (2008) defines community flood education as 'any learning process or activity that builds community resilience to flooding'. The term 'education' in the new approach is viewed in its broadest sense and includes learning both in formal (e.g. schools) and non-formal (e.g. community events) settings. Community flood education can include:

- Public communications, information products and services e.g. publications, Internet sites, displays, promotional products, media liaison, advertising/marketing, public education campaigns;
- Training, development and industry-specific programs e.g. skills development courses, professional training, workplace induction programs, field days;
- Community development programs e.g. public participation programs, awareness-raising programs, discussion groups, developing education networks;
- Use of social media for learning e.g. Facebook, Twitter, YouTube; and
- Comprehensive personal education programs e.g. school curriculum, university curriculum, personal development courses, action research programs, community education courses.

In the new approach, learning is tailored for community sectors including:

- Residents;
- Businesses and Industry;
- Schools, universities and other places of learning;
- Vulnerable people e.g. aged, CALD communities, caravan park residents;
- Government agencies e.g. SES and their volunteers; and
- Local councils.

There are many messages that need to be included within a community education program, but the key message should be to avoid risky behaviour during floods. This would include driving or wading

through floodwaters, or unnecessarily delaying evacuation. Communities need to know what to do in the case of a flood emergency, and more importantly, what not to do. This includes knowing what areas, streets and parklands to avoid, and knowing what alternative routes are available if trying to evacuate to higher ground. However, the education messages need to appropriately and sensitively include advice that there could be some situations where there is no escape possible from life threatening situations in flash flooding. It will also be difficult to distinguish that what might be achievable and suitable in some flood events (e.g. evacuation during small scale flash flooding) may be entirely inappropriate for other events (e.g. large scale overwhelming flash flooding).

Consistent with the concepts of shared responsibility and community resilience building, the development of household and business flood response and evacuation plans needs to be encouraged, and it is expected that this will be one of the outcomes of the Community Education Program. Whilst not considered a substitute for other more pro-active flood management measures, private flood response and evacuation plans will help to raise awareness and instil knowledge of appropriate community response during a flood event. It is not intended that such plans form a condition of consent for future residential development, although it is currently used by CofN for some special commercial developments to help manage third party flood risks.

7.3.2 Flood Predictions and Warning

Wa.1 Provide river flood forecasting for location(s) in Newcastle LGA

There is a flood forecasting model for the Hunter River as far downstream as Raymond Terrace and a hydraulic model of the lower Hunter River that includes tidal effects. This Plan recommends that BoM extends its flood warning to include forecasting of flood levels at one or more locations within the Newcastle LGA (possibly Hexham Bridge). This would provide a local reference for local communities as well as the SES to gauge the imminent flood risk, and respond accordingly.

Wa.2 Develop and operate a complete Flood Warning System for Newcastle (covering Flash, River and Ocean Flooding), including effective broadcasting of warnings and relevant information through multi media and social media channels

When integrated with community education, the development of a complete Flood Warning System for Newcastle forms the cornerstone of this Floodplain Risk Management Plan. With improved warning of an approaching flash flood, the community will hopefully be able to respond in a more responsible and appropriate manner. Flood warnings serve many purposes. Not only do they provide people with a forecast of expected conditions, they help to raise overall community awareness, especially if key messages are reiterated along with the warnings (e.g. do not drive or wade across any floodwaters). Clearly the earlier the warnings are given then the more time communities have to respond.

Existing flood warnings are largely adequate in Newcastle, with the exception of flash flooding. In a comprehensive study on flash flooding in Europe, APFM (2007) proposed that local monitoring networks, systems to warn and inform residents, ongoing community education and training of crisis services are all necessary components of a successful flash flood warning and response program.

These components are also reflected by BoM (2007) as part of its Level 3 Total Flood Warning System provided in the NSW Flash Flood Warning Guidelines.

As reminded by Tokar *et al.* (2006), having a perfect flood forecast will still not mitigate impacts if the community at risk does not receive a timely warning or does not know what to do when the warning is received. Therefore, broadcasting of the warning, and preparing the community to respond accordingly in the event of a warning are critical to the success of a total flood warning system.

There are many new and emerging means of mass communication of flood warnings. 'Emergency Alert' is a telephone-based warning system developed following the 2009 Victorian bushfires, and is under consideration for use in other emergencies, such as flooding. Although research suggests that Emergency Alert only reaches about 60% of intended recipients, such personalized warnings would hopefully have a much greater and targeted response compared to current generic (and usually conservative) flood broadcasts (especially flash flood broadcasts).

It is expected that mobile phone-based SMS warnings could also be developed for registered message recipients. Recently in Japan, millions of people received SMS tsunami alerts on their mobile phones almost immediately after the formal warning was issued. Social media channels such as facebook and twitter have also been used over the last couple of years to supplement traditional methods of dissemination for flood and other emergency information.

Clearly there is a key role here for the BoM. This would include integrating with the existing flash flood detection equipment (rainfall and water level gauges) that has been installed specifically for this purpose by CofN, and providing warnings on the basis of data collected locally (including other regional telemetered gauges, as well as short and long ranging radar – noting that Sydney and Wollongong have now been upgraded to high resolution Doppler radars).

Wa.3 Install passive and active road signage to relay warnings, advise of flooded roads, and provide other emergency information

With the exception of community education, signage will be the principal means of addressing continuing risk to life, especially risks to people trying to evacuate or travelling along roads during flash floods. Passive signs would include flood height markers (as installed around Newcastle after the June 2007 event) as well as commemorative markers indicating heights of historical floods in the area. Active signage involves large electronic boards typically used by the RTA to advise of road conditions, special events etc. In addition, active signage can include smaller electronic signals, similar to flashing 'school zone' signs, which could be automatically triggered by a water sensor installed within an adjacent culvert or road crossing.

Messaging on the large electronic road signs is co-ordinated through the NSW Transport Management Centre, with either automated messages triggered by pre-defined conditions, or specific messaging on request. There are currently 11 electronic signs in the Newcastle region, including the Pacific Highway, New England Highway, Maitland Road and the F3 freeway. Additional signs can be installed at key road locations that are highly susceptible to flooding or represent a very serious risk to life on roads. Signs cost between $150,000 and $300,000 each.

Smaller electronic signals could be installed throughout the city where roadways are susceptible to local overtopping (thus preventing thoroughfare access and representing a hazard for people or vehicles attempting to cross the floodwaters).

The locations for installation of passive and active signage should give consideration to the Risks to Life on Roads maps, provided in **Maps 7A to 7K** (see **Map Series 7** in accompanying ***Compendium of Maps***).

7.3.3 Planning Controls

Pl.1 In concert with existing planning reviews, clarify and implement controls on floatables and car-parking in floodways and/or hazardous areas

There are already a range of development controls that aim to address various aspects of flooding in accordance with current best practice. One of these controls limits the use of 'floatable' structures such as shipping containers, within floodways and other hazardous areas across the Newcastle floodplains. This particular control was introduced following the June 2007 flash flood event when two containers floated into Cottage Creek and subsequently blocked culverts causing substantial flooding upstream.

Another existing control limits the development of carparks. Cars can also float within floodwaters and can cause blockage of channels and culverts, which subsequently can have detrimental impacts on property (and life) upstream. Underground car parks represent a particular hazard to life if there is not internal and direct escape to a flood free refuge. Underground carparks can, however, be effective at containing cars, preventing them from entering waterways and causing issues downstream. On-grade carparks located within floodways or close to channels represent the biggest risk, and should be managed accordingly.

CofN has existing development controls on carparking, and the use of floatables, within the floodplains, and these should be clarified through more investigations to refine and justify the particular restrictions being imposed and their applicable locations. Consideration should also be given to river and ocean flooding.

This work should be reviewed after the present research being carried out by Engineers Australia in the updating of Australian Rainfall and Runoff (AR&R) into the effect and management of blockages and the stability of cars and people in floodwaters is completed.

Pl.2 Encourage redevelopment and renovations with more flood resilient materials and design

In response to the devastating floods in Queensland, NSW, Victoria and WA in early 2011, which affected more than 28,000 properties, the Australian Building Codes are being modified to make greater provision for flood resilience. While the specifics of any changes to the code will likely be directed by the outcomes of the Queensland Floods Commission of Inquiry (and may take several years thereafter to work their way into adopted Building Codes), CofN can still encourage landholders who plan to undertake new developments or renovations to existing buildings to use materials that are more compassionate to flooding.

As outlined in Section 6.4.2.5, this would include for example replacing composite timber kitchen cupboards with solid timber cupboard, replacing carpet with floor tiles, replacing plasterboard wall lining with fibrous cement etc.

Encouragement to be more flood-resilient can be linked to the recommended Community Education Program described in Section 7.3.6.

Pl.3 As a first step towards possible strategic landuse changes, undertake appropriate investigations to develop a Strategic Position that will decide the future management of low-lying areas / suburbs in the long-term (within a 50 yr horizon)

As discussed in Section 6.6.1, the future of low-lying suburbs such as Carrington, Wickham and Maryville is potentially compromised by projected sea level rise. With poor drainage and shallow groundwater tables under the current situation, an increase in mean sea level is likely to introduce significant challenges to on-going occupation of these areas. Of most concern is the potential rise in groundwater level. Should permanent groundwater levels reach the surface, then private lands would become untenable, while services would become difficult to maintain.

Engineering solutions may be available to keep groundwater levels suppressed (e.g. through wells where groundwater in constantly pumped out – called dewatering), with local drainage augmented through mechanical pumping from the existing stormwater system. It is expected, however, that these solutions would only be an interim measure, and a more permanent solution of either raising the entire area (through filling), or retreating from the area (and allowing it to turn to groundwater dependent wetland) would be required (maybe on a 100yr + timeframe).

Given that new development applications are continually being lodged and assessed for these areas, any potential changes to future landuse zonings and/or development controls should be flagged as early as possible. Legal and planning advice will be crucial to the long term feasibility of options.

Pl.4 Undertake a strategic planning review of all floodplain areas, with recommendations for changes to the LEP, DCP and other guiding policies and plans, as appropriate.

The manner in which development is permitted within floodplains across Newcastle (up to the PMF level), as defined within the current Newcastle LEP and DCP, should be reviewed to take into consideration the recommendations and findings of this Study and Plan, including the hazard and risk mapping presented herein, with the aim that no future inappropriate development would be permitted on the floodplain. Under the existing planning arrangement, development is not permitted within a floodway, although the adopted Wallsend Floodplain Management Plan, as well as this Study and Plan recommend some careful redevelopment potential within some areas of the floodplain (along with other recommendations to open-up floodways and flowpaths). The review should identify the most appropriate and compatible landuse for the flood risk profile across the LGA. Thus, whilst the flood risk might be incompatible with some existing landuses, it may still be compatible with other landuses (for example, the mapping presented in this Plan highlights the inappropriateness of

existing residential zoning at Hexham, which could be considered for rezoning to industrial or commercial uses that are more flood-compatible).

It is also proposed that various development control aspects be reviewed, including for example the ability to provide bonus height and/or floor space ratios within floodplains or other concessions to encourage more appropriate flood compatible redevelopment in flood prone areas. Management of densities within floodplains is one aspect that does need more specific consideration. Although ideal, simply not allowing any intensification of development (or indeed reducing densities by limiting development types) within the floodplain may not be practical, and may in fact prejudice opportunities for managing direct flood risk. Freeboard requirements should also be revisited in light of site-specific hydraulic behaviour and future sea level rise projections. Timeframes adopted for planning horizons in certain areas could also be revisited on the basis of possible unviable development potential in the long term (e.g. within the low-lying suburbs of Carrington, Maryville and Wickham). Alternative development controls to be considered as part of the strategic planning review may also include trigger-bound consent conditions, or other more adaptive controls.

Strategic review of floodplain areas should also be undertaken cognisant of the ability to modify zoning and development of adjoining or nearby non-floodplain areas as possible offsets, if considered necessary and appropriate.

It is important that flooding constraints on future development are recognised at the highest planning level, and therefore CofN will be required to liaise carefully with DoPI regarding proposed changes to strategic landuse planning across the LGA. Any proposed changes to the Newcastle LEP and DCP would need to go through the normal process of community and stakeholder consultation before being adopted.

7.3.4 Governance Initiatives

Go.1 Provide an advisory and certification scheme for "flash flood free" refuge

In recognition of the fact that safe evacuation for all people affected by flash flooding will not be possible with the limited warning time available, people should know whether their properties are suitable for on-site refuge, and if not, then what is required to make it safe. A certification scheme is proposed that advises landholders of the adequacy of their properties for taking shelter during flooding. The scheme could be similar to "Neighbourhood Watch" whereby properties that have flood free refuge are identified by a window/letterbox sticker or plaque, potentially providing a more community-wide facility if necessary.

Certification would require technical advice and confirmation of adequacy by CofN staff. Certification should also be linked to SES emergency response data to improve emergency management.

Some 21,500 properties across Newcastle are affected by flooding of some sort, with almost 10,000 affected by flash flooding. Of these, only about 1,500 are considered to be currently unsuitable for on-site refuge. A further 100 or so properties are located within floodways that would not be considered suitable for provision of an elevated flash flood free refuge due to the risks associated with building collapse. The community education program can specifically target those properties outside the floodways that can be modified to accommodate an on-site flood refuge. The education

program would specifically outline what works would be required to individual buildings in order to make them safe, and thus be certified under the flash free refuge scheme.

It is envisaged that the certification scheme could be linked to the S149 notification process, meaning that if the notification indicates the property has a flood risk, then it should also indicate whether it has a valid flash flood free refuge.

All new developments located within a flash flood catchment would be automatically certified given that the current Flood DCP requires the provision of flood-free refuge and structural stability at the PMF.

7.3.5 Property Works

Pr.1 Provide elevated flood-free refuge, in combination with flood vents where required to minimise pressure loading on buildings (1,500 required in total across Newcastle to fully meet needs – aim for 200 over first 5 years)

While successful evacuation is the only failsafe way of avoiding risks to life in floods, evacuation may not always to possible or rational given the nature of flash flooding. As such, there is merit in having safe shelter-in-place refuges. It is worth appreciating that there was no loss of life during floods in Australia between 1997 and 2008 associated with people taking shelter inside buildings. Unfortunately, this changed in the 2011 floods in Grantham and the Lockyer Valley. The game-changing effect of the floods in Grantham and the Lockyer Valley highlights the acute risks associated with flash flooding. Unfortunately, most of the 25 tragic deaths involved people taking refuge in their homes, or trying to flee their homes that were quickly being overwhelmed by floodwaters. The 2011 experience also highlights the added vulnerability of the young (especially infants), as well as the elderly and infirm. Had the properties in Grantham and the Lockyer Valley had a flood-free refuge, and if they were structurally robust enough to withstand the flood forces, then the death toll would have been much less.

In an attempt to try and combat the risk of such an event, it is considered that shelter-in-place refuge is necessary within some areas of the Newcastle floodplains. These voluntary actions can be encouraged almost immediately and there is virtually no cost to CofN. Encouragement and incentive for landowners to undertake these works can relate to “certification” of the refuge, which is part of *Go.1*. Care will need to be taken not to encourage people to spend money on houses which are likely to be part of a voluntary purchase scheme.

The locations of houses that would be applicable for provision of elevated flood-free refuges are provided in **Maps 11A to 11K** (see **Map Series 11** in accompanying ***Compendium of Maps***).

Pr.2 Demolish 681 Hunter St building over Cottage Creek

This building is currently owned by HWC and leased to a third party. The building has been constructed on top of culverts over the lower end of Cottage Creek, and prevents any overland flow over Hunter Street at the culverts.

Whilst the culverts have a design capacity of up to the 1% AEP flood event, they are susceptible to blockage (as occurred during the 2007 flood). If the culverts are blocked, the lack of an alternative overland flowpath means that flood levels increase significantly upstream. It has been determined that blockage in the lower reaches of Cottage Creek exacerbates flooding throughout the Marketown commercial precinct (by about 0.5 metres or more) during a 1% AEP flood event. The probability of blockage within the culverts is unknown for future events, as there are many local factors that can become important (including a local source for blockage material). However, if the June 2007 event is used as a guide, then blockage within any culvert (regardless of size) is a very real possibility and should be considered as part of future floodplain risk management.

Modelling has shown that floods in excess of 1% AEP would also back-up behind the culverts even without blockage.

This Plan recommends that HWC demolish the building in line with good flood management practice and thus provide an alternative overland flowpath for more extreme events, or when the culvert or channel is blocked during flooding (refer Figure 7-1).

Figure 7-1 Shipping container blocking culvert under 681 Hunter Street, June 2007

Pr.3 Investigate voluntary purchase of one or more properties within Morgan – Selwyn floodway, Merewether, and pursue if determined to be appropriate, subject to availability of funding

While there are a number of 'hot spots' for potential voluntary purchase (refer Figure 6-8), the most critical location is likely to be within the Morgan St – Selwyn St floodway in Merewether. Already one property (166 Morgan St) has been purchased by CofN and demolished in order to reduce acute flooding risks. It is considered that one or more additional properties should also be acquired now that the flowpath has been opened up by the recent property demolition.

A physical model, held by the University of NSW's Water Research Laboratory, has been set-up to represent flooding conditions within the Morgan-Selwyn floodway. This physical model should be used opportunistically to supplement numerical modelling predictions regarding to potential flood risk benefits of removal of one or more houses within the floodway. It should be noted that the physical model will be demolished at some point in the future, so any opportunistic use of the model should be arranged within the near future.

7.3.6 Emergency Management

Em.1 Update and implement as required the SES Flood Emergency Plan for Newcastle / Lower Hunter to include flash, river and ocean flood risks and issues

The SES is currently reviewing its Newcastle Flood Emergency Plan and is expected to have that completed by late 2012, early 2013. While this will occur independently of this City-wide Flood Plan, it is important that the SES Plan incorporates all relevant technical data and specific community vulnerabilities (including addresses of areas at highest risk) that have been determined through the Floodplain Risk Management process. Provision of this data is particularly important with regard to those parts of the City that need to evacuate ahead of ocean or river flooding cutting off their evacuation routes. This action needs to be undertaken immediately (in 2012) to meet the SES Plan update timetable.

7.3.7 Continue Existing Initiatives

Ex.1 Continue existing development controls for PMF refuge and structural stability needs

The current Newcastle Flood DCP requires that on-site flood refuge is required where there is a present risk to life (i.e. L4 or higher, unless the property is within 40 metres of the edge of the PMF extent and higher ground is accessible). This refuge is required above the PMF level and needs to accommodate all people reasonably expected to be on the property at any time. Importantly, the DCP requires that the on-site refuge be certified by a practising structural engineer that the building is able to withstand the hydraulic loading due to flooding (at the PMF). As discussed previously, high flood levels can cause substantial hydrostatic pressure on buildings causing collapse. This can be relieved through flood vents or similar.

It is recommended that these existing controls be continued, but closer attention be given to the structural certification process to ensure that adequate consideration has been made for hydrostatic loading, as well as potential impact loading from debris (e.g. floating cars) during flood events. This would be especially the case for properties identified as requiring structural strengthening as presented in **Map Series 11** (refer accompanying ***Compendium of Maps***).

Ex.2 Reinforce controls on building footprints in floodways and flood storages

Controls are currently in place that limit development within floodways and flood storage areas, as defined in flood information certificates obtainable from CofN. The controls state that no building or structure is to be erected and no land is to be filled within any floodways (with some exceptions).

This extends to fencing, which requires fences that cross floodways are to be constructed of open type fencing materials only (or preferably no fencing altogether). Meanwhile, for flood storage area, the controls state that not more than 20% of a flood storage area can be filled.

Clarification is required on the delineation and application of both these controls, which will require further assessment and investigative modelling. Importantly, controls based on PMF conditions target management of Risks to Life, while controls based on 1% AEP conditions target management of Risks to Property.

Clarification is also required where development permits flooding within the building footprint, such as undercover parking, or where a development is raised on columns over the floodplain. Finally, storage should be considered in terms of volume rather than area.

Improvement in the resolution of the current flood modelling would help with better definition of 1% AEP and PMF floodways, flood storages and flood fringes. It is considered that as part of the investigative modelling, the current models are upgraded with finer grid cell resolution (say less than 4 metres, which would allow for better definition of road carriageways and even capture differences in levels between roads and verges). This would reduce the reliance on qualitative interpretation of modelling results to define the floodways, flood storages and fringes.

Ex.3 Continue maintenance of constructed stormwater system to meet design capacities

Channel maintenance is an activity that is already taking place (CofN and HWC spend an estimated $3 million per year on stormwater maintenance). This Plan recommends that CofN and HWC review the frequency of their current maintenance programs and increase this where it can be demonstrated that it would be beneficial in regards to flooding. It is recognised, however, that both organisations will need to fund any additional maintenance activities from existing operational budgets.

7.4 Follow-on and Future Works

7.4.1 Next Steps

Subject to available funding, the First 5 Years should result in the completion of a number of strategies and preliminary investigations to support on-going works. Following completion of the initial package of works nominated for the First 5 Years, the next steps would involve continuation of on-going strategies, particularly those that need to be advanced to design and/or construction stage, as well as commencement of the 'next best' actions identified in the initial rapid analysis (refer Section 7.2). These next steps should include the initiative and works outlined in Table 7-6.

Table 7-6 Next Steps After the First 5 Years

	Recommended Next Step Actions / Strategies
Education Initiatives	
Ed.1	Review effectiveness of community education program to date. If warranted, continue program, possibly in an amended format, subject to the availability of on-going funding

	Recommended Next Step Actions / Strategies
Flood Predictions and Warning	
Wa.2	Continue with operation of complete Flood Warning System for Newcastle
Wa.3	Continue with operation and maintenance of passive and active road signage
Planning Controls	
Pl.2	Continue to encourage redevelopment and renovations with more flood resilient materials and design
Pl.3	Continue with assessments and investigations associated with developing a long-term Planning Strategy for the low-lying suburbs of Newcastle. As appropriate, start to introduce planning reforms to take account of associated no-regrets actions.
Pl.4	Continue with strategic planning review, and as appropriate, change LEP and DCP to reflect outcomes from the review in line with CofN's standard approach to planning changes (including community consultation).
Governance Initiatives	
Go.1	Continue to provide advisory and certification scheme for "flash flood free" refuge
Property Works	
Pr.1	Continue with provision of elevated flood-free refuge, in combination with flood vents where required to minimise pressure loading on buildings (1,500 required in total across Newcastle to fully meet needs – all remaining properties not provided in First 5 Years to be done)
Pr.3	Continue to pursue voluntary purchase of properties within Morgan – Selwyn floodway, Merewether, subject to outcomes of computer and/or physical modelling (undertaken in First 5 Years) and on-going availability of funding
Pr.4	Investigate voluntary purchase of all existing residential properties in hazardous Hunter River floodways, and pursue if determined to be appropriate, subject to availability of funding
Pr.5	Investigate voluntary purchase of any properties that become substantially structurally damaged by flooding, subject to availability of funding
Pr.6	Investigate house raising for properties affected by frequent flash flooding, and pursue if determined to be appropriate
Pr.7	Investigate house raising for properties on Sandgate Road Birmingham Gardens, affected by frequent river flooding, and pursue if determined to be appropriate. These properties (likely to be just 1 property) would also be captured by the need for house raising under flash flood conditions, refer *Strategy Pr.6*
Emergency Management	
Em.1	Continue to implement as required the SES Flood Emergency Plan for Newcastle / Lower Hunter
Structural and Physical Works	
St.1	Prepare feasibility assessments, detailed designs, costs and benefits of larger culverts and compensating detention basins in upper reaches of Elermore Vale / Rankin Park and construct works (provided assessments support such works).
St.2	Prepare feasibility assessments, detailed designs, costs and benefits for augmentation works for existing stormwater system, in concert with investigations for long term resolution of low-lying suburbs (Strategy Pl.3), and any interim measures for improving adaptive capacity
St.3	Prepare feasibility assessments, detailed designs, costs and benefits of levee construction works, in concert with investigations for long term resolution of low-lying suburbs (Strategy Pl.3), and if considered feasible and cost effective, implement works when appropriate

	Recommended Next Step Actions / Strategies
	trigger is reached (e.g. when measured sea level rise has reached *x* cm).
St.4	Investigate opening up the flowpath at Irving Street, Wallsend. If investigations show that there is merit in undertaking works, then secure property easements and construct the necessary works. Give consideration to voluntary purchase as a possible alternative.
Continue Existing Initiatives	
Ex.4	Refine the existing flood models to provide more accurate flood maps, to test the validity of structural options and to give a better appreciation of flood behaviour, including calibration to 2007 flash flood event. Model refinement is to be directed by the pending release of the updated AR&R, including appropriate provisions for refined rainfall statistics, channel/culvert blockage, sea level rise interactions and coincident events.

The Next Steps involve consideration and investigation of possible voluntary acquisition and/or voluntary house raising schemes for parts of Newcastle. In managing risk to life, it is important that people do not seek refuge within building that would be prone to damage or collapse during extreme events. The only way of ensuring that this does not happen is to remove these buildings or to structurally reinforce them to withstand the forces of extreme flooding. This could include house-raising (for suitable structures), providing that the elevated structure can provide flood-free refuge and can remain stable under extreme flood conditions. **Maps 11A to 11K** (see **Map Series 11** in the accompanying ***Compendium of Maps***) highlight those properties that require further investigation in terms of managing Risks to Life.

Ideally a voluntary purchase and/or house raising scheme should not commence until rezoning has taken place and it is known whether there will be a funding mechanism through developer contributions to remove some buildings from floodways and other high hazard areas. The scheme then only needs to focus on the residual properties. Investigations should commence with confirming which properties would be offered voluntary purchase or house raising, through more detailed hydraulic analysis. Given the high costs associated with both purchase and house raising, and the limited State Government funding (to date), it is expected that the scheme would take many years or decades to implement fully. Also, being voluntary schemes there is the need for the co-operation of property owners, which may further delay implementation and completion of the schemes.

7.4.2 Other Works (Longer Term Initiatives)

Any recommended actions from Chapter 6 that are not included in the First 5 Years package, or the next steps as outlined above should still be pursued under the guise of this City-wide Flood Plan, but primarily as longer term initiatives. Some of these actions have more marginal benefit cost outcomes either through possible difficulties in implementation, uncertainty in community acceptance, or excessively high costs and resource demands. These other works would include:

- Investigate lowering Corona St / National Pk St intersection, Hamilton East, and design and construct if determined to be worthwhile and appropriate;
- Investigate voluntary purchase of any properties that become substantially damaged by flooding, subject to availability of funding;
- Investigate raising of the Pacific Highway if voluntary purchase of residential properties in Hexham has been unsuccessful, in combination with rezoning (down-zoning) of hazardous

floodways along Hunter River to prevent any further development in this area, and adopt if determined to be appropriate;

- Significantly improved predictions of flash flooding (using integrated modelling and interpretive radar mapping: “nowcasting”);
- Significantly improved predictions of ocean flooding through integrated barometric forecasting and tidal predictions;
- Investigate revising FPLs to cater for blockages, and adopt if determined to be appropriate; and
- Investigate revising FPLs, triggered when climate change impacts start to manifest.

7.5 Integrating with Current Strategic Planning

Irrespective of the desirable order of implementation (First 5 Years or thereafter) discussed above, all actions should be pursued when a suitable opportunity arises.

CofN’s Urban Planning Team is currently in the process of preparing a Local Planning Strategy for Newcastle. Simultaneously, the Department of Planning and Infrastructure (DoPI) are reviewing the Lower Hunter Regional Strategy 2006-2031, which includes the Newcastle LGA. Depending upon the recommendations of these two strategic documents, once finalised, amendments to land use zones, permitted uses and more may result.

Further investigations of planning controls are necessary, as outlined in the recommendations of this Study and Plan. Should changes to planning controls be supported by CofN and the community, they may be reflected in the Local Planning Strategy which then may inform the Local Environmental Plan for Newcastle (2012) and DCP (2011) once operational.

Any future change in zoning of floodprone land should take consideration of the fact that different landuse types require different flood immunity. For example, critical infrastructure and sensitive uses (such as SES HQ, hospitals, nursing homes, telecommunication centres, power substations, and intended evacuation centres) should not be permitted within areas that can be compromised by any level of flooding (i.e. above PMF extents), whereas commercial and industrial landuses may be able to tolerate a higher degree of disruption damage (on a very occasional basis).

Consideration should also be given to the expected longevity of future development within low-lying suburbs (Maryville, Wickham, Carrington, and part of Islington and Stockton), given projections for sea level rise, which may require a rethink of certain planning horizons. Under these circumstances, time-dependent or trigger-dependent zonings (e.g. having sunset clauses on particular types of development) may be prudent.

It is recognised that much of the current computer modelling is at a resolution that does not allow for assessment of individual properties. Should decisions be required on finer-scale rezoning of land parcels, then refinement of the existing set of models is required. This can be done by simply nesting finer sub-models within the existing models, or increasing the overall grid cell size (noting that there has been a significant improvement in the computing speeds since some of the numerical flood models were first constructed).

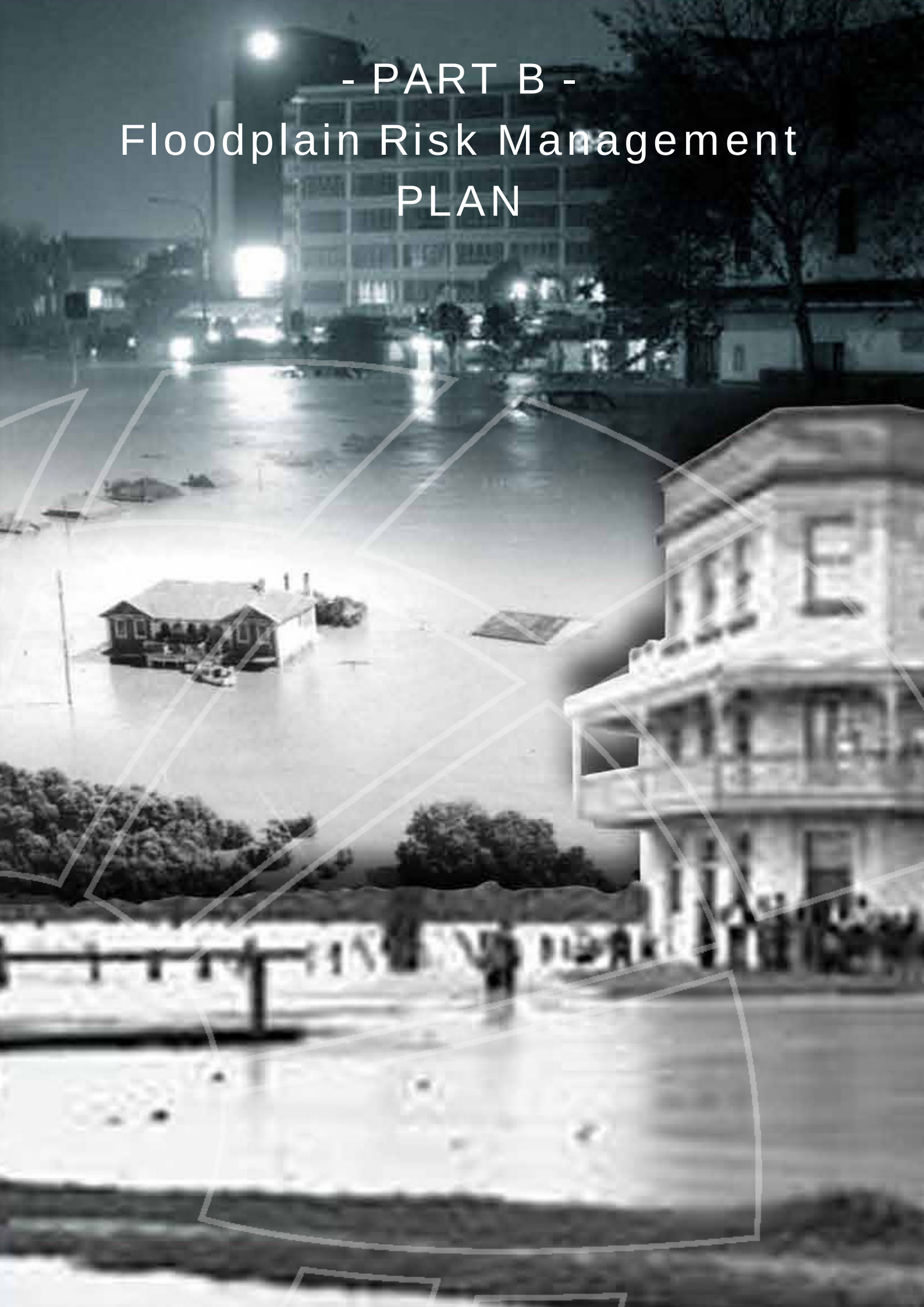
7.6 Integrating with Adopted Wallsend Commercial Centre Flood Plan

The flood behaviour analysis (Chapter 3) and risk to life and property analysis (Chapter 5) highlights the very severe risks posed within the Wallsend Commercial Centre. Within this area, historic development has essentially been located within the middle of the natural, already constrained, flowpath. It is unsurprising therefore that the risks are most acute for this development. Based on this, CofN has been justified in pursuing and accelerating the Wallsend Commercial Centre Flood Plan independent of the City-wide Flood Plan.

As outlined previously, this City-wide Floodplain Risk Management Plan does not include the Wallsend Commercial Centre, as this area has its own adopted Floodplain Risk Management Plan (2009) that should continue to be implemented in parallel with this Plan. The exception to this is the refinement of mapping of flood categories through the Wallsend Commercial Centre, as presented in this Plan, as well as consideration of Wallsend Commercial Centre as part of a proposed Strategic Planning Review.

Implementation of the City-wide Plan should not prejudice the ability to implement the Wallsend Commercial Centre Flood Plan and vica versa. Funding for both Plans will largely be drawn from the same sources (grant programs, CofN contributions etc). CofN will require discretion when applying for grant funding as many funding sources involve competitive bidding and project analysis.

- PART B -
Floodplain Risk Management PLAN



8 IMPLEMENTATION ACTION PLAN

8.1 Introduction

This Implementation Action Plan covers the First 5 Years "package" of actions identified and discussed in Chapter 7, and presented as an integrated framework of actions in Figure 8-1. The totality of the Floodplain Management Plan, however, also includes the complete suite of management actions identified as necessary to fill the gaps considered as not fulfilling the principles of the Manual (as discussed previously in Chapter 7 and outlined further in Chapter 9). Charged with this information, the community and Governments can then make informed decisions in the future on whether or not to accelerate or defer, or even not implement, noting:

- The short term works and actions have been chosen to give maximum priority benefit while also being readily implementable within envisaged affordable budgets. Implementation is still, however, subject to this albeit limited funding - customarily allocated year by year; and

- The longer term initiatives are still needed - to address the assessed gaps and deficiencies of current management. The definition of these longer term initiatives is subject to future review before the short term works and actions are completed. Implementation of reviewed longer term flood management initiates for the Newcastle LGA would be subject to available future funding. It is important that these longer term initiatives are not excluded from Plan, since future communities and Governments will then have opportunity to decide what level of funding is appropriate for ongoing implementation – either accelerated or deferred. These decisions would be made balancing whole of community and Government priorities against practical resourcing, spread across other needs such as health, education, transport and social. Current legislation allows these necessary compromises and protects Governments when they make these decisions.

Whilst this Implementation Action Plan covers only those strategies and actions included in the First 5 Years Package of works, it does not preclude CofN or any other authority or stakeholder from pursuing and actioning other strategies or initiatives flagged within the complete suite of management actions (as discussed in Chapter 7) if an appropriate opportunity arises. This would include, for example, opportunistic house raising or voluntary purchase, if relevant funding was to become available. Acceleration of such actions may be warranted if properties initially flagged for house raising (e.g. refer Figure 6-9) or voluntary purchase (e.g. refer Figure 6-8 and existing Hexham residential area) were to lodge Development Applications or come up for sale.

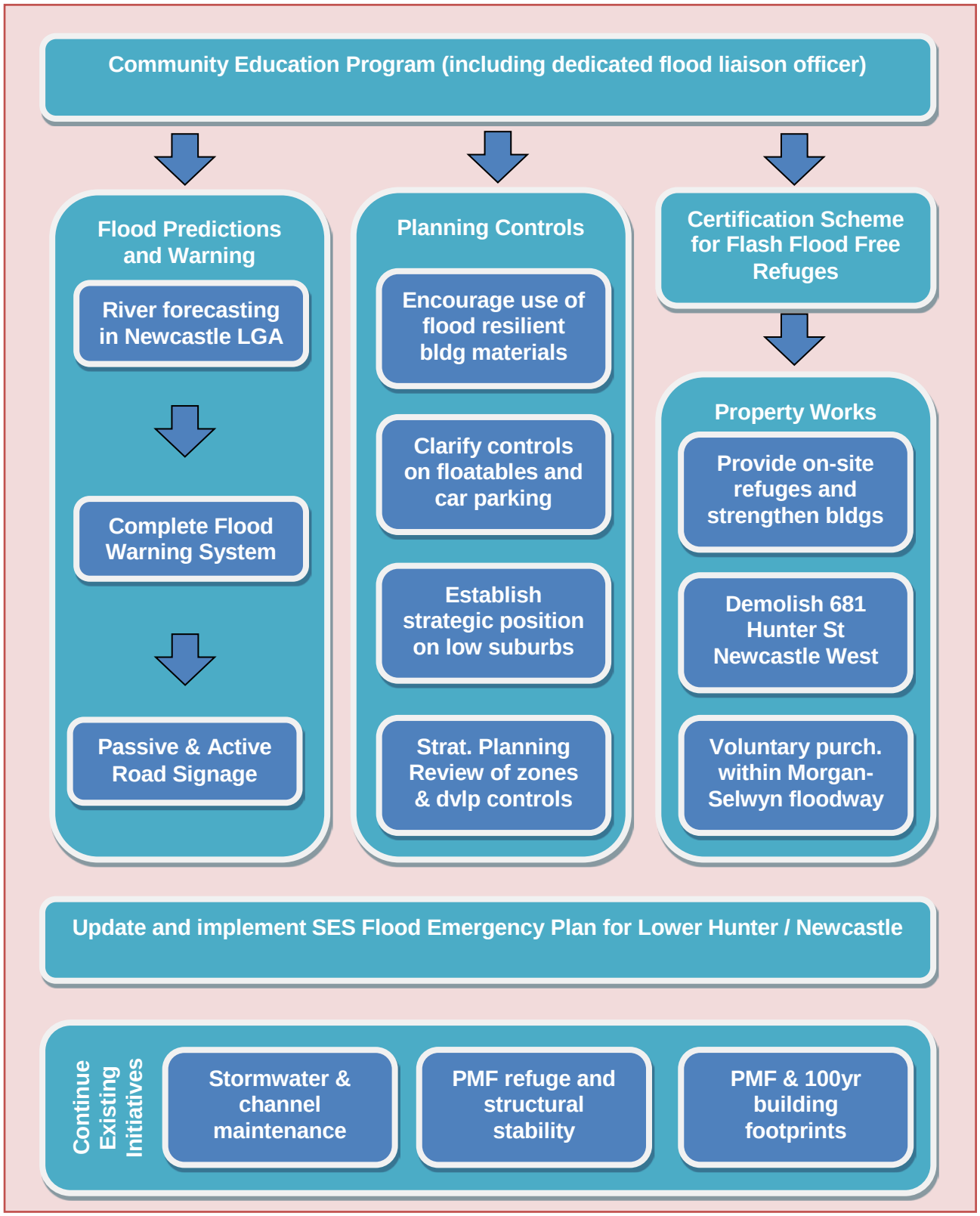


Figure 8-1 Integrated Framework: First 5 Years Flood Management Strategy

8.2 Rationale for Flood Management

The overall rationale for flood management, and the basis of this Floodplain Risk Management Plan, is to mitigate the risks to life and risks to property. Within the continuum of total potential flood risk, the objective therefore becomes managing as much of the risk as possible, so that the residual amount unmanaged risk is minimal (refer Figure 8-2).

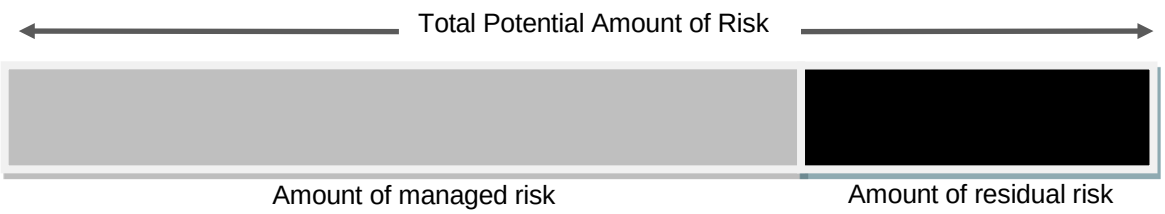


Figure 8-2 Continuum of Managed and Unmanaged Flood Risk

Outlined below is an assessment of how effective this Floodplain Risk Management Plan will be in addressing and mitigating risks to life and risks to property. Reductions in risks to life are calculated on the basis of the population exposed to flooding risks, while reductions in risks to property are calculated on the basis of average annual damages. Calculations and assumptions supporting the numbers presented below are provided in Appendix D.

8.2.1 Risks to Life

Risk to Life can be measured by the size of the total population that is directly threatened by a flood hazard. Within the City of Newcastle, the total population that resides within the floodplain is approximately 58,000. In addition, depending on the time of day, there is expected to be a sizable population that is in transit across the floodplain. Some of these people in transit would also be residents, but a lot would also reside in non-floodplain areas. Also, there are a number of commercial, industrial and business properties located within the floodplain. As for the people on the road, there would be a mix of floodplain residents and non-residents that make up the population of these non-residential properties (noting that the floodplains contain major shopping centres, such as Stockland Jesmond, Wallsend Plaza, Marketown and the Homemakers Centre within Kotara, as well as sections of the Newcastle CBD and other various suburban business districts). Given the above conditions, the total potential risk to life in Newcastle can therefore range between about 60,000 and 100,000 people. For the purposes of this assessment, the total potential risk to life is therefore estimated at approximately 80,000.

Risks to life are managed through various means under existing flood management arrangements. This includes facilitating evacuation through flood warnings and emergency response plans (especially in response to river and ocean flooding), and by having on-site refuge that will remain safe for all floods (including all properties that will have flooding less than 1 metre above floor level at the PMF). It is estimated that some 65,000 people would be adequately managed during all flood events through either evacuation or refuge. Current residual risk to life is therefore 15,000 (refer Figure 8-3).

Subject to available funding, this Floodplain Risk Management Plan proposes the implementation of various measures that, once completed, will mitigate some of the risk to life, and hopefully reduce the residual risk level. The Plan is separated into an initial First 5 Years Package, and then other works and initiatives that should also be pursued once the First 5 Years Package has been actioned. Based on the type and scale of measures proposed in the First 5 Years Package, it is estimated that the number of people managed for risk to life would increase to 72,000 (refer Figure 8-3).

The total package of actions and initiative proposed as part of this City-wide Flood Plan go well beyond that recommended in the First 5 Years package. It is recognised that implementation of the Plan in totality will take many years to decades, as there are a number of property and land management matters that need to be resolved. Once completed, however, the whole Floodplain Risk Management Plan will theoretically increase the number of people effectively managed for risk to life to 77,000, leaving the residual (unmanaged) proportion of the population to less than 4% - these being primarily located on vulnerable roads at the time of the event (refer Figure 8-3).

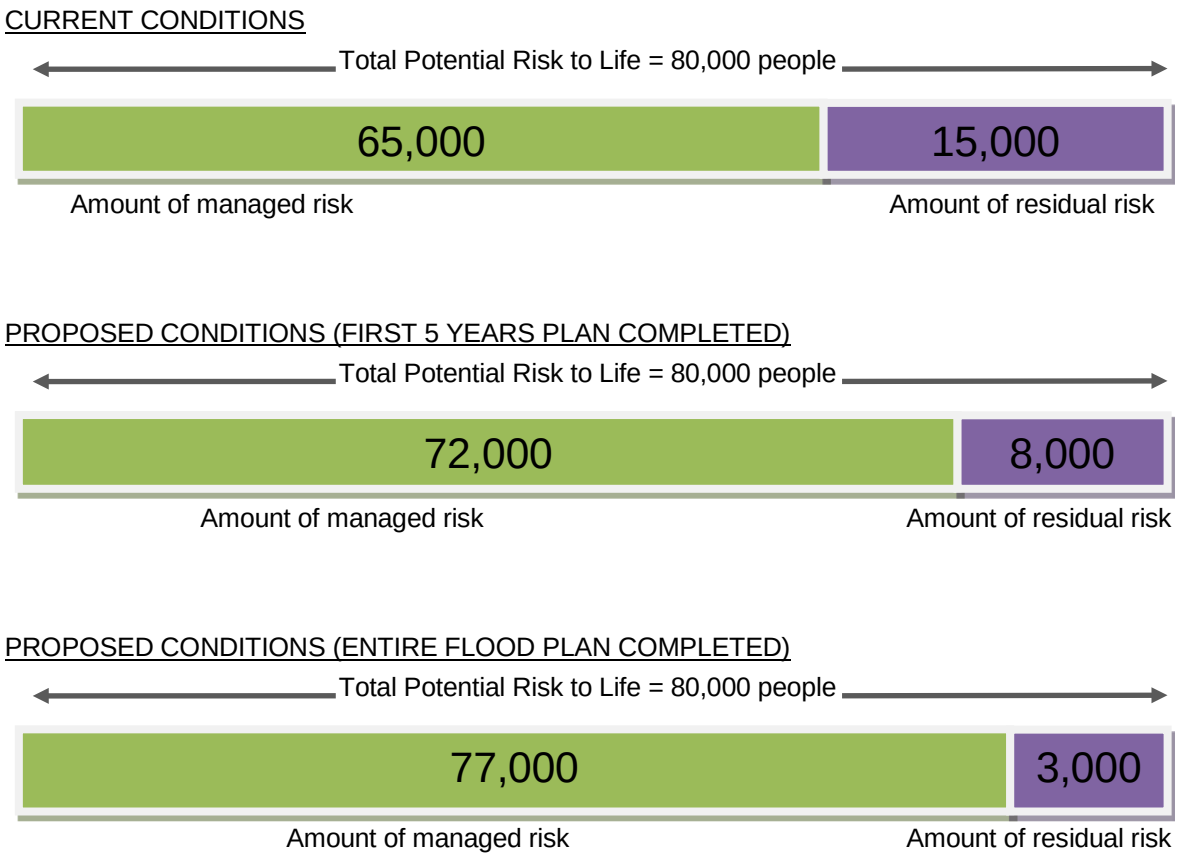


Figure 8-3 Continuum of Risk to Life, Reported as Direct Population at Risk

8.2.2 Risks to Property

The Risks to Property can be measured across the City of Newcastle, essentially as a monetary value of potential flood damages (measured as average annual damage when taking into account the probability of flooding of different levels).

In a similar fashion to Risks to Life, the potential improvement in Risks to Property as a result of implementation of this Floodplain Management Plan (both in terms of the First 5 Years Plan and the entire Flood Plan) can be quantified.

The total potential risk to property in Newcastle is $52 million (average annualised cost). Note that this number is based on the same assumptions as given for Table 5-4, and therefore is expected to be an under-estimate in terms of accounting for industrial and commercial losses. This number also provides for vehicle damage estimates (AAD vehicles = $3m), which is in addition to the property damage figures reported in Table 5-4. The total potential risk to property assumes that all land is developed and all property is constructed at ground level. Current flood management precludes development in some areas, while also requiring minimum level floor heights in order to limit damages. Therefore, based on current flood management practices, it is estimated that the actual (residual) annual average flood damage bill would be $24 million (refer Figure 8-4).

Subject to available funding, full implementation of the First 5 Years Plan will reduce the residual flood damages to $22 million (notably through a reduction in the damage to vehicles), while full implementation of the entire Floodplain Risk Management Plan would lead to potential flood damages of just $18 million (the biggest saving coming from a reduction in potential ocean flooding damage), or about 1/3 of the total potential (refer Figure 8-4).

Comparison of the Risk to Property results to the Risk to Life results highlights that the legacy of past flood development yields a significant on-going cost to the Newcastle community, which cannot be easily mitigated through Floodplain Risk Management Plans like this without significant financial investment (even though there may be significant cost savings in damages to justify the expenditure). The reality is that all levels of government are not keen to outlay such significant capital when trying to be financially responsible for multiple community portfolios. In the absence of more pro-active measures to address existing risk to properties, development controls are considered appropriate for progressively lowering exposure of property to flood hazards. It is nonetheless recognised that property will always be subject to flooding risks beyond FPLs, although the lower probability of these events should not weigh significantly on the average annual damage bill.

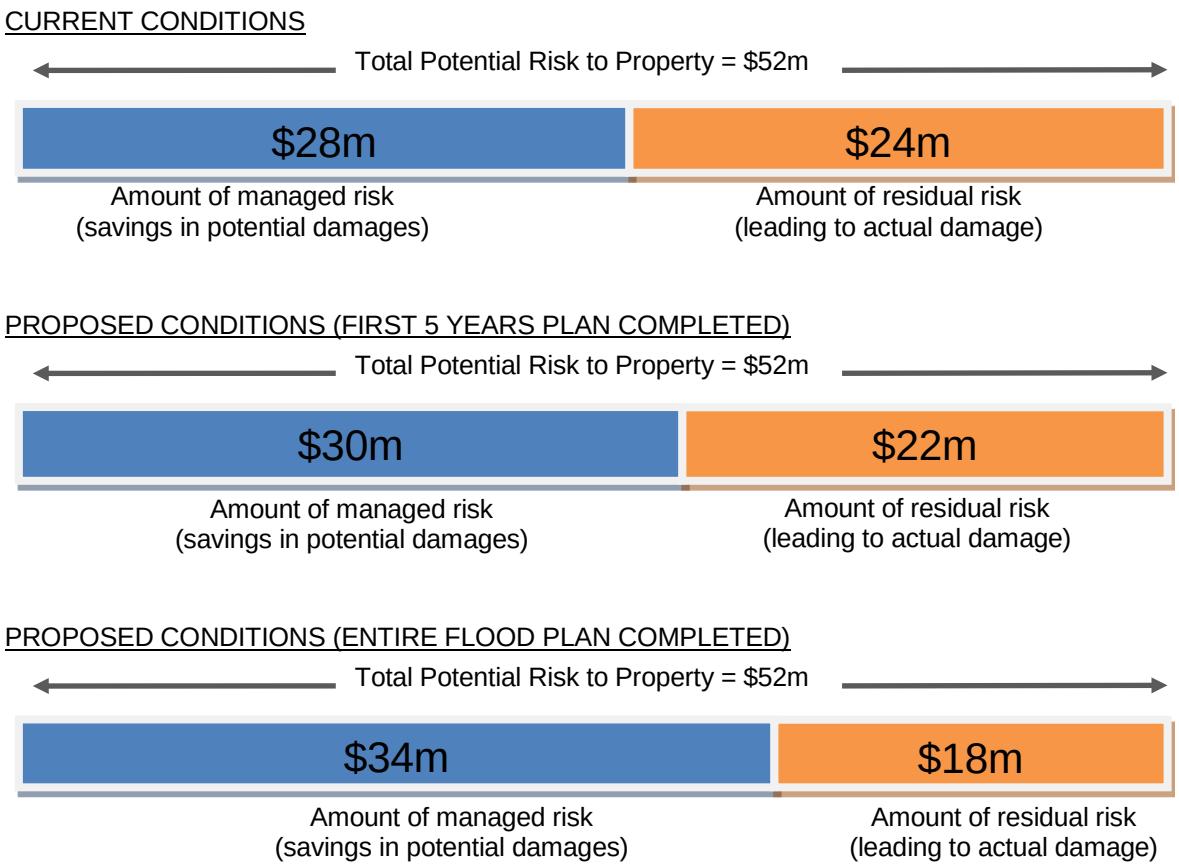


Figure 8-4 Continuum of Risk to Property, Reported as Average Annual Damages

8.3 Implementation Schedule for First 5 Years Package

Table 8-1, which is presented over the following pages, give an 'Implementation Schedule' for the works and initiatives covered under the First 5 Years Package. The schedule provides specific details on what actions need to be undertaken and responsibilities for undertaking the works. Also provided are estimates of cost, as well as a performance measures for determining the success of the works outcomes. A priority scale is also given for the actions. As the total costs of the Package are still high, and only questionably affordable through normal funding avenues without significant preparation and lobbying, the relative prioritisation allows CofN and other authorities to focus initial efforts on those actions that can be achieved easily or are likely to have the best value outcomes in terms of managing risks to life (as a top priority) and risks to property.

Table 8-1 Implementation Schedule for First 5 years Works Package

Ref	Strategy and Specific Actions	Priority	Responsibilities (and relevant department)	Indicative Costs and Potential Funding Source	Performance Measure	Further Details
Education Initiatives						
Ed.1	*Undertake community education, facilitated through a flood liaison officer*					
	a. Prepare a Community Education Program to support and integrate with other Flood Plan initiatives (e.g. Flood Warning System, road signage, refuges etc) and other flood education strategies (e.g. HCRCMA, SES education strategies), to improve preparedness for flooding. Program to be both general and locally-targeted.	1	CofN: *City Engagement and Future City*, SES, HCRCMA, OEH (program possibly developed through an external consultancy)	$100,000 (CofN, State Flood Prog.)	Documented Program of community education works	Refer Section 7.3.1
	b. Recruit a dedicated flood liaison officer to work with existing flood education officers of SES and HCRCMA to implement the Community Education Program, with in-kind assistance and volunteers from agencies as required	2	CofN: *City Engagement*	$100,000 per year (CofN general revenue, special rates/levies, State Flood Prog.)	Officer recruited	
	c. Prepare and deliver a range of resources, materials and community events to support and implement the community education program, including education regarding implementation of a complete Flood Warning System (refer Strategy *Wa.2*)	2	CofN: *City Engagement*, SES, HCRCMA, OEH	$250,000 per year (CofN general revenue, special rates/levies, State Flood Prog.)	Regular reporting to CofN and the Floodplain Management Working Party	
	d. Review the on-going education requirements to maintain community preparedness, and adjust and implement the Program accordingly	3	CofN: *City Engagement*, SES, HCRCMA, OEH	Staff time only	Report to CofN on any changes to Program	
Flood Prediction & Warning						
Wa.1	*Provide river flood forecasting for location(s) in Newcastle LGA*					
	a. Using the existing Hunter River flood model, determine relationship between flood levels at upstream gauges and suitable locations in the Newcastle LGA, taking into account potential variability of tides and storm surge impacts	3	BoM CofN: *Future City*	$50,000 (BoM, CofN, Flood Warning Consultative Committee)	Report outlining the flood forecasting relationship for location in Newcastle LGA	Refer Section 7.3.2

Ref	Strategy and Specific Actions	Priority	Responsibilities (and relevant department)	Indicative Costs and Potential Funding Source	Performance Measure	Further Details
	b. Based on the relationship determined above, provide and broadcast flood forecasting information at one or more suitable locations in the Newcastle LGA in combination with forecasting for other locations along the river.	3	BoM	Staff time only	Flood forecasts of the Hunter River to include predictions for location in Newcastle LGA	
Wa.2	*Develop and operate a complete Flood Warning System for Newcastle (covering Flash, River and Ocean Flooding), including effective broadcasting of warnings and relevant information through multi media and social media channels*					
	a. Establish a steering group comprising representatives from BoM, SES, CofN, OEH and HWC to oversee the development of the complete Flood Warning System for Newcastle. Steering group to agree on charter and responsibilities for development and on-going implementation of the Warning System.	1	CofN: *Future City* BoM SES OEH HWC	Staff time only	Steering Group established and responsibilities and charter agreed	Refer Section 7.3.2, BMTWBM (2008)
	b. Review and update the existing Flash Flood Warning System Overview report (BMT WBM, 2008) including expansion to cover river and ocean flood predications to determine a scope of works for development of the complete Flood Warning System, and integration with other elements of this Flood Plan being implemented.	1	Flood Warning System Steering Group	$50,000 (contributions from steering group members)	A scope of works to develop the complete Flood Warning System	
	c. Design and install additional instrumentation, hardware and software required to develop complete Flood Warning System, including broadcasting avenues (multi-media, social media, SMS, email, 'Emergency Alert' automessaging)	2	Flood Warning System Steering Group	$300,000 (contributions from steering group members + State Flood Prog.)	A fully functional and integrated complete Flood Warning System	
	d. Operate and maintain Flood Warning System in accordance with design, including mechanisms for broadcasting warning, and link with other Strategies, including the Community Education Program (*Ed.1*), Active Road Signage (*Wa.3*) and updates to the SES Flood Evacuation Plan (*Em.1*)	3	Responsibilities as agreed through Steering Group	$25,000 per year additional to costs for other strategies (contributions from authorities responsible)	Periodic operations and maintenance reporting	

Ref	Strategy and Specific Actions	Priority	Responsibilities (and relevant department)	Indicative Costs and Potential Funding Source	Performance Measure	Further Details
Wa.3	*Install passive and active road signage to relay warnings, advise of flooded roads, and provide other emergency information*					
	a. In consultation with the SES and RTA, and giving consideration to Evacuation and Emergency Management Access requirements and road use density, identify priority locations for installation of passive and active road signage. Arterial roads should be an obvious high priority as these would be key evacuation routes and would likely be used for emergency response.	1	CofN: *Future City* RTA SES Flood Warning Steering Group	Staff time only or included as part of Flood Warning System design	List of locations for installation of passive and active signage	Refer Section 7.3.2, Map Series 7, BMTWBM (2008)
	b. Existing RTA overhead electronic boards to be used to provide pre-programmed flood warnings and advise motorists of local nearby road closures, based on instructions provided to Transport Management Centre	2	SES RTA (Transport Management Centre)	Staff time only as agreed as part of Flood Warning System design	Successful operation of existing electronic road signs	
	c. Install passive markers and signage to raise flood awareness and indicate depths of floodwaters. Signage to include instructions not to enter floodwaters irrespective of depths.	2	CofN: *Future City*	$100,000 (CofN, State Flood Prog., other grant programs)	Passive signage installed	
	d. Install customised electronic flood signs (similar to flashing school zone signs) on local roads based on inundation of sensor within waterway or culvert	2	CofN: *Future City*	$250,000 (CofN, State Flood Prog., other grant programs)	Number of local electronic flood signs installed	
	e. Install additional large overhead electronic boards / road signs at select key locations around Newcastle. Target 3 new signs installed within First 5 Years. RTA able to use signs during non-flood time to provide information on road conditions, upcoming events etc.	3	CofN: *Future City* RTA	$900,000 (CofN, RTA contributions, State Flood Prog.)	Active signage installed. Target 3 signs within First 5 Years.	
	f. Operate new electronic signs as per Flood Warning System requirements (see Action b above)	3	SES RTA (Traffic Management Centre) As agreed as part of Flood Warning System	Staff time only as agreed as part of Flood Warning System design	Successful operation of new electronic road signs	

Ref	Strategy and Specific Actions	Priority	Responsibilities (and relevant department)	Indicative Costs and Potential Funding Source	Performance Measure	Further Details
Planning Controls						
Pl.1	*In concert with existing planning reviews, clarify and implement controls on floatables and car-parking in floodways and/or hazardous areas*					
	a. Identify all items used during the construction or on-going operation of developments that can potentially become buoyant by floodwaters and are large enough to cause blockage of stormwater culverts (e.g. containers, vehicles)	1	CofN: *Future City*	Staff time only	List of items that require special attention in the DCP	Refer Section 7.3.3
	b. Change DCP, if required, to impose conditions of consent or to restrict the use of all items identified in a) above, within floodways and other hazardous areas (H4 and above) to ensure that such items cannot enter flood channels and cause blockage. Consideration should be given to conditions within river and ocean flooding as well as flash flooding.	1	CofN: *Future City*	Staff time only	Change to adopted DCP	
	c. Change DCP, if required, to prohibit on-grade carparking within floodways, or within 10 metres of an open stormwater channel, applicable for carparks of more than 2 vehicles.	1	CofN: *Future City*	Staff time only	Change to adopted DCP	
Pl.2	*Encourage redevelopment and renovations with more flood resilient materials and design*					
	a. Identify list of building materials, products and applications that are more flood resilient (i.e. can withstand occasional inundation for short periods of time)	1	CofN: *Future City*	Staff time only	List of flood resilient building items	Refer Section 7.3.3
	b. Prepare a list of local suppliers, if considered appropriate, who can provide flood resilient building materials and products	1	CofN: *Future City*	Staff time only	List of suppliers	
	c. Provide information on using flood-resilient building materials to all potential DA applicants, as well as making available to general public. Integrate with broader community education program (Strategy *Ed.1*).	1	CofN: *Future City* *CofN: Flood liaison officer*	$10,000 for development of information pack.	Information packs provided	
	d. Keep a watching brief on future changes to the Building Codes relating to building within floodplains, and update building requirements for DA as required	1	CofN: *Future City*	Staff time only	Update of DA requirements	

Ref	Strategy and Specific Actions	Priority	Responsibilities (and relevant department)	Indicative Costs and Potential Funding Source	Performance Measure	Further Details
Pl.3	*As a first step towards possible strategic landuse changes, undertake appropriate investigations to develop a Strategic Position that will decide the future management of ow-lying areas / suburbs in the long-term (within a 50 yr horizon)*					
	a. Assess existing Climate Change Adaptation Studies (local and national) to help scope the relevant issues and identify potential investigation needs and future options.	1	CofN: *Future City*	Staff time only	Clear scope of assessments required to investigate and consider future options	Refer Section 7.3.3
	b. Use the Newcastle low-lying suburbs as a case study for Climate Change Adaptation Decision Support System being developed by HCCREMS	1	CofN: *Future City, HCCREMS*	Staff time only	Newcastle low-lying suburbs used as case-study	
	c. Introduce a moratorium on subdivisions, consolidations and spot rezonings within the low-lying suburbs until such time that a long-term strategic position is established and can be supported by more extensive planning reform.	1	CofN: *Future City*	Staff time only	Moratorium or relevant developments imposed	
	d. Undertake preliminary engineering, social, economic, planning and other investigations, as appropriate, to consider the validity and merits of long-term options for the low-lying suburbs, under a range of climate change / sea level rise scenarios. Options should also be explored for short-medium term interim measures in order to "buy time" or increase the adaptive capacity of existing development.	2	CofN: *Future City*, OEH, DCCEE	$500,000 (CofN, State Flood Prog., State and Federal climate change programs)	Reports to CofN and other stakeholders on findings of investigations	
Pl.4	*Undertake a strategic planning review of all floodplain areas, with recommendations for changes to the LEP, DCP and other guiding policies and plans as appropriate*					
	a. Using the flood-risk classification of the floodplain based on mapping provided in this Floodplain Risk Management Study and Plan, evaluate the compatibility of existing landuse zonings and development controls as defined in the Newcastle LEP and DCP, to existing flood risks. In addition to direct flood impacts, the review should consider the ability of people to safely evacuate from high risk areas, or to take safe refuge.	1	CofN: *Future City* DoPI	Staff time only	Review of compatibility of existing zones and development controls to flood risks.	Refer Section 7.3.3

Ref	Strategy and Specific Actions	Priority	Responsibilities (and relevant department)	Indicative Costs and Potential Funding Source	Performance Measure	Further Details
	b. Assuming that there are incompatibilities in the existing zonings and development controls, formulate recommended changes to the existing planning provisions that will ensure new development is more flood-appropriate. This should include developing a hierarchy of development potential based on the floodplain classifications (including differentiation between 1% AEP and PMF floodways, flood storages and flood fringes, as well as the H1-H5, L1-L5, and P1-P5 categories already included in CofN's Flood Policy). This should also include possible development concessions for encouraging more flood compatible redevelopment.	1	CofN: *Future City* DoPI	Staff time only	New planning provisions developed	
	c. Incorporate changes associated with managing flood risks into the Local Planning Strategy as well as into other strategic planning documents (e.g. DoPI regional strategies) as appropriate	1	CofN: *Future City* DoPI	Staff time only	Local Planning Strategy includes flood changes	
	d. Following appropriate consultation with the community and other stakeholders, make appropriate flood-related changes to the LEP, DCP and other relevant policies and plans.	2	CofN: *Future City* DoPI	Staff time only	Changes to LEP, DCP and other documents made	
Governance Initiatives						
Go.1	*Provide an advisory and certification scheme for "flash flood free" refuge*					
	a. Research other similar schemes internationally, investigate the suitability of the scheme for Newcastle, and if considered appropriate, establish the overall architecture of a management and/or certification scheme addressing the fundamentals purpose of the scheme, followed by detailed scheme design, including notifications, renewals and advice for participation.	1	CofN: *Future City* SES (scheme possibly developed through an external consultancy)	Staff time only	Agreed and documented scheme details and design	Refer Section 7.3.4
	b. Provide notification of automatic certification to all landowners of properties located within the floodplain that are considered suitable for flood-free refuge. Estimated number of auto certifications is 11,000. Provide promotional	2	CofN: *Future City*	Staff time only + promotional materials ($10/property –	All automatic properties included in certification scheme	

Ref	Strategy and Specific Actions	Priority	Responsibilities (and relevant department)	Indicative Costs and Potential Funding Source	Performance Measure	Further Details
	materials (e.g. stickers, plaques etc) to certified properties.			included in on-going community education costs)		
	c. Provide notification of the scheme to other properties that are not automatically certified, with recommendations for landowners to undertake necessary works, on a voluntary basis.	2	CofN: *Future City*	Staff time + $10,000 for development of information pack.	Notifications and information packs sent to properties.	
	d. Promote the scheme, in combination with other community education initiatives under Strategy *Ed.1*.	2	CofN: *City Engagement*	Information pack as above	Promotion of scheme	
	e. Provide on-demand advice to landowners seeking to have properties certified under the scheme, and undertake assessment of properties that have been modified for certification. Provide certification to properties if adequate. Target is to have an additional 200 properties certified within the First 5 Years (refer *Strategy Pr.1*). Provide promotional materials (e.g. stickers, plaques etc) to certified properties.	2	CofN: *Future City*	Staff time only + promotional materials ($10/property – included in on-going community education costs)	Number of additional properties included in scheme	
	f. Change S149 certificate property information to include whether certification of flood-free refuge has been awarded	2	CofN: *Future City*	Staff time only	Change to S149 certificates	
	g. Periodically update SES with details of properties that have certified flood free refuges	2	CofN: *Future City*	Staff time only	Information provided to SES	
Property Works						
Pr.1	*Provide elevated flood-free refuge, in combination with flood vents where required to minimise pressure loading on buildings (1500 required in total across Newcastle to fully meet needs – aim for 200 over first 5 years)*					
	a. Confirm which houses need to provide elevated flood-free refuge (indicatively shown in ***Maps 11A to 11K*** in the accompanying ***Compendium of Maps***).	1	CofN: *Future City*	Staff time only	Affected properties confirmed	Refer Section 7.3.5
	b. Identify a list of preferred suppliers of approved products that can be used to provide flood-free refuge and ensure structural stability (e.g. flood vents).	1	CofN: *Future City*	Staff time only	List of suppliers	
	c. Contact the owners of affected houses (as determined through Action a) above), providing suitable information and	2	CofN: *Future City*	Staff time only	All relevant landowners	

Ref	Strategy and Specific Actions	Priority	Responsibilities (and relevant department)	Indicative Costs and Potential Funding Source	Performance Measure	Further Details
	advice on what is recommended and importantly why it should be done (whilst stating there is no legal requirement to comply and that it would be at owner's expense). This should be done after the certification scheme has been established (refer Strategy *Go.1*).				contacted	
	d. Provide advice to landowners, on an as-demand basis, to help them decide how best to provide safe refuge. Propose that works can be covered under exempt development, thus not requiring landowners to obtain formal development approval (except if structural works are required).	2	CofN: *Future City* CofN: *Liveable City*	Staff time only	Advice provided, as requested	
	e. Landowners to undertake property works necessary to provide safe flood-free refuge. Target for First 5 Years is to have 200 new refuges in place. Assume that none of these first 200 require additional structural measures (only 70 of the 1500 properties needing elevated refuge require structural measures to address hydrostatic pressure)	3	Landholders	$1,000 per property (assume no structural works required). Aim for 200 over First 5 Years. (landowner investment)	Number of refuges constructed	
	f. CofN to certify the safe flood-free refuge, as per Strategy *Go.1*.	3	CofN: *Liveable City*	Staff time only	All new refuges certified	
Pr.2	*Demolish 681 Hunter St building over Cottage Creek*					
	a. Fulfil any existing lease commitments of the building before taking vacant possession.	1	HWC	Staff time only	Vacant possession of building	Refer Section 7.3.5
	b. Obtain appropriate development approval before undertaking demolition works to remove building from overland flowpath.	2	*CofN in collaboration and in agreement with* HWC	$100,000	Building demolished	
Pr.3	*Investigate voluntary purchase of one or more properties within Morgan – Selwyn floodway, Merewether, and pursue if determined to be appropriate, subject to availability of funding*					
	a. With the assistance of computer and/or physical modelling (noting that a physical model has already been built by UNSW), investigate and prioritise the benefits of removing one or more existing houses from within the floodway between Morgan and Selwyn Streets, Merewether	1	CofN: *Future City* OEH	$50,000 (CofN, State Flood Prog.)	Vacant possession of building	Refer Section 7.3.5

Ref	Strategy and Specific Actions	Priority	Responsibilities (and relevant department)	Indicative Costs and Potential Funding Source	Performance Measure	Further Details
	b. Based on the outcomes of the modelling and subject to funding availability, purchase one or more properties at market rates. Note, outcomes of modelling should provide prioritisation of property purchases	2	CofN: *Future City* OEH	$800,000 per property, subject to market value, including legal and other expenses (CofN, State Flood Prog.)	Property purchased	
	c. Obtain appropriate approvals and demolish all buildings from purchased properties to open up flowpath. Note, construction of some velocity control measures may be required to protect downstream properties.	3	CofN: *Future City* OEH	$150,000 per property (CofN, State Flood Prog.)	Buildings removed from floodway flowpath	
Emergency Management						
Em.1	*Update and implement as required the SES Flood Emergency Plan for Newcastle / Lower Hunter to include flash, river and ocean flood risks and issues*					
	a. Provide SES will all relevant mapping and flood behaviour information (covering flash, river and ocean flooding) in order to feed into Flood Emergency Plan. Provide on-request advice and assistance to SES in interpreting flood information.	1	CofN: *Future City*	Staff time only	SES provided with all relevant information	Refer Section 7.3.6
	b. Update the SES Flood Emergency Plan, as necessary, to incorporate new information regarding flooding in Newcastle. Periodically update Plan to take into account the development of new flood refuges or other flood management works / initiatives achieved through the implementation of this Floodplain Risk Management Plan.	1	SES	Staff time only	Completed updated version of Flood Emergency Plan	
	c. Implement the SES Flood Emergency Plan, as needed, during flood emergencies in Newcastle. Review the success of the Plan following any emergencies, and adjust Plan as appropriate.	1	SES	Staff time only	Successful implementation of Plan during flood emergencies	

Ref	Strategy and Specific Actions	Priority	Responsibilities (and relevant department)	Indicative Costs and Potential Funding Source	Performance Measure	Further Details
Existing Initiatives						
Ex.1	*Continue existing development controls for PMF refuge and structural stability needs*					
	a. Pending appropriate clarification from DoPI and legal advice, consider obtaining formal exception to s117 directives for imposing controls on development beyond FPL, given the unique nature of risk to life in Newcastle beyond the FPL.	1	CofN: *Future City* DoPI	Staff time only	Authority for adopting exception from DoPI	Refer Section 7.3.1
	b. Amplify and reinforce requirements of the current Flood DCP for structural engineers to demonstrate how design meets PMF hydrostatic and dynamic (impact) loadings as part of construction certification.	1	CofN: *Future City*	Staff time only	Change to adopted DCP	
	c. Add clause to DCP that specifies, where on-site refuge may be required, this requirement only applies where over-floor flooding in a PMF exceeds 1 metre	1	CofN: *Future City*	Staff time only	Change to adopted DCP	
Ex.2	*Reinforce controls on building footprints in floodways and flood storages*					
	a. Undertake expert interpretation of existing flood modelling and other hydrologic assessments to further refine the delineation of floodways, flood storages and flood fringes.	1	CofN: *Future City,* with appropriate consultant engaged to provide expert interpretation	$50,000	Change to adopted mapping	Refer Section 7.3.1
	b. Undertake investigative scenario testing using existing flood modelling to refine requirements of current Flood DCP for flood storage 'volume' to optimise development potentials without undue impacts on risks to life and property.	2	CofN: *Future City,* with appropriate consultant engaged to provide modelling	$50,000	Change to adopted DCP	
Ex.3	*Continue maintenance of constructed stormwater system to meet design capacities*					
	a. With relevant asset owners, collaboratively review and prioritise the current stormwater maintenance programs and determine adequacy in terms of reducing exacerbation of flooding due to blockage, sediment build-up or vegetation.	1	CofN: *Liveable City* HWC	Staff time only	Report on adequacy of maintenance	Refer Section 7.3.1
	b. Modify the schedule, as required from step a) above, and continue maintenance of stormwater system, including	1	CofN: *Liveable City* HWC	Maintain existing spending. Est.	Regular maintenance	

Ref	Strategy and Specific Actions	Priority	Responsibilities (and relevant department)	Indicative Costs and Potential Funding Source	Performance Measure	Further Details
	responding to specific community requests, as appropriate.			$3.0m/yr (CofN and HWC contributions)	reporting	

8.4 Timeline and Costs for Implementation

A Gantt Chart describing the timeline for implementation of the First 5 Years strategies is provided in Table 8-2. Within this timeline, Priority 1 actions broadly cover Years 1 and 2, Priority 2 actions broadly cover Years 2, 3 and 4, and Priority 3 actions broadly cover Years 4 and 5. It is recognised that a number of the strategies have Priority 1, 2 and 3 actions, which need to be implemented in order to achieve the desired outcomes of the strategy.

Table 8-2 also provides estimates for the cost of implementation of the First 5 Years Package. The indicative total cost (excluding in-kind contributions from existing staff) of implementing the First 5 years is approximately **$4.7 million** (excluding continuation of existing maintenance costs).

Subject to negotiation and available funding, financing of the implementation of the First 5 Years Package is expected to come from a number of sources, with contributions from agencies responsible for implementation of the individual Strategies and Actions of the Plan, including SES, BoM, HWC, RTA and the Hunter Central Rivers Catchment Management Authority. In addition, as this Plan has been developed under the NSW Government's Floodplain Management Program, CofN can apply for funding from OEH, on a 2(State):1(CofN) basis to fund relevant actions.

CofN's individual contribution could be sourced through a special flood management levy imposed on all ratepayers. It is expected that a very modest additional charge (< $10 per year) to landholders would be sufficient to secure necessary funds to implement CofN's contribution to the First 5 Years Package. It should be noted that these costs do not include any works or costs associated with the implementation of adopted Wallsend Commercial Centre Flood Plan.

8.5 Flood Planning Levels

This Floodplain Risk Management Plan does not recommend any immediate changes to current Flood Planning Levels (FPL).

At present the Flood Planning Level across Newcastle is defined at the 1% AEP flood level plus a 0.5m freeboard. The 1% AEP flood levels and therefore the FPLs are defined by the result of CofN's most recent flood modelling for all of the catchments and flood mechanisms.

8.5.1 Blockages

It is possible that blockages within the stormwater channels and culverts during a flood event would increase flood levels locally immediately upstream. Depending on the topography of the floodplain and the availability of overland flowpaths, the blockage may have a variable impact on flood levels. Blockages within the more incised floodplains of Dark Creek and Ironbark Creek for example can be expected to have a larger impact than blockages within the Throsby/Styx and Cottage Creek floodplains. There are, however, a number of 'critical' culverts located throughout Newcastle that if blocked would lead to substantial and extensive backwater events. These critical culverts are typically under rail lines, where an elevated embankment has been constructed across the floodplain that constrains natural overland flow.

Table 8-2 Timeline and Costs for Implementation of First 5 Year Strategies ($ '000)

	Year	1	2	3	4	5
Education Initiatives						
Ed.1	*Undertake community education, facilitated through a flood liaison officer*	*50*	*50*	*350*	*350*	*350*
Flood Prediction & Warning						
Wa.1	*Provide river flood forecasting for locations(s) in Newcastle LGA*				*50*	*nil*
Wa.2	*Develop and operate a complete Flood Warning System for Newcastle (covering Flash, River and Ocean Flooding), including effective broadcasting of warnings and relevant information through multi media and social media channels*	*nil*	*50*	*150*	*150*	*25*
Wa.3	*Install passive and active road signage to relay warnings, advise of flooded roads, and provide other emergency information*	*nil*	*100*	*250*	*450*	*450*
Planning Controls						
Pl.1	*In concert with existing planning reviews, clarify and implement controls on floatables and car-parking in floodways and/or hazardous areas*	*nil*	*nil*	*nil*	*nil*	*nil*
Pl.2	*Encourage redevelopment and renovations with more flood resilient materials and design*	*nil*	*10*	*nil*	*nil*	*nil*
Pl.3	*As a first step towards possible strategic landuse changes, undertake appropriate investigations to develop a Strategic Position that will decide the future management of low-lying areas / suburbs in the long-term (within a 50 yr horizon)*	*nil*	*100*	*200*	*200*	
Pl.4	*Undertake a strategic planning review of all floodplain areas, with recommendations for changes to the LEP, DCP and other guiding policies and plans as appropriate*	*nil*	*nil*	*nil*	*nil*	
Governance Initiatives						
Go.1	*Provide an advisory and certification scheme for "flash flood free" refuge*	*nil*	*10*	*nil*	*nil*	*nil*
Property Works						
Pr.1	*Provide elevated flood-free refuge, in combination with flood vents where required to minimise pressure loading on buildings (1500 required in total across Newcastle to fully meet needs – aim for 200 over first 5 years, although the uptake is voluntary)*	*nil*	*nil*	*nil*	*100*	*100*
Pr.2	*Demolish 681 Hunter St building over Cottage Creek*	*nil*	*100*			
Pr.3	*Investigate voluntary purchase of one or more properties within Morgan – Selwyn floodway, Merewether, and pursue if determined to be appropriate, subject to availability of funding*	*50*			*800*	*150*
Emergency Management						
Em.1	*Update and implement as required the SES Flood Emergency Plan for Newcastle / Lower Hunter to include flash, river and ocean flood risks and issues*	*nil*	*nil*	*nil*	*nil*	*nil*
Existing Initiatives						
Ex.1	*Continue existing development controls for PMF refuge and structural stability needs*	*nil*	*nil*	*nil*	*nil*	*nil*
Ex.2	*Reinforce controls on building footprints in floodways and flood storages*	*50*	*50*			
Ex.3	*Continue maintenance of constructed stormwater system to meet design capacities*	*Continue existing spending*				
	TOTAL ($ '000)	***150***	***470***	***950***	***2,100***	***1,075***

It is inherently difficult to predict the impacts of blockage, as the locations of blockages within the stormwater system are unknown. Indeed each flood results in a unique combination of channels and culverts being blocked. Furthermore, the current review and update of Australian Rainfall and Runoff (the Australian rainfall and flood standard) is expected to give some guidance on blockage and how to provide for blockage within planning controls. It is recommended that no further work on blockage be carried out until such time as the standards are finalised (expected within the next 2 – 3 years), and more detailed and targeted modelling assessments can be carried out.

8.5.2 Climate Change and Sea Level Rise

Climate change and sea level rise may have a significant impact on flooding within Newcastle. The NSW Government's adopted values for future sea level rise have already been incorporated into CofN's Flood Models, which have been used to set current FPLs. Changes in design rainfall intensity may also have an impact on flood levels, however, until such time that any changes become more certain, it is recommended that the current modelling results be used as the basis of setting FPLs.

Current FPLs for the low-lying suburbs of Wickham, Maryville and Carrington incorporate a sea level rise projection of 0.9 metres. Thus, the FPL therefore is based on a 1% AEP ocean storm level occurring once the sea level has risen by 0.9 metres (giving a design 1% AEP ocean flood level of 2.3m AHD). With a 0.5 m freeboard, the FPL in these areas is set at 2.8m AHD. It is considered, however, that if sea level rose by 0.9 metres, these low lying suburbs would actually be uninhabitable, as groundwater would be permanently at surface level, making the areas permanently swampy. Indeed this situation is likely to occur with a sea level rise of less than 0.5 metres (i.e. within about 50 years based on government sea level rise projections). It is for this reason that this City-wide Flood Plan recommends the development of a *Strategic Position* on the future management of these low-lying suburbs within a timeframe of about 50 years. Given this ultimatum position and the associated timeframe/trigger for impacts, it would seem unreasonable to continue to impose FPLs within these suburbs at levels based on a sea level rise that cannot be accommodated. It is recommended that as part of the strategic planning review process, further consideration be given to the measures imposed on future development within these areas. In time, it is envisaged that the Strategic Position for future management of the low-lying suburbs that will be established by CofN will become enshrined within future planning provisions. Thus further changes to landuse planning and/or development controls may be required, and will be included as part of on-going strategic planning review.

8.6 Section 149 Certificates

A Section 149 Planning Certificate is a zoning certificate issued under the provisions of the EPA Act, and must be attached to a contract prepared for the sale of property. The Certificate identifies matters affecting the land of which CofN is aware, and particularly if there are associated development controls that apply to the land. Flooding clearly is one of these matters.

The Floodplain Development Manual (2005) defines flood prone land as all land potentially affected by inundation during a flood, up to the PMF event. CofN therefore identifies flood hazard on both S149(2) and S149(5) certificates for all properties affected by flooding, up to the PMF. Approximately 22,000 properties in Newcastle are located within the PMF extents, all of which have S149 notifications relating to flooding.

S149 notations do not limit permissibility of development, but rather, aim to provide factual information (important due to liability issues) and increase awareness of the potential flood risk known to CofN.

Strategy *Go.1* (refer Section 7.3.4) recommends a certification scheme be established for flash flood free refuges. It is proposed as part of that strategy that S149 certificates be amended to recognise certification of flood free refuge for approved properties.

8.7 Actions the Community Can Do

International and national literature repeatedly highlights the importance of community education in managing risks to life and risks to property from flooding. Ultimately, it is people's personal response to a flooding situation that will greatly determine their fate. As such, the most effective way of minimizing risks to life and risks to property is to change people's behaviour during a flood event. Flood education, combined with improved flood warnings and emergency response therefore are the most critical elements of this Floodplain Risk Management Plan.

The Community Education Program aims to provide people with a greater appreciation for local flooding conditions, including flooding that has not been experienced to date. The Program also aims to arm the community with knowledge about what to do during a flood event, and more importantly, what not to do in a flood.

From a community perspective, it is important to understand flooding in Newcastle, and be prepared to act appropriately should flooding occur. In essence, the community needs to become 'flood ready'. This can include preparing a personal emergency plan for a house or business, which should include options for evacuation, if possible, or otherwise shelter safely in-place.

The community should also be 'tuned in' to possible flood warnings, thus giving themselves the maximum possible opportunity to prepare and respond to the flood. Once set up, the Newcastle Flood Warning System will allow community members to be included on automatic notifications of flood warnings (such as subscribed to SMS or email alerts, or connected to facebook or twitter accounts used to disseminate warnings).

Overall, the best thing that community members can do is to take an interest in flooding issues in Newcastle. This way, they will be more aware and better prepared if a flood strikes suddenly.

Effective management of flooding in Newcastle will require bold decisions and significant investment in long term outcomes. It is expected that effective flood management will not be achieved unless there is strong political support for such actions, and this will only occur if the community are active and engaged in the issues, and are placing pressure on the local, state and federal politicians to act and respond with the good governance on behalf of the entire community.

9 BEYOND THE FIRST 5 YEARS PACKAGE

The Implementation Schedule presented in Table 8-1 provides details on all the Strategies and Actions that should be pursued within the First 5 Years of this Plan. Once these Strategies and Actions are implemented (indicatively after a period of 5 years, subject to available resources and funding), this Flood Plan should be reviewed in accordance with the monitoring and evaluation process described in Chapter 10.

Considerable foundation work has been carried out to date, as presented in Chapters 1 to 7 of this document, and it is expected that the review would not involve rework and evaluation of such components unless there has been new information that is relevant to floodplain management in Newcastle (e.g. new guidelines produced, new flood models developed, new flood mitigation products invented). Rather, the review at the end of 5 years would involve assessment of the success of implementation of the Plan to date, and preparation of Implementation Schedules for the next best strategies as previously identified in the overall management strategy (refer Chapter 7). The new Implementation Schedules would take into consideration any difficulties encountered in the First 5 Years, and attempt to resolve such issues through alternative approaches.

9.1 Immediate Next Steps

The immediate next steps following successful completion of the First 5 Years would involve continuation of on-going strategies, as well as commencement of the 'next best' actions identified in the initial rapid analysis (refer Section 7.2) (refer Table 9-1).

Table 9-1 Next Steps After the First 5 Years

	Recommended Next Step Actions / Strategies
Education Initiatives	
Ed.1	Review effectiveness of community education program to date. If warranted, continue program, possibly in an amended format, subject to the availability of on-going funding
Flood Predictions and Warning	
Wa.2	Continue with operation of complete Flood Warning System for Newcastle
Wa.3	Continue with operation and maintenance of passive and active road signage
Planning Controls	
Pl.2	Continue to encourage redevelopment and renovations with more flood resilient materials and design
Pl.3	Continue with assessments and investigations associated with developing a long-term Planning Strategy for the low-lying suburbs of Newcastle. As appropriate, start to introduce planning reforms to take account of associated no-regrets actions.
Pl.4	Continue with strategic planning review, and as appropriate, change LEP and DCP to reflect outcomes from the review in line with CofN's standard approach to planning changes (including community consultation).
Governance Initiatives	
Go.1	Continue to provide advisory and certification scheme for "flash flood free" refuge
Property Works	
Pr.1	Continue with provision of elevated flood-free refuge, in combination with flood vents

	Recommended Next Step Actions / Strategies
	where required to minimise pressure loading on buildings (1,500 required in total across Newcastle to fully meet needs – all remaining properties not provided in First 5 Years to be done)
Pr.3	Continue to pursue voluntary purchase of properties within Morgan – Selwyn floodway, Merewether, subject to outcomes of computer and/or physical modelling (undertaken in First 5 Years) and on-going availability of funding
Pr.4	Investigate voluntary purchase of all existing residential properties in hazardous Hunter River floodways, and pursue if determined to be appropriate, subject to availability of funding
Pr.5	Investigate house raising for properties affected by frequent flash flooding, and pursue if determined to be appropriate
Pr.6	Investigate house raising for properties on Sandgate Road Birmingham Gardens, affected by frequent river flooding, and pursue if determined to be appropriate. These properties (likely to be just 1 property) would also be captured by the need for house raising under flash flood conditions, refer *Strategy Pr.5*
Emergency Management	
Em.1	Continue to implement as required the SES Flood Emergency Plan for Newcastle / Lower Hunter
Structural and Physical Works	
St.1	Prepare feasibility assessments, detailed designs, costs and benefits of larger culverts and compensating detention basins in upper reaches of Elermore Vale / Rankin Park and construct works (provided assessments support such works).
St.2	Prepare feasibility assessments, detailed designs, costs and benefits for augmentation works for existing stormwater system, in concert with investigations for long term resolution of low-lying suburbs (Strategy Pl.3), and any interim measures for improving adaptive capacity
St.3	Prepare feasibility assessments, detailed designs, costs and benefits of levee construction works, in concert with investigations for long term resolution of low-lying suburbs (Strategy Pl.3), and if considered feasible and cost effective, implement works when appropriate trigger is reached (e.g. when measured sea level rise has reached *x* cm).
St.4	Investigate opening up the flowpath at Irving Street, Wallsend. If investigations show that there is merit in undertaking works, then secure property easements and construct the necessary works. Give consideration to voluntary purchase as a possible alternative.
Continue Existing Initiatives	
Ex.4	Refine the existing flood models to provide more accurate flood maps, to test the validity of structural options and to give a better appreciation of flood behaviour, including calibration to 2007 flash flood event. Model refinement is to be directed by the pending release of the updated AR&R, including appropriate provisions for refined rainfall statistics, channel/culvert blockage, sea level rise interactions and coincident events.

The Next Steps involve consideration and investigation of possible voluntary acquisition and/or voluntary house raising schemes for parts of Newcastle. In managing risk to life, it is important that people do not seek refuge within building that would be prone to damage or collapse during extreme events. The only way of ensuring that this does not happen is to remove these buildings or to structurally reinforce them to withstand the forces of extreme flooding. This could include house-raising (for suitable structures), providing that the elevated structure can provide flood-free refuge and can remain stable under extreme flood conditions. **Maps 11A to 11K** (see **Map Series 11** in the

accompanying ***Compendium of Maps***) highlight those properties that require further investigation in terms of managing Risks to Life, while Figure 6-9 also presents priority locations for house raising within the Flash Flood catchments. Similarly, Figure 6-8 presents priority locations for voluntary purchase within the Flash Flood catchments, and generally include properties positioned within significant overland floodways.

Ideally a voluntary purchase and/or house raising scheme should not commence until rezoning has taken place and it is known whether there will be a funding mechanism through developer contributions to remove some buildings from floodways and other high hazard areas. The scheme then only needs to focus on the residual properties. Investigations should commence with confirming which properties would be offered voluntary purchase or house raising, through more detailed hydraulic analysis. Given the high costs associated with both purchase and house raising, and the limited State Government funding (to date), it is expected that the scheme would take many years or decades to implement fully. Also, being voluntary schemes there is the need for the co-operation of property owners, which may further delay implementation and completion of the schemes.

9.2 Other Works (Longer Term Initiatives)

Other works that could also be considered further and potentially pursued in the future include several of the recommended actions from Chapter 6, but which are not included in the First 5 Years package (Section 8.3) or the immediate next steps (Section 9.1) due to more marginal benefit cost outcomes either through possible difficulties in implementation, uncertainty in community acceptance, or excessively high costs and resource demands. These other works would include:

- Investigate lowering Corona St / National Pk St intersection, Hamilton East, and design and construct if determined to be worthwhile and appropriate;
- Investigate voluntary purchase of any properties that become substantially damaged by flooding, subject to availability of funding;
- Investigate raising of the Pacific Highway if voluntary purchase of residential properties in Hexham has been unsuccessful, in combination with rezoning (down-zoning) of hazardous floodways along Hunter River to prevent any further development in this area, and adopt if determined to be appropriate;
- Significantly improved predictions of flash flooding (using integrated modelling and interpretive radar mapping: “nowcasting”);
- Significantly improved predictions of ocean flooding through integrated barometric forecasting and tidal predictions;
- Investigate revising FPLs to cater for blockages, and adopt if determined to be appropriate; and
- Investigate revising FPLs, triggered when climate change impacts start to manifest.

10 MONITORING AND REVIEW OF PLAN PROGRESS & SUCCESS

10.1 Performance Evaluation

The Newcastle City-wide Floodplain Risk Management Plan requires evaluation and reporting regarding its successful implementation, and thus the successful management of existing, future and continuing flood risks. Where implementation performance is sub-optimal, contingencies should be emplaced to remedy the situation. A two tier process of performance evaluation is recommended, as discussed below.

10.1.1 Primary Performance Measures

The first set of performance measures should ascertain whether the strategies are actually being implemented or not in accordance with the priorities and triggers designated within the Plan. As such, the primary performance measures are simply a *measure of action initiation*.

Organisations (mostly CofN) responsible for implementation will need to review the Plan carefully and ensure that adequate funding and resources are allocated to the various strategies and actions to ensure that implementation is achieved within the First 5 Years.

Specific questions to be answered as part of an evaluation process are:

- What strategies have actually been implemented (regardless of outcome – see Secondary Performance Measure)?
- What strategies are outstanding, and should have been implemented within this nominated timeframe?

If it is determined that the strategies are not being implemented in accordance with the nominated timeframe, then one or both of the following *contingencies* should be adopted:

- Determine the cause for the delay in implementation. If delays are funding based, then seek alternative sources of funding. If delays are resource-based, seek additional assistance from stakeholder agencies and/or consider using an external consultancy to coordinate implementation of the Plan; and
- Modify and update the Floodplain Risk Management Plan to reflect a timeframe for implementation that is more achievable. Any revised version of this Plan would need to be endorsed by all relevant stakeholders and agencies responsible for implementation, and may need to be publicly exhibited for community input.

10.1.2 Secondary Performance Measures

The second set of performance measures relate to *measuring specific outputs* from the individual strategies, as appropriate. These “measurables” define what the specific outcome from each action should be. If these outputs are delivered as defined, then the action (or strategy) is considered to have been successful. Outputs will vary according to the individual strategy and are identified as the “Performance Measures” with the Implementation Schedule (refer Table 8-1).

The specific question to be asked in evaluating the secondary performance measures is:

- Of the strategies that have been implemented, has the nominated "Performance Measures" been achieved?

If specific outputs, as defined by the "Performance Measures", are not generated from implementation of the Plan then the following *contingencies* need to be adopted:

- Determine the reason for not producing the specified output. If the reason involves a lack of funding or resources, then similar contingency measures to those described for the primary performance measures should be adopted. If the reason is of a technical nature, then expertise in the area should be consulted to overcome the technical problem. OEH and other government agencies should have the necessary in-house expertise to assist in most cases; and
- Review the appropriateness of the specific output of the management strategy, and if necessary, modify the output described in the Plan to define a more achievable product.

10.2 Plan Review

It is recommended that the Implementation Schedule for the First 5 Years Package be reviewed annually, to determine progress with individual actions and strategies, while a broader audit and update be conducted every 5 years. The annual review should focus on funding, resources and barriers to implementation of the individual actions and strategies within the First 5 Years Package. The first extensive audit, after approximately 5 years, should target re-assessment of progress towards overall risk management and reduction. The audit should review the implemented management strategies and identifying possible avenues for increasing the effectiveness of the Plan in the future.

From the 5 year audit, changes can be made to the Plan to ensure the document remains current, and relevant to the changing landuse and community demands within the Newcastle floodplains. It is envisaged that another 5 year implementation plan would be developed as an outcome of the more extensive audit. The new implementation plan should start to include a number of the Next Steps (refer Section 7.4.1) and possibly 'fast track' other initiatives (refer Section 7.4.2) identified previously in order to make significant progress towards managing flood risks. Many of these Next Steps and other initiatives involve larger scale works, actions and possible broad landuse changes. Successful implementation of the First 5 Years Package will be important in gaining some "quick wins" in order to gain confidence in making more difficult and strategic decisions as required for some of the longer term works (for example, establishing a Strategic Position on abandoning or rescuing the low-lying suburbs around Lower Throsby Creek and Newcastle Harbour).

10.3 Factors for Success

The success of the Newcastle City-wide Floodplain Risk Management Plan can be improved by the following factors:

- Broad stakeholder and community agreement on the overall approach and individual strategies for reducing flood risks;
- Understanding and agreement on implementation responsibilities and funding opportunities by CofN and other government agencies, stakeholders and the general community;

- Commitment by organisations involved to dedicate appropriate time and resources to achieve the objectives and timeframe of the Plan; and
- Actively sourcing of appropriate resources and funds, through grants, user contributions, and in-kind commitments from the agencies, stakeholders and community.

A particularly important aspect is the acceptance and agreement by the local community. Without significant support and pressure by the local community, CofN may find it difficult to prioritise flood management works when considering the full range of CofN assets and lands requiring attention in the future.

11 ASSUMPTIONS AND LIMITATIONS

11.1 Assumptions

Flood planning has been carried out at a broad City-wide scale. A broadscale approach has been necessary in order to determine the relative significance and magnitude of flooding and flood risks across the entire Newcastle LGA. In this manner, further attention can be given to areas that are at most risk across the whole City, rather than focussing on one catchment at a time.

Much of the work presented in this Floodplain Risk Management Plan has been based on the results of computer flood modelling. There are fundamental simplifications and assumptions that are necessary in order to numerically simulate floods. For example, flood models cannot take into account local turbulence or impediments to flow that occur at a small and localise scale. The models are generally unsuitable for assessment of individual properties, given the cell size is typically 10m x 10m. As part of Strategy *Ex.4 (to be implemented after the First 5 Years)*, it is recommended that these models be upgraded with finer cell resolution, which would allow for better representation of localised impacts. Calibration of the models to the June 2007 flood data is also recommended as part of any future modelling exercise. Improved model resolution will assist with refinement of other future strategies, such as confirming which houses should be pursued for voluntary purchase or voluntary house raising.

Rainfall standards are currently being reviewed and updated across Australia. It is expected that rainfall probabilities for the Newcastle area may change. If and when they do, there would be merit in revisiting the modelling that has been undertaken to date, to determine if any changes in FPLs are justified. At the same time, it would be worthwhile to undertake further analysis into blockages across the Newcastle stormwater system, also to determine if any changes in FPLs are justified. It is envisaged that the impending release of standards for rainfall and runoff (scheduled over the next 2 – 3 years) will provide advice and recommendations on how best to accommodate the propensity for blockage within planning and design standards. These re-modelling tasks are also flagged as part of Strategy *Ex.4 (to be implemented after the First 5 Years).*

11.2 Limitations

11.2.1 Modelling

Flood modelling of the Newcastle floodplains has been developed over the past decade. Over this time the computational power has increased substantially, meaning that some of the previous models, whilst state-of-the-art when developed, are now considered coarse. At the resolution of the current modelling (about 5 – 10m grid cells), it is considered that there would be potential for significant improvement in flood behaviour representation through model refinement. Although still adequate for first pass and more holistic planning purposes, opportunities to update and refine the existing models should be sought through the on-going Plan review process, or opportunistically at third party cost (e.g. as part of possible future development assessments). Future review of the modelling should aim to use the June 2007 flood data for model calibration and validation. Note that only the review and update of the Wallsend flood study model has used the 2007 observed flood levels for model calibration at the time of writing.

11.2.2 Blockages

Blockages within the stormwater system can have an impact on flood levels upstream and downstream. There are hundreds or thousands of potential locations where blockages could occur within Newcastle, and each potentially has a different possible impact. Indeed blockage at the same location could have different impacts from one flood to the next depending on the behaviour of the flood and the timing of the blockage. Some sensitivity analysis has been carried out that highlights these potential impacts within the Newcastle floodplain, as presented in this document. Engineers Australia is currently updating Australian standards for hydrology and flood modelling. The new version of Australian Rainfall and Runoff (AR&R), which is due for progressive release over the next 3 years or so, will include guidance on how to provide for blockage within stormwater systems. From a planning and development perspective, localized impacts of flood behaviour, such as impacts of nearby blockages, are already accounted for by the provision of a 0.5m freeboard within the Flood Planning Level, although it is recognised that in some locations, this provision may be inadequate. It is recommended that the existing provisions from freeboard within the FPL continue to be adopted until further analysis can be undertaken that accords with the requirements that will be set out in the upcoming AR&R.

12 REFERENCES

12.1 Background Documentation

In addition to the reference list provided below, readers are referred to a compilation of background work that was undertaken specifically for this Study and Plan by specialist floodplain management consultants Molino Stewart. This compilation document is available through CofN.

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APPENDIX A: COMMUNITY & STAKEHOLDER CONSULTATION DETAILS

Stakeholder Details

Table A.1 List of External Stakeholders Consulted during Process

Association
Hunter Water Corporation (HWC)
AGL Energy Limited
Ausgrid
Australian Rail Track Corporation Ltd
Baulkham Hills Shire Council
Bewsher Consulting, assisting BMT WBM
BMT WBM
Church Street Community Garden
Department of Environment and Climate Change (former Dpt)
Department of Planning
Don Fox Planning, assisting BMT WBM
Energy Australia
Federal Park Commercial Centre
Housing NSW
Hunter Development Corporation
Hunter New England Health/ Department Forensic Medicine
Lake Macquarie City Council
Mine Subsidence Board
New Lambton Residents Association
Newcastle City Centre Committee
Newcastle Master Builders Association
Newcastle Pipeline Company Pty Ltd
Newcastle Port Corporation
Newcastle Innovation
NSW Floodplain Management Authorities
NSW Police Hunter – Central Coast Emergency Management District
Office of Sonia Hornery MP
Parsons Brinckerhoff, assisting BMT WBM
Pittwater Council
Port Waratah Coal Services Ltd
Roads & Traffic Authority
RPS
State Emergency Service (SES)
Telstra
University of Newcastle
Voice
Wallsend Town Committee
WorleyParsons

Community Workshop Participation

Table A.2 Attendees during First Round of Community Workshops

Date	Workshop Type	Location	Time	Attendance Numbers
20 April 2010	Focus Group	Hexham		
28 April 2010	Focus Group	Hamilton North	9-11am	24 people
28 April 2010	Focus Group	Hamilton North	7-9pm	???
29 April 2010	Focus Group	Dixon Park	10-12pm	13 people
29 April 2010	Focus Group	Dixon Park	7-9pm	8 people
06 May 2010	Focus Group	Wallsend	10-12pm	???
06 May 2010	Focus Group	Wallsend	7-9pm	9 people
			Total Number of Attendees	XXX = people

Table A.3 Attendees during Second Round of Community Workshops

Date	Workshop Type	Location	Time	Attendance Numbers
2 March 2011	Focus Group	Hexham	10 -12pm	Cancelled Due to Low Numbers
2 March 2011	Focus Group	Hexham	7-9pm	Cancelled Due to Low Numbers
3 March 2011	Focus Group	Wallsend	10 -12pm	25 people
3 March 2011	Focus Group	Wallsend	7-9pm	7 people
9 March 2011	Focus Group	Hamilton North	10 -12pm	23 people
9 March 2011	Focus Group	Hamilton North	7-9pm	12 people
10 March 2011	Focus Group	Dixon Park	10 -12pm	11 people
10 March 2011	Focus Group	Dixon Park	7-9pm	Cancelled Due to Low Numbers
			Total Number of Attendees	= 78 people

Newspaper Advertisement for Workshops

Newcastle Floodplain Study and Plan

You will have the opportunity to hear how Council and its expert consultants have considered the community feedback from the consultation conducted in 2010, and be involved in further flood planning developments. Eight focus group sessions are being held to provide information and seek public comment on flood planning.

Time: 10-12 noon OR 7-9PM Date: Wednesday 2 March 2011 Venue: Hexham Bowling Club, 290 Old Maitland Rd, Hexham	Time: 10-12 noon OR 7-9PM Date: Thursday 3 March 2011 Venue: Wallsend District Library Bunn St, Wallsend
Time: 10-12 noon OR 7-9PM Date: Wednesday 9 March 2011 Venue: Hamilton Nth Bowling Club, Boreas Rd, Hamilton Nth	Time: 10-12 noon OR 7-9PM Date: Thursday 10 March 2011 Venue: Dixon Park Surf Club, off John Pde, Merewether

Please register on 4974 2878 – numbers limited

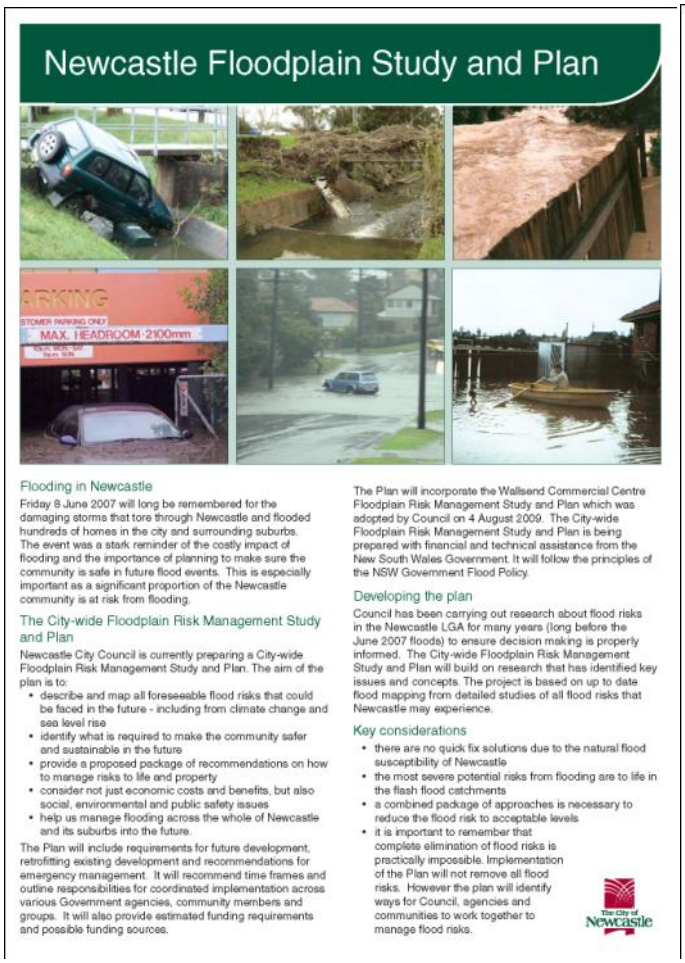
If you are not able to attend a focus group please send your comments either online to: **www.newcastle.nsw.gov.au**, via email to **mail@ncc.nsw.gov.au** or write to **The General Manager, Attention: David Gibbins, The City of Newcastle PO Box 489, Newcastle 2300** by Friday 25 March 2011.

The City of Newcastle will publicly exhibit the proposed City-wide Floodplain Risk Management Plan and consider its adoption in the last half of 2011.

For more info please contact David Gibbins on 4974 2888.

The City of Newcastle

Round 1 Information Sheet



Newcastle Floodplain Study and Plan

Flooding in Newcastle

Friday 8 June 2007 will long be remembered for the damaging storms that tore through Newcastle and flooded hundreds of homes in the city and surrounding suburbs. The event was a stark reminder of the costly impact of flooding and the importance of planning to make sure the community is safe in future flood events. This is especially important as a significant proportion of the Newcastle community is at risk from flooding.

The City-wide Floodplain Risk Management Study and Plan

Newcastle City Council is currently preparing a City-wide Floodplain Risk Management Study and Plan. The aim of the plan is to:

- describe and map all foreseeable flood risks that could be faced in the future - including from climate change and sea level rise
- identify what is required to make the community safer and sustainable in the future
- provide a proposed package of recommendations on how to manage risks to life and property
- consider not just economic costs and benefits, but also social, environmental and public safety issues
- help us manage flooding across the whole of Newcastle and its suburbs into the future.

The Plan will include requirements for future development, retrofitting existing development and recommendations for emergency management. It will recommend time frames and outline responsibilities for coordinated implementation across various Government agencies, community members and groups. It will also provide estimated funding requirements and possible funding sources.

The Plan will incorporate the Wallsend Commercial Centre Floodplain Risk Management Study and Plan which was adopted by Council on 4 August 2009. The City-wide Floodplain Risk Management Study and Plan is being prepared with financial and technical assistance from the New South Wales Government. It will follow the principles of the NSW Government Flood Policy.

Developing the plan

Council has been carrying out research about flood risks in the Newcastle LGA for many years (long before the June 2007 floods) to ensure decision making is properly informed. The City-wide Floodplain Risk Management Study and Plan will build on research that has identified key issues and concepts. The project is based on up to date flood mapping from detailed studies of all flood risks that Newcastle may experience.

Key considerations

- there are no quick fix solutions due to the natural flood susceptibility of Newcastle
- the most severe potential risks from flooding are to life in the flash flood catchments
- a combined package of approaches is necessary to reduce the flood risk to acceptable levels
- it is important to remember that complete elimination of flood risks is practically impossible. Implementation of the Plan will not remove all flood risks. However the plan will identify ways for Council, agencies and communities to work together to manage flood risks.

The City of Newcastle

You are invited to be involved

We want you to get involved in the development of the City-wide Floodplain Risk Management Plan for Newcastle.

Community engagement will play a significant role in the development of this Plan. Local people, organisations and businesses are encouraged to put their views forward and to attend a series of community forums to be held throughout 2010.

This first round of consultation is aimed at informing people about the research already carried out, and to hear what people would like to say before specific potential flood management measures are scenario tested and evaluated.

Focus Groups

Community focus groups will be held at the following times and locations:

Time: 10-12 noon and 7-9PM Date: Wednesday 21 April Venue: Hexham Bowling Club, 290 Old Maitland Rd, Hexham	Time: 10-12 noon and 7-9PM Date: Wednesday 28 April Venue: Hamilton North Bowling Club, Boreas Rd, Hamilton Nth
Time: 10-12 noon and 7-9PM Thursday 6 May Venue: Wallsend District Library, Bunn St, Wallsend	Time: 10-12 noon and 7-9PM Date: Thursday 29 April Venue: Dixon Park Surf Club, off John Pde, Merewether

Please register by Friday 16 April on 4974 2878 – numbers limited.

You can also tell us about your views on our online form on Council's website at www.newcastle.nsw.gov.au, by emailing mail@ncc.nsw.gov.au, or by writing to the General Manager, Attention David Gibbins, Newcastle City Council, PO Box 489 Newcastle NSW 2300. **Comments close Friday 21 May 2010.**

Where to next?

A second and final round of consultation in the development of the Draft City-wide Floodplain Risk Management Study and Plan is scheduled for late 2010 to provide feedback from the scenario testing.

Council will place the Draft Plan on public exhibition in 2011.

The Draft Plan will then be amended as appropriate and presented to the elected Council for formal adoption in 2011.

Once the Plan has been formally adopted Council will work with various agencies and groups to seek funding from Government (and other) sources for implementation over time.

Council will also coordinate implementation by the various Government agencies, community members and groups, possibly through a dedicated implementation Task Force.

More information

Visit Council's website at www.newcastle.nsw.gov.au

Contact details

Please contact the Project Coordinator, David Gibbins via email: dgibbins@ncc.nsw.gov.au or call 4974 2888.

The City of Newcastle

Letters Sent to Community for Workshop Invitation

FUTURE CITY.D GIBBINS.NP
Phone: 02 4974 2888

16 February 2011

«Title» «First_name» «Surname»
«Address1»
«SUBURB»

Dear «Title» «Surname»

NEWCASTLE CITY-WIDE FLOODPLAIN RISK MANAGEMENT PLANNING - SECOND ROUND OF CONSULTATION - FOCUS GROUPS

Thank you for your interest and attendance at the first round of Focus Groups in April/May 2010, and for providing your contact details. You will recall that Council undertook to notify you when the next round of Focus Groups was going to be held.

I am pleased to let you know that Council has now publicly advertised for the next round of Focus Groups. These Focus Groups will give you the opportunity to hear how Council and its expert consultants have considered the community feedback from the consultation conducted in 2010, and to be involved in further flood planning. Eight focus group sessions are being held:

Time: 10am -12noon OR 7-9pm Date: Wednesday 2 March 2011 Venue: Hexham Bowling Club 290 Old Maitland Road, Hexham	Time: 10am -12noon OR 7-9pm Date: Thursday 3 March 2011 Venue: Wallsend District Library Bunn Street, Wallsend
Time: 10am -12noon OR 7-9pm Date: Wednesday 9 March 2011 Venue: Hamilton Nth Bowling Club, Boreas Road, Hamilton North	Time: 10am -12noon OR 7-9pm Date: Thursday 10 March 2011 Venue: Dixon Park Surf Club, off John Parade, Merewether

It is essential to register your interest to attend these focus groups by telephoning (02) 4974 2878 as numbers will be limited.

If you are not able to attend, Council invites comments from any person in relation to the Newcastle's City-wide Flood Planning work to date. An on-line comment form will be placed on Council's website. Comments must be in writing and addressed to:

The General Manager
Attention: Mr David Gibbins
The City of Newcastle
PO Box 489
NEWCASTLE NSW 2300 or email: **mail@ncc.nsw.gov.au**

To receive consideration, **comments must be received by 5.00pm on Friday 25 March 2011**.

Council will publicly exhibit the proposed City-wide Floodplain Risk Management Plan and consider its adoption in the last half of 2011.

If you have any questions or matters you would like to discuss, please do not hesitate to call me on (02) 4974 2888.

Yours faithfully

David Gibbins

David Gibbins
SENIOR STRATEGIST
INTEGRATED FLOOD PLANNING

Avenues for Community to Make Comments

Newcastle Floodplain Study and Plan

MOLINO STEWART
ENVIRONMENT & NATURAL HAZARDS

The City of Newcastle

SECOND ROUND COMMUNITY CONSULTATION 2 TO 25 MARCH 2011

HOW TO MAKE COMMENTS

This second round of consultation provides the community with the results of research and investigations into the matters raised by the community in the first round, and with the opportunity to give their initial reactions to these findings.

A record will be made of the comments made at the focus groups.

However, if you are not able to attend a focus group, or wish to make comments at other times, please send your comments **by Friday 25 March 2011** either

- **Using the online submission form at: www.newcastle.nsw.gov.au**
- **or via email to mail@ncc.nsw.gov.au**
- **or by writing to:**

The General Manager,
Attention: David Gibbins,
The City of Newcastle
PO Box 489,
Newcastle NSW 2300.

March 2011

Newcastle City-wide Floodplain Risk Management Working Party

Table A.4 Membership and contributors of the Newcastle City-wide Floodplain Risk Management Working Party

Name	Capacity
Cr T Crakanthorp	Chair and Councillor
D Gibbins	Coordinator CoN
R Hardwick	Team Coordinator Natural Resources Planning CoN
A Peddie	Senior Development Officer (Engineering) City of Newcastle (CoN)
J Gaynor	Manager- Strategic Planning Services
J Jaeger	Director of Future City
J Johnston	Manager- Infrastructure Management Services
N Peattie	Strategic Planning Services Administration CoN
Cr John Tate	Lord Mayor
Cr M Osborne	Councillor
Cr Scott Sharpe	Councillor

Cr S Connell	Councillor
Peter Evans	Office of Environment and Heritage
Lara Davis	Office of Environment and Heritage
Trevor Cameron	Hunter Central Rivers Catchment Management Authority
Colin Rae	Newcastle Port Corporation Representative
Jackie Braithwaite	Newcastle Port Corporation Representative
Julia Irwin	Hunter Water Corporation Representative
Ken Speer	SES Regional Controllers Office
Brian Carr	SES
A Nelson	Community Representative
D Horkan	Community Representative
H Willems	Community Representative
E Crawford	Community Representative

Community & Stakeholder Consultation Outcomes

The community can have very diverse and very passionate views on flood issues, particularly following first-hand experience of flooding (as is now the case following the June 2007 event). “Managing the risk” and “living with the risk”, rather than removing the risk can be quite difficult messages to convey to the public.

Public information regarding flooding can also be perceived by some within the community as having potentially detrimental impact on property values. Landowners may sometimes want to know what risks they are exposed to by flooding, but may not want this knowledge to be conveyed to others, especially potential purchasers of their land.

Community members have also formed opinions about options which they believe will reduce or even eliminate flooding problems, including for example ‘bigger drains’, ‘detention basins’, ‘diversion channels/pipes to the ocean’, and simply ‘no more upstream development’. In reality there are no quick-fix solutions to flooding in Newcastle given the natural flood susceptibility of the floodplains on which the city has been built. A combination of approaches will therefore be necessary to reduce flood risks in the future, recognising that elimination of risks is practically impossible.

The key outcomes of community and key stakeholder consultation and are provided in Table A.5. The development of this Plan carefully considered these comments, issues and suggestions from the community and key stakeholders. Where warranted, the computer flood behaviour models were used to test some of the suggestions (such as dredging the lower end of Throsby Creek, and lowering the major Stormwater Channels). Some suggestions have been included in the Plan – such as easily accessible flood information.

Table A.5 Summary of the issues raised during the consultation period

Topic	Issues summarised
Evacuation	• **Need to have good warning systems-** It is essential to provide a good warning system – and ensure that everyone knows what to do for their individual circumstances. This is especially true in flash flood situations. Some indicated that individuals should decide for themselves. Some in the Hexham area indicated they did not believe it could flood (like the 1955 flood) again – and they were better informed than the emergency management authorities to decide when to leave. Others indicated this was a complex matter that requires people's psychology in emergency situations to be understood. • In an evacuation event, elderly, ill health, disabled people and people with mobility problems should be considered and moved/ evacuated early. • Many felt that there needs to be clear information on evacuation points both in neighbourhoods and in private spaces such as shopping centres (that are considered public spaces). • There needs to be information and factsheets that are attention grabbing and placed in many locations to get as many people to read them. The information needs to be more comprehensive, more detailed and more relevant. • Some considered finishing the flash flood warning system – especially Wallsend (consider freeway type signs) a priority. • Evacuation must be personalised – and maintained. And it needs to be recognized that there are some areas where evacuation will not work (therefore need vertical – e.g. attic). • Many emphasized that flood warning systems do not always work; people need to be educated about what to do. • Some recognized that people in cars are a problem in flood situations.
Mitigation	• **Control the floodwaters to stop / cut down flooding-** Examples included suggestions of stopping or slowing the water through dams or lots of small holding basins high up in the catchments, digging parks down for storage of flood waters; getting the water away quicker through bypass channels, widened bridges and channels, bigger pipes; Controlling the floodwaters with levees. • Need a clear plan that involves more than evacuation. • Need boom gates or warning signs to stop cars attempting to drive though flooded roads. • Need to make the drains work, there needs to be a recalculation on the adequacy of the drainage and to consider the cumulative impacts of new development. • Another option discussed was for CofN to buy houses 50m either side of the drains and channels and turn them into bushland to slow the water. • **Keep the drains clean -** Examples included removing trees and shopping trolleys from creeks and stormwater channels, stopping shipping containers and cars entering stormwater channels, keeping the drains clean at all times and dredging the downstream end of Throsby Creek near Islington Park. • **Make the drains follow the lay of the Land-** In terms of flash flood areas, the main channels should follow the natural lay of the land – even if this means resuming properties.
Building Modifications	• Many recognized that there are ways to live with floods e.g. some support the option of house raising. • Consideration should be on the problems of building modification and the accessibility for elderly and people with mobility problems. • Need an incentive or subsidized schemes to fix infrastructure, this should also have ideas and options for people, to make it easier for people to take up the initiative. • CofN needs to set a good example, but it is also important that people understand that CofN can only do so much and people should be educated on personal responsibility.

	• There is support for upper refuges (or community local upper refuge), but also consideration on onsite refuges, which can cause more problems for emergency services and combat agencies and can trap people because it can be difficult to rescue or let anyone know they are there. This can be alleviated though properly constructed and designed retreats that can be used for 10/12 hours. • Education to teach residents that building modifications are warranted. • Need to remove flood risks, eg. Solid fences in flood areas. • Modifications should consider water sensitive urban design • DA waiver fee.
Re-development / Planning Controls	• **Stop approving flood causing Developments** –Many of the developments approved by CofN make flooding worse by replacing grass with concrete. For example the new retail development off Bradford Close and Park Avenue Kotara will make flooding worse in Hamilton North. • Mandatory floor levels should consider fast and slow movements of floodwaters and should have exceptions. • Housing design should be directed by CofN's Development Control Plan and the Local Environmental Plan should direct development away from water channels and in unsuitable flood affected areas.
Warnings	• Expectations of sirens in business and shopping centre's (big air raid siren). • Need to re-education people to not drive in cars- stay where they are. • Emphasis that knowledge is power- people need to plan. • Commercial and school buildings should have emergency plans. • SMS system and SMS system and radio; the media needs inform people of the rainfall and river heights. • Have a registration list of who needs to be contacted first- so they have max time to remove or respond. • Highlight to people the importance of generators. • Have a warden for each block- they would liaise with CofN and neighbors (distribute pamphlets). • Issues with how to get information to people in private spaces that are considered public spaces. • Should have one number to call, either CofN or HWC.
Other	• **Make Flood Information Freely Available** - We should not have to pay for flood information. We need this to inform us what things we might need to do – for example raising floors or making a refuge in the roof. Flood information should be available on the internet as well as other options for people who don't have access or a computer. • **Insurance Premiums are rising** – Our (household) insurance premiums have risen. Some attributed this to the 2007 flood event, insurance companies taking account of developments that have been approved, and CofN supplying flood information to insurance companies. Others said that what is being described by this work as flash flooding should not be labelled flooding. This causes issues and difficulties with insurance companies. It is really a drainage problem that should be fixed. Perhaps if certain actions were done (e.g. making buildings more resistant to flooding) insurance premiums could be reduced? • To learn about managing your flood risk a letter should be sent directly to the household owner. • **Who is going to pay? -** Costs should not be shifted on to individuals. Individuals would oppose some measures such as house raising or providing refuges if they had to pay. Finding the large government funding required for implementation will be very difficult – if not impossible. • **Why is this taking so long? -** Nothing has actually been done on the ground – This is taking too long. What would happen if we got another flood like what happened in 2007? • **Need better future planning and climate change adaptation -** The mistakes of the past should not be repeated. We need to think of the long term and consider

	climate change and sea level rise. • **Agencies need to work together -** Agencies such as HWC need to be at the workshops. HWC owns the major stormwater channels. • **More People Need to be Involved -** More people need to be involved in the flood planning process. • Problem and issue with tenants caring about flooding as it is not their property. • There should be a complete education pack available that is broad as well as area specific. • Should consider flood information awareness week. • Newcastle voice emails reminder about what to do in a flood. • People are unsure about the current warning systems. • Some would like to see a more defined classification of what is and isn't flood, to help with insurance claims. Should the terminology be considered water inundation strategy? • CofN maps have caused some issues with increased premiums (general and extra premium for flooding) (because of being mapped flood prone). • New people should make enquires about the are and the flooding history when buying a property. • The plan should present costs in a different fashion- label savings rather than costs. • Levy property owners with hazard zones. • The study and plan needs to include a historical perspective. • Living on a floodplain, the emphasis is on draining the water away. Parts of the plan should include plans to collect the water, conserve it and then reuse it elsewhere. • Concerns over the actions and strategies in the plan not happening due to lack of funding. • Consideration should be on small floods not just PMF floods

Experts Workshop

Table A.6 Participants in the CofN Floodplain Management Experts Workshop (October 2008)

Name	Association
Mr Greg Bernard	Department of Environment and Climate Change
Mr Peter Medi	Department of Environment and Climate Change
Mr Duncan McLuckie	Department of Environment and Climate Change
Mr Ken Speer	SES
Mr Brian Carr	SES
Mr Wilton Boyd	NSW Floodplain Management Authorities
Ms Sue Ribbons	Pittwater Council
Mr Allan Gear	Baulkham Hills Shire Council
Mr David McConnell	WorleyParsons, Consultant responsible for Wallsend Business District Flood Plan
Mr Drew Bewsher	Bewsher Consulting, Consultant assisting BMT WBM
Mr Paul Grech	Don Fox Planning, Consultant assisting BMT WBM
Mr Stuart Holle	Parsons Brinckerhoff, Consultant assisting BMT WBM
Mr Alastair Peddie	Newcastle City Council Senior Development Officer (Engineering)

Ms Fiona Leatham	Newcastle City Council Principal Strategist City Coast & Estuary
Ms Leanne Kruger	Newcastle City Council, Principal Strategist City Directions
Mr David Gibbins	Newcastle City Council, Senior Strategist Integrated Flood Management
Ms Ruth McLeod	Newcastle City Council, Senior Strategist Integrated Planning - Facilitator
Dr Philip Haines	BMT WBM, Consultant, Project Manager
Mr Daniel Williams	BMT WBM, Consultant

APPENDIX B: CITY OF NEWCASTLE FLOOD POLICY AND FLOOD DCP

FLOOD POLICY

PART A :PRINCIPLES

ADOPTED 23 MARCH 2004

sustainable**NEWCASTLE**

The City of Newcastle

Enquiries:

For further information, contact:

Council's City Strategist for Floodplain Risk Management or Council's Engineering Planner
Newcastle City Council
Tel: 02 4974 2000
Fax: 02 4974 2222

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Web: www.ncc.nsw.gov.au

Adopted Version 1: 23 March 2004

Cover Photo:

Flooding has always been a part of the Newcastle landscape. Council's policy seeks to balance and manage all risks to the economy, the environment and people through responsible application of flood risk management principles.

Foreword

Flooding is a significant issue affecting existing and future development in the City of Newcastle. Many thousands of properties are potentially affected by flooding in some way.

Major river flooding from the Hunter River is one of a number of contributing causes. More importantly, flooding also occurs due to flooding from local streams, stormwater channels and drains, often with little or no warning. In certain locations adjoining the Hunter River estuary, flooding due to coastal inundation also occurs.

Flooding involves significant issues of risk, including risks to life and property. Flood risks cannot be eliminated, but they can be managed . This Policy provides a local expression of the general flood risk management principles outlined in the *NSW Flood Prone Land Policy*. It outlines a preliminary policy position pending the completion of flood studies and detailed flood risk management plans throughout the Newcastle area.

In particular, the Policy:

- describes principles relating to the preparation of flood risk management plans, local environmental plans and master plans
- provides the rationale for development assessment criteria contained in the *DCP*
- guides the provision of flood information to the community
- incorporates an action plan for the completion of flood studies and flood risk management plans
- makes provision for ongoing review as detailed studies are completed.

The Policy will be of particular interest to the development industry, consultants and other members of the community with an interest in the use and development of flood prone land.

Lord Mayor

Newcastle

At a glance

This policy provides a framework to

Reduce the impact of flooding and flood liability, utilising ecologically positive methods wherever possible, using a merit approach taking into account social economic and ecological considerations as well as flood risk management.

It represents a significant change from the paradigm of the past, which was "to dispose of rainfall waters by a system of drains so as to prevent flooding." Council now understands that flood prevention is and always was largely unachievable in practice for all the flood risks.

The change in approach accords with changes in NSW Government Floodplain Management Policy, and forms part of Newcastle's vision for a sustainable water cycle and city. It is both more responsive to the needs of the whole community and more complex because it is multi-objective.

Many people will be unaware that large parts of Newcastle could flood in the future, including many of the people who live in those areas. The surprise is many of these areas are in the suburbs away from the Hunter River Floodplain.

Emerging research is suggesting that nearly 50% of the properties in Newcastle may be flooded in the future. A very small proportion of these properties are in the Hunter River floodplain. The remaining are in the suburbs where urban areas have often been built on former watercourses, flow paths and wetlands subject to 'flash flooding'.

This flood policy covers the management of future development, natural areas and already developed suburbs.

Management of Newcastle's flood risks is achievable over time.

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Section 1 Preliminary

Outline of the Policy

This Policy is divided into 2 parts:

Part A: Principles

- **Foreword**
- **Section 1 Preliminary**—describes the purpose, strategic vision and legal aspects of the Policy.
- **Section 2 Background**—explains important concepts underlying the Policy, outlines major flooding issue affecting the Newcastle area, summarises the current status of flood studies, explains why the Policy is necessary, and identifies related policy issues.
- **Section 3 Policy framework**—describes the framework for flood risk management. It outlines flood management principles and how they are to be applied by the Council when exercising its planning, regulatory and service functions
- **Section 4 Management strategy**—outlines the program of measures that are proposed to be carried out in order to achieve the objectives of the Policy.
- **Section 5 Implementation**—outlines the overall strategy for implementing the Policy as part of an adaptive management approach
- **Section 6 Glossary**—explains terms with special or technical meanings.
- **Section 7 Appendices**—provides relevant background and technical information.

Part B: Flood information atlas provides a generalised snapshot of the flood information currently available for each of six separate flood management areas. These are discrete subcatchments having similar management issues, development pressures and level of flood information.

1.1 Title

This Policy is called *Newcastle Flood Policy 2003* ('the Policy').

1.2 Status

The Policy is:

- a preliminary floodplain risk management policy prepared in accordance with the *Floodplain Management Manual*, as notified under section 733(5) of the *Local Government Act 1993*
- adopted by resolution of the Council

- a policy document for the purposes of the *Freedom of Information Act 1989* that is required to be listed in the Council's *Summary of Affairs*.

1.3 Commencement & operation

The Policy commences on a date to be nominated by the Council, and remains in force until a flood risk management plan is adopted for all or part of the land to which the Policy applies.

Note: The Policy commenced on …… 2003 (see Strategic Issues Committee Item … of … 2003).

1.4 Policy Statement

Newcastle City Council will r*educe the impact of flooding and flood liability, utilising ecologically positive methods wherever possible, using a merit approach taking into account social economic and ecological considerations as well as flood risk management by:*

- providing a more detailed expression of the general flood risk management principles outlined in the *NSW Flood Prone Land Policy*, having regard to local circumstances and conditions
- providing a framework for managing flood risk based on current (but incomplete) flood information and understanding, which can be updated progressively to reflect:
  - improvements in flood information and understanding
  - the adoption of flood risk management plans
- outlining flood risk management principles that will guide Council when exercising its functions relating to:
  - corporate planning
  - environmental planning
  - development assessment
  - public land management
  - provision of works and services
  - provision of flood information

and;

- providing the community with general information regarding the likely extent and degree of flood risk within the City of Newcastle.

1.5 Objectives

The objectives of the Policy are:

- to ensure that the use and development of flood prone land:

- has risk consequences that are acceptable to the community
- takes into account the full spectrum of flood risks across all risk dimensions
- recognises the social, economic and environmental values of flood prone land
- is consistent with the principles contained in the *Floodplain Management Manual*

- to ensure that flood risk is considered as early as possible in the planning and development process
- to ensure that planning and development decisions affecting flood prone land take into account the best available flood information
- to avoid unnecessary restrictions on the development of flood prone land through consideration of the full range of issues.
- to ensure that the Council exercises its functions relating to flood risk management with reasonable care and diligence
- to facilitate the ongoing collection of flood information, and the orderly provision of such information to the public
- to promote integration between the Council's flood risk management activities and flood-related emergency management undertaken by the State Emergency Service and the Newcastle Emergency Management Committee.

1.6 Scope of the Policy

The Policy applies to all risks associated with flooding up to and including the probable maximum flood, but does not apply to risks associated with:

- tsunami
- very minor nuisance flooding, such as the trapping of surface runoff in a road shoulder or against a building.

1.7 Application of the Policy

The Council is to consider and give effect to the Policy when it:

- prepares a draft Council Management Plan
- prepares a draft Local Environmental Plan that relates to flood prone land
- approves a master plan that relates to flood prone land
- adopts a Plan of Management for Community land that relates to flood prone land
- determines a development application that relates to flood prone land via the accompanying Development Control Plan

- proposes to undertake works on flood prone land
- issues flood information to the public, such as by way of flood information certificates
- contributes to emergency management
- undertakes or contributes to other measures to manage flood risks.

The Council is to review the Policy in accordance with clause 5.43.

1.8 Relationship to other policies & plans

The policy:

- provides more detailed expression of the general principles outlined in the *NSW Flood Prone Land Policy* (refer to Appendix 7.1)
- provides the rationale for flood risk management activities identified in the Council's Management Plan, as prepared annually under Part 2 of Chapter 13 of the *Local Government Act 1993*
- specifies principles that are to guide the preparation of:
  - amendments to the *Newcastle Local Environmental Plan 2003*
  - master plans under pursuant to Council's Development Control Plans
  - plans of management for community land,

  where these relate to flood prone land
- provides the rationale for development assessment criteria contained in Councils Development Control Plan relating to flood risk management.

1.9 Definitions

Terms used in the Policy with special or technical meanings are defined or explained in Part 6: Glossary.

Section 2 Background

Outline of Part 2

This Part provides the background to the Policy. It explains important concepts underlying the Policy, outlines major flooding issues affecting the Newcastle area, summarises the current status of flood studies, explains why the Policy is necessary, and identifies related policy issues.

2.1 What is flooding?

2.11 Definition

Flooding refers to the inundation of land that is not usually inundated. Flooding may occur due to a variety of reasons, either separately or in combination. Important types of flooding include:

- *river flooding*—caused by a river or stream overtopping its banks onto the surrounding floodplain
- *urban flooding*—caused by urban stormwater flows during an intense rainfall event, such as surface flows, surcharge from piped drainage systems or overflow from man-made stormwater channels.
- *coastal inundation*—caused by sea water inundation due to king tides, storm surge, barometric effects, tsunami, shoreline recession, subsidence, the enhanced greenhouse effect or other causes.

Tsunami and very minor nuisance flooding (such as the trapping of surface runoff in a road shoulder or against a building) are specifically excluded from the application of the Policy.

2.12 Flooding as a chance event

Flooding is a relatively rare event that is reflects the laws of chance. This means that:

- the occurrence of flooding is random
- it is not possible to predict the timing or magnitude of a particular flood event, but it is possible to estimate the mathematical probability that such an event will occur in any given year
- the larger the flood, the smaller the probability of occurrence
- the probability that a flood will occur is not affected by the length of time that has elapsed since the previous flood, and therefore very rare floods may occur several times within a short period

- some locations that are prone to very rare floods may not experience a flood within several lifetimes, centuries or millennia; consequently human perceptions or experience of the likelihood of flooding may not be a reliable indicator of actual likelihood.

The likelihood that flooding will occur at a particular location can be expressed quantitatively by 'annual exceedance probability'. This is the probability that a flood of a given or larger magnitude will occur within a period of one year, expressed as a proportion or a percentage

Floods of a particular annual exceedance probability can also be referred to by their 'average recurrence interval'. This is the average period between floods of a given or larger magnitude, expressed in years. It is the reciprocal of annual exceedance probability.

2.2 Application of risk management to flooding

2.21 Hazard, consequence, probability & risk

Hazard refers to a source of potential harm or a situation with a potential to cause loss. Flooding is an example of a hazard.

Consequence refers to the impact (negative or positive) of a particular hazard once it has occurred. Consequence varies on a scale from insignificant to catastrophic when discussing the flood hazard.

Probability refers to the chance of something (in this case flooding) happening that will have an impact on the objectives of a person, organisation or the community. Such impacts may be negative (losses) or positive (opportunities).

Risk refers to the compounding of probability and consequence such as to identify the impact of the hazard occurring and re-occurring over a long period of time. Risk is the ultimate expression of the concept and will be the main focus of the discussion from here.

Flood risk refers to risk arising from flooding.

2.22 Risk management

Risk management refers to the process of identifying, analysing, evaluating, treating, monitoring and communicating risks in a way that minimises losses and maximises opportunities.

Risk management involves the identification of all risk and then deciding which risks should be treated due to their unacceptable level. Some risk may be of a lower level and may be 'accepted'. There may be a need to treat some of the accepted risk to a lesser standard in order to mitigate the residual risk further.

This Policy is a particular example of risk management, that is, the management of flood risk.

2.23 Risk acceptance

In an uncertain world, it is not possible to eliminate all risk. In many instances, the social, economic or environmental costs of risk treatment do not justify the benefits. Consequently, it is necessary to accept some risks.

Risk acceptance involves an informed decision to accept the consequences and the likelihood of a particular risk. No attempt is made to treat such risks.

Decisions relating to risk acceptance will reflect social, economic, environmental, operational, technical, financial, legal and other considerations. The relative importance of these matters will vary depending on the issues being examined and local community values and perceptions. Because of the public nature of flood risk, suitable community processes must be established to reach agreement on the level of risk acceptance.

The concept of risk acceptance implies that the 'risk universe' can be divided into two broad regions according to the type of management response:

- *treatable risk*—risk that can be actively dealt with by the application of risk treatment measures
- *residual risk*—risk that remains after risk treatment measures have been undertaken.

2.24 Existing & future risks

Another dimension of risk is whether it presently exists, or whether it could potentially arise in the future. This distinction is important in relation to flood risk, since present-day decisions may leave a long-term legacy for future generations. Thus it is possible to distinguish between:

- *existing flood risk*—the flood risk associated with existing development on flood prone land
- *future flood risk*—the flood risk associated with new development on flood prone land.

2.25 Risks relating to different consequences

Risks can also be categorised according to what the hazard impacts on

- *risk to life*—the risk of injury or death
- *risk to property*—the risk of damage to buildings, building contents, fences, crops, livestock or other personal property
- *risk to the environment*—the risk of degradation to ecosystems or ecological processes
- *societal risk*—risks borne by the community generally, such as loss of social or economic opportunity, loss of access or loss of cultural heritage.

2.26 Relationships between risk dimensions

Flood risk can be categorised in three separate dimensions, that is, according to management response (treatable and residual risks), generational impact (existing and future risks) and type of consequences (risk to life, risk to property, risk to the environment and societal risk). The relationship between these risk dimensions is illustrated in Figure 2.1.

	Existing risk		Future risk	
Treatable risk	Life	Property	Life	Property
	Environment	Society	Environment	Society
Residual risk	Life	Property	Life	Property
	Environment	Society	Environment	Society

Figure 2.1 The dimensions of flood risk

2.3 Definition & extent of flood prone land

Flood prone land is land that is subject to flood risk, irrespective of the level of that risk. It thus encompasses all land susceptible to inundation by the probable maximum flood (the largest flood that could conceivably occur at a particular location). Flood prone land may thus include land that is inundated on extremely rare occasions, or for which there is no recorded instance of flooding.

Because flood information held by the Council is not definitive, and is being constantly updated, flood prone land is defined by the Policy as:

> *land that, on the basis of flood information held by the Council, is likely to be inundated by the probable maximum flood.*

The approximate extent of flood prone land within the City of Newcastle, based on current flood information and understanding, is shown diagrammatically in Part B of the Policy.

The affected area includes approximately 25,000 properties, or about 40% of all properties within the local government area. Actual flood risk may range from negligible to extreme. Contrary to popular perception, most of these properties are not affected by river flooding from the Hunter River.

2.4 Flooding issues

2.41 Historical context

Flooding is a natural process that plays an essential role in the evolution of riverine and estuarine landforms and the maintenance of

associated ecosystems. The Newcastle urban area has been superimposed over such landforms and ecosystems, resulting in significant modification to hydrological and ecological conditions during the past two centuries.

Many locations within the urban area correspond to former watercourses, flow paths or wetlands. Such locations are potentially subject to flooding even though physical evidence of these former hydrological features may not be readily apparent to the casual observer. Moreover, the full range of potential floods have not been experienced during the short period since European settlement.

Major floods have been recorded on numerous occasions, including 1864, 1895, 1908, 1920, 1927, 1937, 1955, 1963, 1971, 1988 and 1990. Figure 2.2 shows the extent of several recent floods.

Urban development in the 19th century took the form of a network of small villages adjacent to coal mines and the port. Subsequent growth onto intervening low lying land led to significant flooding problems, resulting in the construction of extensive channelised drainage systems in the late 19th and early 20th centuries. These systems were intended to accommodate frequent flood events, but were designed on the basis of European knowledge and experience as Australian rainfall and flooding patterns were not well understood at that time.

The drainage channel network was subsequently expanded as development proceeded further into the upper catchments. This has worsened flooding impacts in established areas.

As in other areas, flood risk management in Newcastle has traditionally emphasised risk to property. This is reflected in the adoption of the 1% AEP ('once in a lifetime') flood as the acceptable level of risk (to property). However, there is growing awareness of risk associated with floods that are much larger and rarer. Such floods can affect many thousands of dwellings, and incur highly significant risks to life. Recent occurrences of rarer and more severe floods have highlighted the need to consider the consequences of the full range of flooding up to the 'probable maximum flood'.

2.42 River flooding

River flooding has been a traditional focus of flood risk management. Rivers such as the Hunter River have large catchments and slow response times, providing ample warning of impending floods. Flood outcomes can be reasonably well predicted, and planned emergency response can generally be readily implemented.

A significant minority of flood-affected properties within the Newcastle local government area are subject to river flooding from the Hunter River. In some cases, flood waters can reach hazardous depths and velocities. However, the actual level of risk is lessened by adequate warning times.

2.43 Urban flooding

Urban flooding in local catchments is a major and widespread issue affecting the Newcastle local government area. Increased attention has been given to understanding this issue during the past decade.

Newcastle's urban catchments are relatively small and are subject to high intensity rainfall that may affect entire catchments. As a consequence, these catchment respond very rapidly to runoff. Severe flooding can occur within 15-30 minutes, leaving insufficient warning time for evacuation of affected properties. Properties can become surrounded or engulfed by high energy flood waters, creating significant risks to both life and property. For example, it is estimated that under certain conditions, floodwaters can reach 5 metres deep in the Wallsend business district in less than one hour. The Newcastle community has yet to experience a severe flood of this magnitude.

Lack of warning time for potential flooding over large areas amplifies the level of risk and complicates its management. This issue needs to be specifically addressed by flood risk management measures.

2.44 Coastal inundation

Coastal inundation associated with king tides and other coastal processes occurs in certain limited locations in Maryville, Wickham, Stockton and Carrington. It causes minor flooding from time to time, with generally low levels of risk to property.

Potential consequences of the 'enhanced greenhouse effect' such as sea level rise and increased storm surge may increase the severity or frequency of this flooding in the future.

2.5 Existing flood studies

Knowledge and understanding of flood risk in the Newcastle local government area is highly incomplete. Detailed data sets with high confidence levels are available for selected locations. However, over wide areas, only limited information is currently available. The current status of flood studies for each of 16 flood management areas is described in Part B of the Policy (Atlas).

It is not expected that 'complete' information will be available for the entire local government area for many years. This will require a progressive program of studies over the coming decade.

Until the *Throsby Creek TCM Strategy* (1989), flooding in the Newcastle area has been studied primarily in relation to the Hunter River. However, with improved understanding of river flooding in the Hunter River floodplain, the focus has shifted to urban flooding, with a particular interest in the potential for very large floods that incur significant risks to life.

The *Ironbark Creek TCM Strategy* (1996) was notable for a change in emphasis from traditional management of risk to property (based on

mitigation measures and protection works), to a recognition of the full potential range of floods and the need to address social consequences.

The *Honeysuckle Flood Management Platform* and subsequent related flood management plans (1997-1998) addressed the full spectrum of flood risks, including risk to property, risk to life and societal risk. The approach taken has since been applied to several commercial and institutional developments, and is now considered a requisite component for all future studies.

2.6 Floodplain Management Manual

The NSW Government has published the *Floodplain Management Manual* to assist local councils in the preparation of flood risk management plans. The manual outlines the following flood risk management process.

- *Data review*—identifies currently available data.
- *Flood study*—identifies flood risk by providing information on the extent, level and velocity of flood waters and on the distribution of flood flows across various sections of the floodplain.
- *Flood risk management study*—identifies and evaluates options for managing flood risk with respect to social, economic and environmental criteria, and recommends a set of preferred options.
- *Flood risk management plan*—describes the proposed suite of flood risk management measures, such as planning and development controls, development modification programs, education and awareness programs and emergency planning, and outlines details relating to timing, responsibility and implementation.
- *Flood risk management policy*—summarises the flood risk management plan.
- *Implementation and review*—the ongoing implementation and review of flood risk management measures.

2.7 Statutory exemption from liability

Under section 733 of the *Local Government Act 1993*, a council does not incur any liability in respect of advice furnished in good faith, or anything done or omitted to be done in good faith, relating to the likelihood or extent of flooding.

A council is taken to have acted in good faith if the advice was furnished, or the thing was done or omitted to be done, substantially in accordance with the principles contained in the manual notified for that purpose by the Minister for Urban Affairs and Planning (that is, the *Floodplain Management Manual*). The exemption applies generally, but the following are specifically identified as being subject to the exemption:

- the preparation or making of a local environmental plan or development control plan
- the determination of development application or a complying development certificate application
- the imposition of conditions in relation to the above applications
- advice furnished in a planning certificate
- the carrying out of flood mitigation works.

2.8 Need for a 'preliminary policy'

Appendix C of the *Floodplain Management Manual* permits the adoption of a 'preliminary floodplain risk management policy' prior to the completion of floodplain risk management plans in accordance with the manual. Such a policy is needed for the Newcastle local government area due to the currently incomplete knowledge and understanding of flood risks, and the length of time need to undertake necessary studies.

As a preliminary floodplain risk management policy, this Policy:

- expresses the Council's present flood risk management position
- outlines future work that will enable the preparation of flood risk management plans in accordance with the *Floodplain Management Manual*
- guides decisions that affect flood prone land pending the preparation of flood risk management plans
- addresses the same matters that a flood management plan will cover
- is based on the body of knowledge contained in studies that have been carried out to date (many of which are in draft form and subject to ongoing review), as well as judgements where studies have not yet been carried out
- will be updated at the completion of each study phase to reflect improved knowledge and understanding
- where no flood information of any kind is available—identifies locations that are believed may be subject to flood risk.

2.9 Related policy issues

2.91 Urban water cycle management

There is currently a movement toward 'urban water cycle management' that addresses all urban water flows as an interlinked system, including mains water supply, rainwater, stormwater and wastewater. This approach promotes the adoption of on-site stormwater control measures (such as stormwater re-use) to limit

runoff velocities and reduce sediment and pollutant transport during high-frequency rainfall events.

Such measures can potentially have some benefits for controlling discharges during rainfall events that are associated with relatively small flood risks. However, it is important to recognise that flooding is a natural process, and that flood risk will be present even if pre-development drainage behaviour can be replicated. In particular the major rare floods will not be materially changed by environmentally oriented controls.

2.92 Stormwater management for development sites

Impervious surfaces and associated drainage systems can potentially impact on flooding by increasing runoff volumes, increasing flow velocities, reducing lag times and increasing flood peaks. In recognition of these changes Council's stormwater management DCP requires new development to limit the discharge of stormwater in order for the developed catchment to emulate undeveloped runoff regimes.

It is important to recognise that, whilst new development may cause increased flooding in the case of medium-sized rainfall events, such effects are much less marked or even non-existent for very large rainfall events. In such cases, the ground becomes totally saturated, causing permeable surfaces to act as if they were impermeable. Consequently, the intensity of development has little impact on flooding arising from rainfall events that are very large and rare.

Flooding is part of a natural process and occurs in undeveloped catchments. It is therefore necessary to have additional development controls in place to ensure that downstream development is compatible with the flood risk inherent in building on a flood plain.

2.93 Civil drainage design

Issues associated with the existing local piped drainage design will be experienced from time to time, principally because of the era in which much of the drainage infrastructure was constructed. These issues are often addressed through civil works programs. Defining the limits of the trunk drainage system principally affected by flooding, and the local drainage system can sometimes be difficult. Decisions on the line of demarcation are made based on prevailing circumstances.

In new urban areas, the major / minor drainage principle is very important. Underground piped drainage systems may only be designed to cater for nuisance events, and it may be reasonably common for road carriageways to be inundated from time to time. Important drainage design principles include the shaping of road cambers so that no trapped low points are created, and the retention of all major overland flow paths in public ownership.

2.94 Stream restoration

As already noted, an important hydrological feature of the Newcastle area is the extent to which its natural watercourses have been replaced by engineered, concrete-lined channels. Whilst providing some protection against flooding impacts, channelisation has had the effect of diminishing other catchment values such as water quality, streamflow, stream ecology, riparian access and recreational opportunities. Simplification of channel morphology (removal of pools, riffles and meanders), concrete lining of channels and removal of riparian wetlands and vegetation has created a hostile aquatic environment with minimal habitat value.

Since many sections of concrete-lined channel are currently reaching the end of their economic life, interest has increasingly been given to restoring channels to 'natural profile' streams. This will require long-term asset replacement programs over many decades. Careful consideration will need to be given to flood hazards and other constraints.

Most channels are the direct responsibility of the Hunter Water Corporation, thereby necessitating collaborative programs. Stream restoration programs are currently being investigated for Ironbark Creek at Wallsend, and at Lambton Park.

Section 3 Policy framework

Outline of Part 3

This Part describes the framework for flood risk management. It outlines key decision-making principles and how they are to be applied by the Council when exercising its planning, regulatory and service functions.

3.1 Overall structure

The overall framework for flood risk management under the Policy includes the following elements, as illustrated in Figure 3.1:

- *NSW Flood Prone Lands Policy* (refer to clause 3.2)
- *Floodplain Management Manual* (refer to clause 2.7)
- section 733 of the *Local Government Act 1993* (refer to clause 2.8)
- adopted flood management principles (refer to clause 3.3)
- flood studies and plans (refer to clause 4.1)
- plan making (refer to clause 4.2)
- development assessment (refer to clause 4.3)
- risk reduction programs (refer to clause 4.4)
- flood information (refer to clause 4.5)
- community education and awareness (refer to clause 4.6)
- emergency management (refer to clause 4.7).

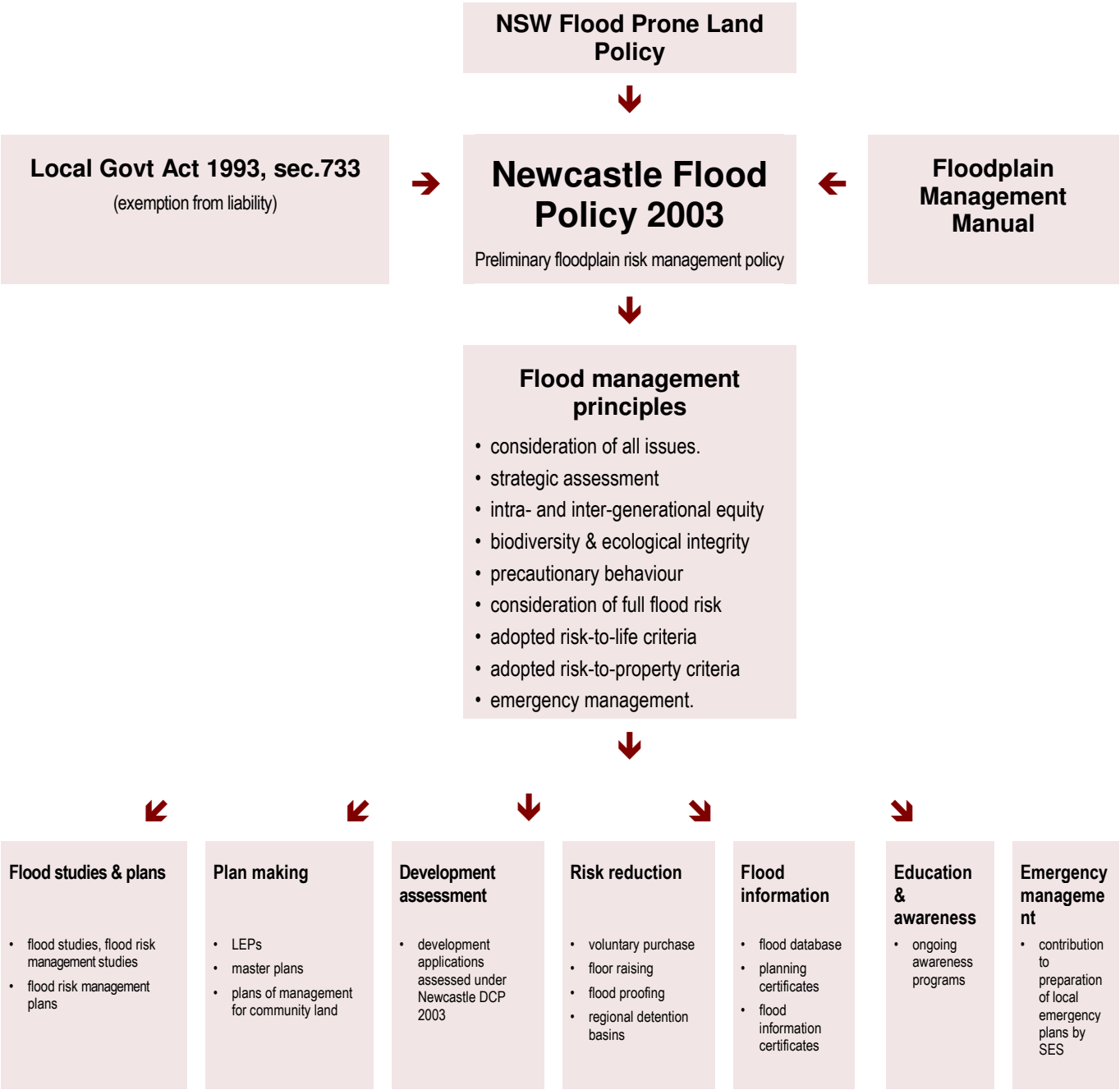
The framework is a preliminary one pending the completion of necessary flood studies and flood risk management plans.

3.2 NSW Flood Prone Land Policy

The primary objective of the *NSW Flood Prone Land Policy* (refer to Appendix 8.1) is to reduce the impact of flooding and flood liability on individual owners and occupiers of flood prone property, and to reduce private and public losses resulting from floods. The policy recognises the benefits of floodplain occupation, the social, economic and environmental values of flood prone land, and the need for an approach that balances the full range of issues.

Primary responsibility for achievement of the policy's objectives rests with local councils. This entails the preparation and implementation of flood risk management plans that identify a suite of appropriate flood risk management measures, such as planning and development controls, development modification programs, education and awareness programs, protection works and emergency management.

Figure 3.1 Preliminary framework for flood risk management



3.3 Flood management principles

There are nine general principles that are to underpin all decisions relating to the utilisation of flood prone land or the management of flood risks :

- consideration of the full range of issues
- strategic assessment
- intra- and inter-generational equity
- conservation of biodiversity & ecological integrity
- precautionary behaviour and uncertainty
- consideration of full flood risk
- adopted risk-to-life criteria
- adopted risk-to-property criteria
- integration with emergency management.

3.31 Consideration of the full range of issues

Decisions should take into account all potential opportunities and losses associated with the utilisation of flood prone land.

Assessment requires the potential benefits of using flood prone land to be weighed against the inherent costs. The existence of flood risk is, by itself, insufficient reason to preclude development.

Potential opportunities include use of existing infrastructure and avoidance of substantial opportunity costs. Potential losses include injury, loss of life, property damage, social impacts, ecological impacts and cost of risk treatment measures. By obtaining an acceptable balance, this assessment avoids the imposition of unnecessary development restrictions. This allows outcomes that are equitable and which maximise long-term benefits for the community.

An implication of merit-based assessment is the need for development assessment criteria to reflect actual levels of risk (likelihood and consequences) for specific locations and types of development. This requires an understanding of how flood characteristics vary in space, the impacts of development on flood characteristics, and the vulnerability of different types of development to flooding.

3.32 Strategic assessment

Decisions should consider the strategic context within which they are made, including possible cumulative impacts.

It is insufficient to consider acceptability of flood risk solely on the basis of a particular proposal at a particular location. Case-by-case

decision-making cannot take into account aggregated and interactive effects of a multitude of activities or decisions over time.

It is thus necessary to place all decisions within a strategic assessment framework that takes into account:

- social, economic, environmental and organisational context
- likely future changes in population, density and value of property
- cumulative impacts on flood behaviour and their consequences, assuming a multitude of similar decisions over time
- adopted risk acceptance criteria.

The current strategic context for specific flood management areas is summarised in Part B of the Policy.

3.33 Intra- and inter-generational equity

Decisions should promote equitable sharing of risk, both within the present generation and in relation to future generations.

Intra- and inter-generational equity is a key principle of ecologically sustainable development that has important implications to flood risk management. For example:

- consideration of the full range of issues when assessing development proposals, thereby avoiding undue burden on the owners of flood prone land
- decisions should seek to prevent future growth in risk, except where the likely benefits to both present and future generations from taking the risk outweigh the potential consequences.

3.34 Conservation of biodiversity & ecological integrity

Decisions should seek to protect and maintain the continuity of biodiversity and ecological integrity.

Conservation of biodiversity & ecological integrity is a key principle of ecologically sustainable development that has important implications to flood risk management. For example:

- Riverine environments within the City of Newcastle have been severely degraded by stormwater channelisation schemes constructed in the early 20th Century. Whilst providing some protection against flooding impacts, channelisation has had the effect of diminishing other catchment values such as water quality, streamflow, and aquatic and riparian ecology.
- Restoration of channelised streams to reinstate natural values will require long-term solutions over several generations. Careful consideration will need to be given to flood hazards and other

constraints. Strategies will need to be incorporated in long-term asset replacement programs for streets, drainage, housing and other elements of the urban environment.

- Development, flood management and stormwater management activities should be undertaken in a manner that promotes the long-term restoration of aquatic and riparian environments. Consequently, further channelisation of streams, or the construction of buildings and culverts over streams and channels, should not be supported.
- Activities involving the handling of toxic materials should not be located on flood prone land.

3.35 Precautionary behaviour & uncertainty

Decisions should address uncertainty and limitations in flood information and understanding, particularly if there is the possibility of serious or irreversible consequences.

The precautionary principle is a key principle of ecologically sustainable development. Important implications to flood risk management include:

- decisions should be guided by the risk-weighted consequences of various options
- decisions need to carefully address implications of uncertainty and limitations in the understanding of hydrological and other processes
- management decisions should be flexible, robust and capable of addressing the full consequences of risk.

Flood information may have a variety of different confidence levels depending on the methods that were used in the derivation of that information, the status of review and the extent of confirmation. Consequently, flood information needs to be carefully categorised according to its confidence level so that an appropriate level of reliance can be placed upon it when making decisions.

In some circumstances, flood information on which decisions are based may be preliminary and subject to review at a later date. As more accurate or confident information becomes available, decisions should be based on the best available flood information, rather than older information used as the basis for past decisions. This may result in apparent discrepancies between historical and recent decisions.

3.36 Consideration of full flood risk

Decisions should address the full spectrum of flood risks across all risk dimensions.

The entire universe of flood risk illustrated in Figure 2.1 should be addressed in all decisions. This involves consideration of three risk dimensions:

- *management response*—treatable and residual risks
- *generational impact*—existing and future risks
- *type of consequences*—risk to life, risk to property, risk to the environment and societal risk.

Consideration of full flood risk implies that the geographical extent of flood risk management must extend to the theoretical limit of flooding, that is, the probable maximum flood.

This differs from traditional approaches that have adopted a restricted definition of flood prone land based on the acceptable level of risk to property (generally corresponding to the 1% AEP flood). Such approaches do not explicitly recognise the existence of residual risk. Whilst residual risks are not the subject of active risk treatment measures, nevertheless, consideration should be given to the likely means of responding to and recovering from the occurrence of such an event (for example, an extremely rare but catastrophic flood). For example, essential services should generally not be located on flood prone land.

In keeping with the principle of inter-generational equity, it is essential to consider both existing and future risks. This will ensure that the burden of risk is not transferred to future generations.

Attention also needs to be given to social, economic and environmental consequences of flood risk and risk treatment measures. In addition to injury, death and property damage, consideration should be given to issues such as damage to public infrastructure, social impacts, economic disruption, and ecological impacts. Care is required to ensure that decisions are not made solely on narrow financial or economic grounds.

3.37 Adopted risk-to-life principles

Development should be consistent with adopted risk-to-life criteria.

Assessment of flood risk has traditionally focussed on property damage, and generally has not fully considered the risk to life. This reflects a general lack of awareness in the community of the risks to life posed by very infrequent floods.

Because of the very high value placed on life, the acceptable risk-to-life criteria adopted by this policy relate to the probable maximum flood (PMF), that is, the largest flood that could conceivably occur at a particular location.

In order to facilitate the assessment of proposals, the hydraulic hazard categories defined in the technical manual are adopted.

Detailed risk-to-life assessment criteria for individual development proposals are as specified by Council's Development Control Plan. Since local catchments have the potential to rise within half an hour during a PMF event, there will generally be insufficient warning time to allow safe evacuation across flood-affected land. Consequently on-site refuge will normally be required to satisfy the acceptable risk-to-life criteria.

3.38 Adopted risk-to-property principles

Development should be consistent with adopted risk-to-property criteria.

In Australia, the 1% AEP flood event has traditionally been adopted as defining the acceptable risk-to-property criteria. This reflects the community's willingness to bear 'once in a lifetime' property damages in return for (on average) a century or more of social, economic and other benefits. Where floods are more frequent (that is, where the chance of a flood occurring in any one year is greater than 1 in 100), the risk-reward tradeoff is generally not considered acceptable to the community, thereby warranting publicly imposed restrictions on development.

Areas with unacceptable risk to property are generally delineated by means of an adopted flood planning level (FPL). The FPL is the level below which development is subject to flood-related development controls relating to risk to property. It corresponds to a selected annual exceedance probability value, with an additional allowance for freeboard. Different FPLs may apply to different types or purposes of development according to the level of risk involved.

The Policy adopts a FPL corresponding to the 1% AEP flood for all development. This criteria is to be reviewed through the completion of detailed flood studies and flood risk management plans.

In order to facilitate the assessment of proposals, the hydraulic hazard categories defined in the technical manual are adopted.

Detailed risk-to-property assessment criteria for individual development proposals are as specified in Council's Development Control Plan. In general, floor levels should be set above the FPL in order to protect the contents of the building from unacceptably frequent flooding. Decisions regarding additions and alterations to existing flood-affected development should consider the merits of the case, subject to the general principle that the overall level of risk should not be increased.

3.39 Integration with emergency management

Decisions should address any implications for flood-related emergency management.

Emergency management refers to measures that are intended to prevent, prepare for, respond to and recover from an emergency. The State Emergency Service through local emergency management committees is responsible for preparing local emergency plans, including local flood plans.

It is important that decisions relating to the utilisation of flood prone land do not have adverse consequences for emergency management. This requires careful consideration of issues such as evacuation and warning.

3.4 Flood management process

Due to the absence of adopted flood risk management plans, care is required to ensure that all decisions relating to the utilisation of flood prone land or the management of flood risks reflect the flood management principles outlined in clause 3.3 above.

The decision-making process illustrated in Figure 3.2, seeks to apply these principles. The process applies irrespective of the geographical scale in question (such as allotment, precinct, catchment or subregion).

Figure 3.2 Flood management process

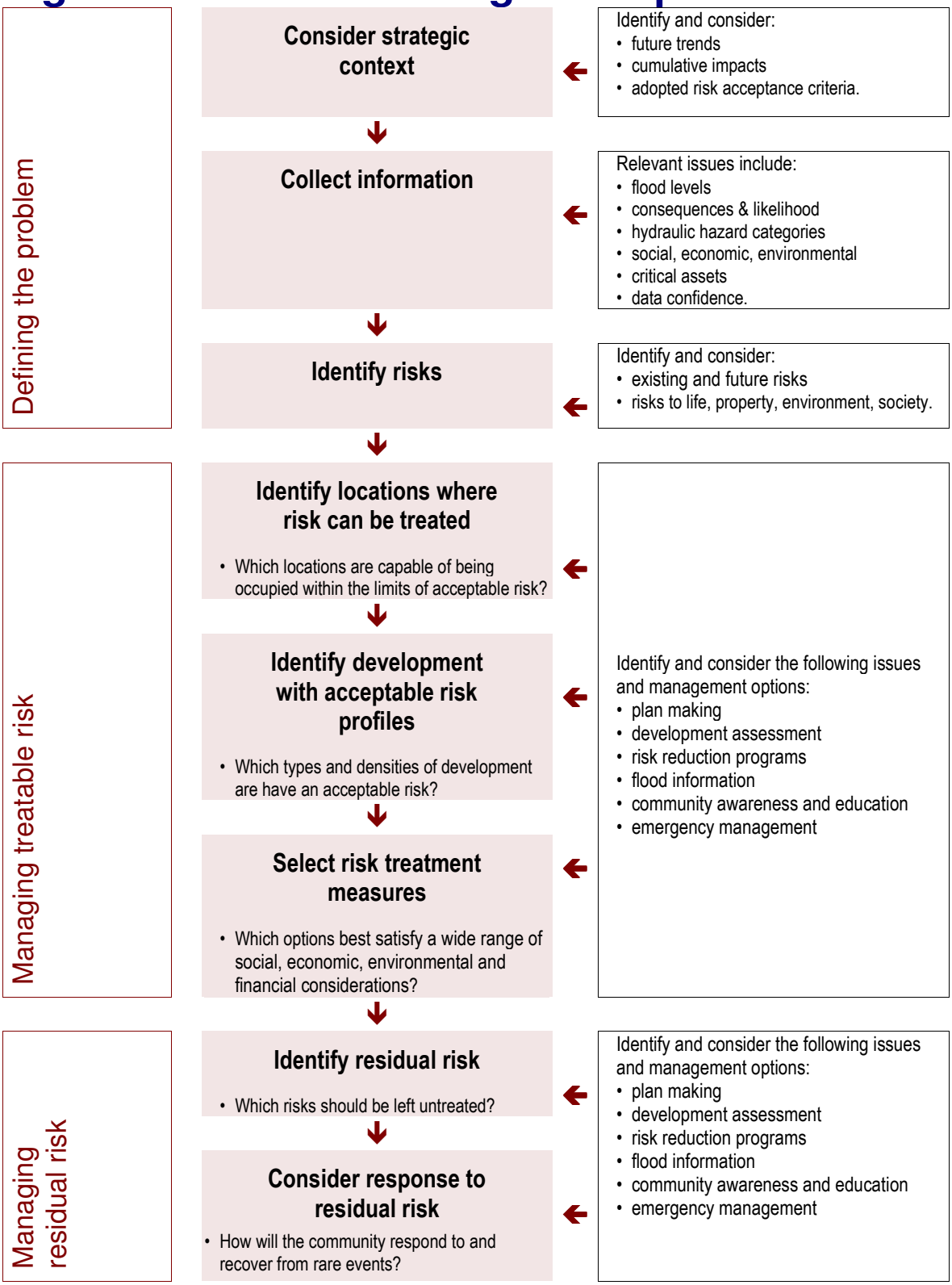


Figure 3.3

Flood management process outcome scenarios

	Is Development Compatible with Flood Risks/ Environment Strategy?	Incompatible Risks and Incompatibilities Treatable?	OUTCOME
ALREADY DEVELOPED	**YES**	**N/A**	Continue Occupation
	NO	**YES**	Modify Risk Environment eg increased awareness and warnings, house ranking, if feasible modify flood ?
		NO	Cease Operation
POTENTIAL FUTURE DEVELOPMENT	**YES**	**N/A**	Continue planning for future (compatible) development
	NO	**YES**	Modify or change development (eg. filling if no adverse impacts, reduce scale, to compatible development types)
		NO	Unsuitable for future (Incompatible) development (and possibly unsuitable for all future development)
ALREADY DEVELOPED	**YES**	**N/A**	Continue with present emergency response provisions (SES – Flood Plan)
	NO	**YES**	Modify emergency response provisions (SES – Flood Plan) including warning capacities.
		NO	People's lives and property will be lost in floors where this should not happen
POTENTIAL FUTURE DEVELOPMENT	**YES**	**N/A**	Continue planning for future (compatible) development
	NO	**YES**	Modify or change development (eg. filling if no adverse impacts, reduce scale, to compatible development types)
		NO	Unsuitable for future development (all development)

BEFORE THE FLOOD (PLANNING FOCUSED)	DURING & AFTER THE FLOOD (REAL TIME EMERGENCY RESPONSE FOCUS)

Section 4 Management strategy

Outline of Part 4

This Part outlines the program of measures that are proposed to be carried out in order to achieve the objectives of the Policy.

4.1 Flood studies & plans

4.11 Completion of studies & plans

Flood studies, flood risk management studies and flood risk management plans shall be completed across the City of Newcastle. All studies and plans are to be prepared in accordance with the *Floodplain Management Manual* having regard to:

- the flood management principles referred to in clause 3.3
- the flood management process referred to in clause 3.4
- the strategic context for the particular flood management areas, as summarised in Part B of the Policy.

4.12 Completion of City-wide flood risk management plan

Upon completion of flood studies, flood risk management studies and flood risk management plans for all flood management areas, a consolidated City-wide flood risk management plan is to be completed. This is to be encapsulated as a Newcastle Flood Risk Policy that will replace subsequent versions of this Policy.

4.2 Plan making

4.21 Application of the Policy

The Council will apply the Policy when it prepares or approves any of the following plans that apply to flood prone land:

- draft local environmental plans
- master plans
- plans of management for community land.

4.22 Matters for consideration

The Council is to take into consideration each of the following:

- the flood management principles referred to in clause 3.3

- the flood management process referred to in clause 3.4
- the strategic context for the particular flood management area, as summarised in Part B of the Policy.
- the suitability of the site (refer to clause 4.23)
- the impact of permitted development (refer to clause 4.24)
- the need for special plan provisions relating to the management of flood risk (refer to clause 4.25)

4.23 Site suitability

The characteristics of flooding at a site may make it unsuitable for particular types of development. This will occur when the level of risk to life or property is unacceptable, and it is not possible or practicable to apply measures to reduce those risks to acceptable levels.

For example, some areas may have deep and relatively fast flowing water, major damage potential and be generally unsuitable for most development. Circumstances in which various types of development are considered unsuitable are outlined in detail in the technical manual.

The Council is to consider the suitability of the site for development proposed to be permitted under the plan. It should not prepare or approve a plan that would permit development of a type for which the site is unsuitable. When approving a plan, the Council must be satisfied that the plan will not give rise to unacceptable risks to life, property, the environment or society.

4.24 Impact of permitted development

It is necessary to consider how development that is permitted under a proposed plan could affect flooding behaviour at other locations. This will depend on both the characteristics of flooding at the site, and the type of permitted development.

Development that alters the contours of flood prone land, or that presents an impediment to the free flow of floodwaters, has the potential to affect flooding at other sites. This applies particularly to development within floodways. It is not only necessary to consider the impacts of proposed development, but also the cumulative impacts of all development likely to occur within the catchment. This underlines the need to consider the strategic context (see clause 3.32).

The Council should not prepare or approve a plan that would permit development that is likely to induce unreasonable flooding impacts at other locations. When approving a plan, the Council must be satisfied that the plan will not give rise to unacceptable risks to life, property, the environment or society.

4.25 Measures to manage flood risk

Before approving a plan, the Council is to consider the need to include special provisions in the plan relating to the management of flood risk (including risk to life, risk to property, risk to the environment and societal risk). Such provisions could relate to:

- matters required to be taken into consideration by the Council when granting development consent in relation of the land
- measures that must be undertaken by a proponent before the Council may grant development consent in relation of the land.

4.26 Local flood studies

The Council is to obtain and consider a local flood study if there is insufficient information available to allow an adequate consideration of the matters referred to in clause 4.22. The purpose of such a study is to enable the Council to:

- assess the degree of flood risk (including risk to life, risk to property, risk to the environment and societal risk)
- ascertain the extent of any likely cumulative impacts
- determine whether the risks are acceptable
- make an informed decision as to whether it should proceed with the draft plan.

The appropriate level of detail for the local flood study will depend on the circumstances. The scope of the study should be established in consultation with relevant Council officers. Generic specifications for a local flood study are outlined in the technical manual .The proponent is responsible for undertaking and paying for a the local flood study.

4.3 Development assessment

4.31 Development Control Plan

The policy has a related Development Control Plan (DCP) that is intended to guide development assessment. The principles of this policy are embodied in the DCP. The DCP has a common technical manual with this policy as both rely on the same body of definitions for hazards and other technical data.

4.4 Risk reduction programs

4.41 Applicable matters

Risk reduction programs comprise works and other measures that seek to improve the acceptability of flood risk associated with existing development that is inappropriately located or designed. Examples include:

- voluntary purchase schemes in locations with unacceptably high risk to life or property
- relocation of development to sites with lower risk profiles
- raising buildings or facilities above an adopted flood planning level
- flood proofing of buildings
- redesign of buildings or infrastructure to reduce adverse hydraulic impacts
- construction of regional flood detention basins.
- flood depth warning indicators in areas where flooding occurs more frequently than 2 years ARI

4.42 Initiation of new programs

Proposals to undertake risk reduction programs need to be supported by reliable, high-confidence flood information. Due to the incomplete state of flood information for most Newcastle catchments, the Council is to generally refrain from initiating new risk reduction programs pending the completion and adoption of flood risk management plans.

4.43 Ongoing programs

Some risk reduction programs operate on an ongoing basis under Commonwealth-State funding arrangements. Proposals under such programs should be carefully evaluated according to the following selection criteria so as to reflect a wide range of social, economic, environmental and financial considerations.

- *Sustainability*—the proposal is consistent with the principles of ecologically sustainable development.
- *Understanding of flood environment*—there is sufficient flood information available to enable a proper assessment of the impacts of the proposal, including cumulative impacts.
- *Likely impacts*—the social, economic and environmental impacts are acceptable to the community.
- *Acceptable risk*—the level of risk to life, property and the environment is acceptable.
- *Cost-benefit*—the cost-benefit of the proposal is positive, and is superior to alternative options.
- *Financial*—the proposal can be adequately financed, both initially and in the long term.
- *Legal and regulatory*—the proposal is compatible with legal and regulatory constraints, including land tenure issues and approvals by Commonwealth and State agencies.
- *Public domain*—the option protects or enhances the public domain, particularly the public's right to access, use and enjoy foreshores and waterways.

- *Community support*—the community understands and supports the proposal.

4.5 Flood information

4.51 Applicable matters

The Council will apply the Policy when it:

- records and keeps information relating to the likelihood, extent and other characteristics of flooding ('flood information')
- supplies flood information to the public.

4.52 General principles

Flood information should be gathered, kept and disseminated in such a manner as to:

- provide a basis for informed and merit-based planning decisions
- facilitate its provision to the community
- enable the Council to exercise its duties with reasonable care and diligence
- acknowledge any limitations on information, such as its degree of uncertainty or accuracy, collection date and purpose of collection.

4.53 Flood database

So as to facilitate its functions relating to flood management, the Council is to maintain a dedicated information system for flood information.

Wherever possible, details are to be kept regarding the source, collection date, collection purpose and confidence level of data kept within the information system. The following confidence level categories should generally be adopted.

Category	Confidence description
0	No specific flood information or flood management results are available. However, the area is identified as having a potential risk of flooding based on a field inspection or indicative ground level contours.
1	The flood information or flood management results are judgements only, using available indicative information such as historic flood information, accurate ground level contours and field inspections.
2	Preliminary study
3	Confident study (draft)
4	Confident study (adopted)

4.54 Availability of information

Flood information held by the Council will be made available to the public by the following means:

- by issuing flood information certificates
- by making documents and public registers available for inspection
- by providing access to documents in accordance with the *Freedom of Information Act 1989*.

4.55 Planning certificates

A planning certificate is a certificate issued under section 149 of the *Environmental Planning and Assessment Act 1979*. It provides information about planning and other matters relating to a specified parcel of land. Planning certificates are of two types:

- certificates containing only information on matters prescribed under section 149(2) ('basic certificates')
- certificates containing information provided under section 149(2) and additional information under section 149(5) ('full certificates').

The following information is to be disclosed under section 149(2) in relation to Item 7: *Council and other public authority policies on hazard risk restrictions*.

- A statement that the Council has adopted the *Newcastle Flood Policy 2003* and associated development assessment criteria contained in DCP 55, 'the Policy and DCP' as a preliminary measure pending the completion of all necessary flood studies and flood risk management plans.

- A statement that information currently held by the Council regarding the likelihood, extent or other characteristics of flooding affecting the land may be obtained by applying for a flood information certificate.

4.56 Flood information certificates

More detailed flood information is disclosed on a flood information certificate. Any person may apply for a flood information certificate on payment of the approved fee.

The following information is to be disclosed on certificates relating to land that is flood prone land.

- Brief details regarding the extent, likelihood or other characteristics of flooding affecting the land of which the Council is aware, including:
  - flood levels for 10% AEP, 5% AEP, 2% AEP, 1% AEP and PMF floods (where known)

- hydraulic hazard categories for 1% AEP and PMF floods (where known)
- confidence levels associated with the above information.
- applicable freeboard

- Particulars of the title, author and date of reports or studies from which the above information is sourced.
- A statement that the above reports or studies may be inspected upon request at the office of the Council.
- A statement that prospective purchasers and others are advised to examine and consider the contents of those reports or studies.
- A statement that the flood information held by the Council is not definitive, and that prospective purchasers and others are advised to make their own investigations as to the extent, likelihood or other characteristics of flooding affecting the land.

4.6 Community awareness & education

Community awareness and education is a critical part of the policy. This is because on average, floods are a rare event and the community and decision makers can lose awareness of the risks in the times between floods.

From time to time, Council will conduct flood oriented community awareness programs to the community and decision makers.

4.7 Emergency management

Emergency management is the province of the State Emergency Service, with some related agencies providing assistance (for example the Bureau of Meteorology in flood warnings).

Council will maintain a close liaison with the Emergency Management Agencies by sharing information and seeking their direct participation in plan making and related decision making.

Section 5 Implementation

Outline of Part 5

This Part outlines the overall strategy for implementing the Policy as part of an adaptive management approach.

5.1 Council management plan

The objectives and management strategy of the Policy are to be integrated within the council's Management Plan process.

Under sections 402-406 of the *Local Government Act 1993*, the council must prepare and adopt an overall 'Management Plan' that articulates adopted visions and goals and the proposed means by which these are to be pursued in the short-to-medium term. The Management Plant is revised and updated on an annual cycle.

This Policy is to be reflected in the Council's Management Plan on an ongoing basis. Relevant objectives and programs will need to be incorporated within the Management Plan. This will:

- ensure that the Council's activities reflect the objectives and principles of this Policy
- assist integration of flood risk management initiatives across the entire organisation
- help explain flood risk management issues to the community
- ensure that proposed programs are adequately funded
- facilitate ongoing plan evaluation
- create formal links to state of the environment reporting.

5.2 Inter-agency collaboration & coordination

The Council will maintain close working relationships with the following key agencies

- Department of Infrastructure Planning and Natural Resouerces
- Hunter Water Corporation
- Hunter Catchment Management Trust
- Surrounding Councils
- State Emergency Services
- NSW Flood Warning Consultative Committee
- The Floodplain Management Authorities of NSW

These relationships will be through these agencies participating in Council's Flood Risk Management Committee, or strategic coordinating committees.

5.3 Community partnerships

The Council will strengthen partnerships with community, industry and other stakeholder groups.

5.4 Reporting, evaluation & review

5.41 Reporting & evaluation

The Council is to monitor, evaluate and report on the implementation of this Policy, with specific reference to:

- *flood studies and plans*—the extent to which the targets referred to in clause 4.1 have been met
- *plan making*—the extent to which new local environmental planning instruments are considerate of clause 4.2
- *development assessment*—the extent to which new development embodies the principles of this plan, and what amendments are required to the plan and the DCP in order to ensure development continues to be appropriately assessed.
- *risk reduction programs*—identifying new risk reduction programs that may be required from time to time in accordance with cause 4.4 and the extent to which they are implemented.
- *flood information*—the number of certificates issued and any strategic issues that arise from the issuing of those certificates
- *community education and awareness*—the nature of any education programs in accordance with clause 4.6 and extent to which they are successful.
- *emergency management*—the relationship with the State Emergency Service and the nature of any other disaster management planning or implementation program and the extent to which they are successful.

The results of such monitoring are to be to be included in the Council's annual report as to the state of the environment prepared under section 428(2)(c) of the *Local Government Act 1993*.

5.43 Review of the Policy

The Council is to commence a review of the Policy immediately upon any decision to prepare a flood risk management study in accordance with the *Floodplain Management Manual*.

The purpose of the review is to determine whether the objectives of the Policy remain valid, and whether the contents of the Policy remain appropriate for securing those objectives. In undertaking the review, the Council is to:

- consider the findings of relevant studies
- consult with relevant public authorities or other persons
- consult with the community in accordance with the Council's *Community Consultation Policy* (1998).

Following completion of the review, the Council is to arrange for an updated policy to be adopted in parallel with the adoption of any flood risk management plan arising from the flood risk management study.

5.5 Floodplain risk management committee

The Council will manage its affairs with respect to the implementation of this policy and any other matters to do with flooding through a forum of interested persons to be known as the Newcastle Flood Risk Management Committee.

The committee will be made up of:

- Councillors
- Council officers
- Officers of the NSW State Government
- Community representatives
- Hunter Water Corporation officers
- SES officers
- Newcastle Port Corporation officers
- Professional and Industry (eg development)
- Other interested parties from time to time

The committee may form sub-committees as the need arises to address particular issues.

Section 6 Glossary

Annual exceedance probability (AEP) is the probability that a flood of a given or larger magnitude will occur within a period of one year. Its reciprocal is equivalent to average recurrence interval.

Australian height datum (AHD) is a standard datum for expressing vertical information. It corresponds approximately to mean sea level.

Average recurrence interval (ARI) is the average period between floods of a given or larger magnitude, expressed in years. Its reciprocal is equivalent to annual exceedance probability.

Building includes a structure.

Catchment is the entire area of land drained by a river and its tributaries.

Consequence refers to the outcome of an event expressed qualitatively or quantitatively, being loss, injury, disadvantage or gain. There may be a range of possible outcomes associated with an event.

Continuing flood risk—see 'residual flood risk'.

Council means Newcastle City Council

Council management plan is the corporate plan required to be prepared annually under Part 2 of Chapter 13 of the *Local Government Act 1993*. It describes the Council's principal activities for a period of at least three years, and specifies objectives, performance targets and performance evaluation criteria in relation to these activities.

Cumulative impact refers to the aggregated and interactive effects of a multitude of activities or decisions over time, usually at a regional or catchment level.

Development is defined by the *Environmental Planning and Assessment Act 1979* to mean the use of land, the subdivision of land, the erection of a building, the carrying out of a work, the demolition of a building or work, or any other act, matter or thing controlled by an environmental planning instrument.

Development control plan (DCP) is a type of plan prepared under the *Environmental Planning and Assessment Act 1979*. DCPs provide more detail than a local environmental plan, and must be considered when councils determine development applications.

Ecologically sustainable development: An approach to development that considers the needs of future generations whilst satisfying present day aspirations. Under the *Local Government Act 1993*, it is part of each local council's charter to promote certain principles of ecologically sustainable development relating to precautionary

decision-making, intergenerational equity, conservation of biodiversity and valuation of resources.

Emergency management refers to measures that are intended to prevent, prepare for, respond to and recover from an emergency.

Essential services refers to services and facilities the operation or availability of which are important to the recovery from an emergency, and include hospitals, educational establishments, places of assembly, places of public worship, police stations, fire stations, ambulance stations, telephone exchanges, electricity substations and water and sewerage pumping stations

Existing flood risk refers to flood risk associated with existing development on flood prone land.

Flood information refers to information relating to the likelihood, extent or other characteristics of flooding.

Flood information certificate is a certificate issued by the Council that provides information about the likelihood, extent or other characteristics of flooding known to affect a specified parcel of land.

Flood planning level (FPL) refers to a level below which specified development is subject to flood-related development controls relating to risk to property. The FPL adopted by the *Newcastle Flood Policy 2003* for all development is the flood level corresponding to a flood event with an annual exceedance probability of 1%, with an additional allowance for freeboard.

Flood prone land refers to land that, on the basis of flood information held by the Council, is likely to be inundated by the probable maximum flood.

Note: The approximate extent of flood prone land is shown diagrammatically in Part B of the Policy.

Flood risk refers to risk arising from the likelihood of flooding. Flood risk can be categorised in several different ways:

- treatable and residual risks
- existing and future risks
- risks relating to different consequences—risk to life, risk to property, risk to the environment and societal risk.

Flooding refers to the inundation of land that is not usually inundated. Flooding may occur due to a variety of reasons, either separately or in combination. Important types of flooding include:

- *river flooding*—caused by a river or stream overtopping its banks onto the surrounding floodplain
- *urban flooding*—caused by urban stormwater flows during an intense rainfall event, such as surface flows, surcharge from piped drainage systems or overflow from man-made stormwater channels.

- *coastal inundation*—caused by sea water inundation due to king tides, storm surge, barometric effects, tsunami, shoreline recession, subsidence, the enhanced greenhouse effect or other causes.

Tsunami and very minor nuisance flooding (such as the trapping of surface runoff in a road shoulder or against a building) are specifically excluded from the application of the Policy.

Floodplain refers to flood prone land situated along the course of a river and subject to periodic inundation due to the river overtopping its bank.

Floodplain Management Manual refers to the manual relating to the management of flood liable land notified under section 733(5) of the *Local Government Act 1993*.

Floodplain risk management plan is a plan that identifies a suite of appropriate risk management measures that are to be implemented in relation to a given area of flood prone land. Possible risk management measures could include planning controls, land acquisition programs, floor raising programs, structural mitigation works, education and awareness programs, emergency management and other measures. Floodplain risk management plans are prepared following a comprehensive investigation of flood behaviour, likely cumulative effects and social, economic and environmental factors.

Floodway refers to a pathway taken by major discharges of floodwaters, the obstruction or partial obstruction of which would cause a significant redistribution of floodwaters, or a significant increase in flood levels. Floodways are often aligned with natural channels, are usually characterised by deep and relatively fast flowing water, and have major damage potential.

Freeboard is a safety margin applied to the estimation of flood levels to compensate for uncertainties due to factors such as wave action, localised hydraulic behaviour and climatic change.

Frequency is a measure of the rate of occurrence of an event expressed as the number of occurrences of an event within a given time.

Future flood risk refers to flood risk associated with new development on flood prone land.

Hazard refers to a source of potential harm or a situation with a potential to cause loss. Flooding is an example of a hazard.

Hydraulic hazard category refers to a set of circumstances that constitutes a particular level of hydraulic hazard, as specified in Appendices 7.3 and 7.4 of this Policy.

Hydraulics refers to the study of the flow characteristics of water. In relation to flooding, hydraulics is concerned with the evaluation of flow parameters such as water level and velocity, and the interaction of flow with buildings, embankments and other obstructions.

Hydrology refers to the study of the rainfall and runoff processes. In relation to flooding, hydrology is concerned with the evaluation of peak flows, flow volumes and their variation through time.

Likelihood refers to a qualitative description of probability or frequency.

Local flood study is a study of flood behaviour and flood risk undertaken in relation to a specific study area or development proposal by the proponent. It seeks to:

- assess the degree of flood risk (including risk to life, risk to property, risk to the environment and societal risk)
- ascertain the extent of any likely cumulative impacts
- determine whether the risks are acceptable
- provide an adequate factual basis for the council to make decisions on draft planning proposals or development applications.

Generic specifications for a local flood study are outlined in Appendix 7.2.

Local environmental plan (LEP) is a type of planning instrument prepared under the *Environmental Planning and Assessment Act 1979*. LEPs provide the broad framework for environmental planning and development control, and outline objectives, planning principles, urban structure, land use controls, approval criteria, and other matters.

Loss refers to any negative consequences, financial or otherwise.

Master plan means provisions contained in a Development Control Plan that relates to a specific geographical area that specify objectives, principles or criteria for the design and layout of development within a defined precinct or location. A master plan may consist of written information, maps and diagrams.

On-site stormwater detention (OSD) is a stormwater management practice that limits the rate of discharge from a site using outlet restriction devices. Stormwater flows in excess of the capacity of the outflow control device are temporarily stored either in tanks or surface depressions until the storm event recedes, and then released to the drainage system at a controlled rate.

On-site stormwater retention is a stormwater management practice that provides temporary storage of storm runoff, which is subsequently infiltrated to the surrounding soil or utilised within the site. It seeks to reduce peak flows, runoff volumes and pollution conveyance to downstream waters. Examples include infiltration trenches and leaky wells. Design needs to consider site conditions such as soil permeability and reactivity to water.

Plan of management for community land is a plan adopted under Division 2 of Part 2 of Chapter 6 of the *Local Government Act 1993*. Such plans specify how an area of community land is to be used and managed.

Planning certificate is a certificate issued under section 149 of the *Environmental Planning and Assessment Act 1979* that provides information about planning and other matters relating to a specified parcel of land. Planning certificates are of two types:

- certificates containing only information on matters prescribed under section 149(2) ('basic certificates')
- certificates containing information provided under section 149(2) and additional information under section 149(5) ('full certificates').

Under the *Conveyancing (Sale of Land) Regulation 2000*, a 'basic certificate' must be attached by the vendor to any contract for the sale of land. It is not mandatory to provide a 'full certificate' with such a contract.

Probability refers to the likelihood of a specific event or outcome, measured by the ratio of specific events or outcomes to the total number of possible events or outcomes. It is expressed as a number between 0 and 1, or as a percentage.

Probable maximum flood (PMF) is the largest flood that could conceivably occur at a particular location.

Residual risk refers to the remaining level of risk after risk treatment measures have been undertaken. It is sometimes also referred to as 'continuing risk'.

Risk refers to the chance of something happening that will have an impact on the objectives of a person, organisation or the community. It is measured in terms of consequences and likelihood.

Risk acceptance refers to an informed decision to accept the consequences and the likelihood of a particular risk.

Risk management refers to the process of identifying, analysing, evaluating, treating, monitoring and communicating risks in a way that minimises losses and maximises opportunities. It is described generically in *AS/NZS 4360:1999 Risk Management*.

Risk treatment refers to the selection and implementation of appropriate options for dealing with risk. Risk treatment options include:

- avoiding the risk
- reducing the likelihood
- reducing the consequences
- transferring the risk
- retaining the risk.

Runoff is the portion of rainfall that flows across the ground surface as water.

Subcatchment is a component of a catchment which drains into a discrete section of the river system.

Treatable risk refers to risk that is actively dealt with by risk treatment measures. It is located below an adopted flood planning level.

Tsunami refers to long period ocean waves generated by geological processes such as faulting, volcanic activity or undersea landslides. They are often incorrectly referred to as 'tidal waves'.

Section 7 Appendices

7.1 NSW Flood Prone Land Policy

Reproduced from NSW Government (2001) *Floodplain Management Manual*, Department of Land & Water Conservation, Newcastle.

The Policy Statement

The primary objective of the policy is to reduce the impact of flooding and flood liability on individual owners and occupiers of flood prone property, and to reduce private and public losses resulting from floods, utilising ecologically positive methods wherever possible. That is:

- a merit approach shall be adopted for all development decision, which takes into account social, economic and ecological factors, as well as flooding considerations;
- both mainstream and overland flooding shall be addressed, using the merit approach, in preparation and implementation by councils of floodplain risk management plans;
- the impact of flooding and flood liability on existing developed areas identified in floodplain risk management plans shall be reduced by flood mitigation works and measures, including ongoing emergency management measures, the raising of houses where appropriate and by development controls; and
- the potential for flood losses in all areas proposed for development or redevelopment shall be contained by the application of ecologically sensitive planning and development controls.

To achieve its primary objective, the policy provides for:

- financial assistance by the NSW government for works to reduce potential flood damage and personal danger in existing developed areas;
- the provision of technical support to local government in ensuring that the management of flood prone land is consistent with flood risk and that such development does not cause undue future distress to individuals nor unduly increase potential flood liability to them or to the community;
- emergency management and flood recovery programs and their linkage with the floodplain risk management process;
- the protection of councils, government agencies and their staff against claims for damages resulting from their issuing advice or granting approvals on floodplains, providing such action was taken in accordance with the principles and guidelines in the Floodplain Management Manual.

The policy shall be implemented in the following manner.

- The management of flood prone land is, primarily, the responsibility of councils. As such, the standards and implementation arrangements shall be in accordance with the policies, procedures and management plans determined by councils.
- The NSW Government, through the Department of Land and Water Conservation, the Department of Urban Affairs and Planning and the State Emergency Service, shall provide specialist technical assistance on all flooding matters. The Floodplain Management Manual shall be provided to assist councils in the preparation of floodplain risk management plans.
- The establishment of local floodplain risk management committees by councils, through which local community groups and individuals can effectively communicate their aspirations concerning the management of the flooding problem.
- The State Government continuing to subsidise floodplain risk management studies, works and measures.

Policy provisions

The policy provides for:

- a flexible merit based approach to be followed by councils, when dealing with flood prone land management;
- high government priority for floodplain risk mitigation programs;
- recognition of the need to consider the full range of flood sizes, up to and including the probable maximum flood and the corresponding risks associated with each flood;
- councils to be responsible for the determination of flood planning levels and appropriate planning and development controls based on social, economic and ecological, as well as flooding considerations;
- an emphasis on the importance of developing and implementing floodplain risk management plans based on an integrated mix of management measures that address the existing, future and continuing risk;
- the provision of NSW government technical and financial support to councils in relation to flooding matters;
- floodway definition to be based on hydraulic, hazard and potential damage considerations, with provision for restricted development depending on circumstances;
- inclusion of a local Catchment Management Board representative on council's floodplain risk management committee;
- explicit recognition that floodplain risk management needs to take into consideration government policies and legislation allowing for

the sustainable usage of the floodplain as a natural resource, and that the planning and assessment requirements laid down in those policies and legislation must be complied with by all agencies associated with the use, development and management of the floodplain;

- An emphasis on the need to consider ways of maintaining and enhancing the riverine and floodplain ecology in the development of floodplain risk management plans;
- recognition of the importance of the continuing flood risk addressed in the *State Emergency Service Act 1989* and *State Flood Plan* and the close relationship between the emergency management and floodplain risk management processes;
- recognition of the potential implications of climate change on flooding behaviour (global warming);
- the policy and detailed arrangements for implementation to be included in the Floodplain Management Manual;
- protection of councils and other public authorities and their staff against claims for damages, providing they act in accordance with the government's policy at the time; and
- relief from land tax, council rates and water and sewerage rates where vacant land cannot be developed because of its flood prone nature.

Enquiries

General enquiries on the policy, and its currency, should be directed to relevant public authorities, viz, Department of Land and Water Conservation, Department of Urban Affairs and Planning (planning matters) and State Emergency Service (flood warning, evacuation and community education matters).

Enquiries regarding the flood liability of individual properties and proposals for development should be directed to the relevant council.

4.3 Flood Management

About this Element

This element outlines requirements to ensure flood risk management practices that achieve balanced environmental, social and economical outcomes.

Element applies to:

This Element applies to all development on flood prone land in the Newcastle Local Government Area.

Definitions:

Annual exceedence probability; Average recurrence interval; Basement garage; Catchment; Estate development; Flood fringe areas; Flood information certificate; Flood Planning Level (FPL); Flood prone land; Flooding; Floodway; Flood refuge; Flood storage area; Freeboard; Hydraulic threshold category; Life hazard; Occupiable rooms; Planning flood; Probable Maximum Flood (PMF); Property hazard; Riparian Zone; Tsunami.

Date adopted by Council:

11 October 2005

Related technical information:

Refer to the Flooding Technical Manual and atlas for further information relating to flooding

The Atlas contains basic flood mapping information. For more detailed information regarding your development site, a flood information certificate is available on application from Council's Customer Service Centre.

Provisions

Objectives:

To:

- Guide the development of floodprone land, applying balanced strategies to economically, socially and environmentally manage risk to life and property;
- Set aside appropriate areas to convey and/or store flood waters and to protect and restore the riparian zone;
- Ensure development, when considered both individually and as an instance of cumulative development trends, will not cause unreasonable adverse flooding impacts in other locations; and
- Implement the principles of the Newcastle Flood Policy 2003 to new development as applicable.

4.3.1 Applicability

These provisions should be read as a whole. All of these provisions apply to all development on flood prone land in Newcastle with the exception of some forms of development as qualified in the statements below.

4.3.1 a) Estate development

Newcastle City Council intends to develop a suite of planning controls aimed specifically at estate development. While this element does not strictly apply to estate developments, it should be applied. In general, greenfield developments should not create new allotments below the 1% AEP flood level or within the riparian zone.

4.3.1 b) Minor additions to existing buildings

Minor additions are allowable without further reference to these provisions provided that the flood risk is not unreasonably increased. Additions are minor additions if they fall below the following limits.

Existing Building Area	Minor addition limit
< 250m2	50m2
250m2 – 750m2	20% of the existing building area
> 750m2	150m2

4.3.1 c) Some change of use applications

Each application for change of use will be assessed as to whether this element should apply according to the extension of risk posed by the new use. Where existing buildings do not comply with the provisions of this element, the new use will generally only be approved if the applicant can demonstrate that there is no increased impact on or as a result of flood risk.

4.3.2 Floodways

Floodways are shown on a flood information certificate obtainable on application from Council. Floodways are required for the conveyance of essential flood flow and are to be retained in a condition capable of doing so. In general, development other than low level driveways and parking areas is not practicable in floodways. Floodways are not necessarily indicative of high hazard flow, although the two will generally coincide. It is necessary to separately investigate hazard in order to determine if parking areas and the like are suitable within floodways.

i) No building or structure is to be erected and no land is to be filled by way of the deposition of any material within any area identified as a floodway except for:

- Minor alterations to ground levels for roads, parking, below ground structures and landscaping, provided that the fundamental flow patterns are not significantly altered.

ii) Where dividing fences across floodways are unavoidable, they are to be constructed only of open type fencing that will not restrict the flow of flood waters and be resistant to blockage. New development shall be designed to avoid fences in floodways.

4.3.3 Flood storage areas

Flood storage areas are identified on the flood information certificate. They are required to provide storage of floodwaters to ensure that other areas are not significantly worse off due to development of the site.

i) Not more than 20% of the area of any development site in a flood storage area is to be filled. The remaining 80% can generally be developed allowing for underfloor storage of floodwater by the use of suspended floor techniques such as pier and beam construction.

ii) Where it is proposed to fill development sites, the fill is not to impede the flow of ordinary drainage from neighbouring properties, including overland flow.

4.3.4 Risk to property

This provision limits the risk of inundation relative to the flood planning level (FPL). The FPL is the water surface level of the relevant “planning flood” plus a freeboard. Compliance with the flood planning level does not guarantee that flooding will not affect the development.

The “planning flood” for all development in all areas of Newcastle is the 1% Annual Exceedence Probability event.

In most cases, the flood planning levels and the property hazards are given on the flood information certificate for the relevant property.

i) Floor levels of all occupiable rooms of all buildings are not to be set lower than the FPL.

ii) Garage floor levels are to be set no lower than 300mm below the FPL. However it is recognised that in some circumstances this may be impractical due to vehicular access constraints. In these cases, garage floor levels should be as high as practicable.

iii) Basement garages may be acceptable where all potential water entry points are at or above the probable maximum flood (PMF), excepting that vehicular entry points can be at the FPL. In these cases, explicit points of refuge should be accessible from the carpark in accordance with the provisions for risk to life set out below.

iv) Electrical fixtures such as power points, light fittings and switches are to be sited above the FPL unless they are on a separate circuit (with earth leakage protection) to the rest of the building.

v) Where parts of the building are proposed to be below the flood planning level, they are to be constructed of water-resistant materials.

vi) Areas where cars, vans and trailers etc are parked, displayed or stored are not to be located in areas subject to property hazard of P2 or higher. Containers, bins, hoppers and other large floatable objects also are not to be stored in these areas. Heavy vehicle parking areas are not to be located in areas subject to property hazard P3 or higher.

vii) Timber framed, light steel construction, cavity brickwork and other conventional domestic building materials are generally not suitable forms of construction where the property hazard is P4 or higher. Where property hazard is P4, the structure shall be certified by a practising structural engineer to withstand the hydraulic loads (including debris) induced by the flood waters.

viii) Property hazards of P5 are generally unsuitable for any type of building construction and building is discouraged from these areas. Where building is necessary, the structure is to be certified by a practising structural engineer to withstand the hydraulic loads (including debris) induced by the flood waters.

4.3.5 Risk to life

4.3.5 a) On site refuge

Where flood flows are likely to present a risk to life, flood refuge is to be provided as appropriate. Refuge can be in the form of on site refuge or convenient access to flood free ground. In general, it is not acceptable to rely on refuge provided by or on other development sites. In all cases where on site refuge is provided, it is to be both intrinsically accessible to all people on the site and an integrated part of the development (eg a second storey with stair access). The route to the refuge is to be fail safe, plainly evident and self-directing.

In most cases, life hazard categories are nominated on the flood information certificate for the relevant property.

i) On site refuge is to be provided for all development where the life hazard category is L4 or higher unless the proposed development is less than 40m from the perimeter of the PMF extent and the higher ground is accessible.

4.3.5 b) Standards for on site refuge

Where on site refuge is required for a development, it should comply with the following minimum standards.

i) The minimum on-site refuge level is to be the level of the PMF. On site refuges are to be designed to cater for the number of people reasonably expected to be on the development site and are to be provided with emergency lighting.

ii) On site refuges are to be of a construction type able to withstand the effects of flooding. Design certification by a practising structural engineer that the building is able to withstand the hydraulic loading due to flooding (at the PMF) is required.

4.3.6 Riparian zone

The riparian zone is an area of land associated with a creek, stream, river or gully that supports riparian ecosystems. It provides numerous environmental benefits when well vegetated. In many circumstances in Newcastle the riparian zones are in a badly degraded state, thus compromising their capacity to support biodiversity. These provisions seek to improve the viability of the riparian zone where possible.

For the purposes of these guidelines, the riparian zone includes the stream bed and extends beyond the top of the bank to a point not less than 40m from the top of the bank. It is recognised that there are substantial areas of existing development within the riparian zone in Newcastle. It is not intended that these provisions should affect existing development next to concrete lined channels. However, there are also areas of the city where development has not yet encroached on this zone. These undeveloped riparian zones generally should not be developed.

Similarly, the redevelopment of an existing site should involve the reinstatement of riparian vegetation where the opportunity arises.

i) Buildings and developments in general, including landscaping incorporating exotic (non-indigenous) species are generally discouraged within the riparian zone.

ii) Where riparian vegetation is in good condition, it is to be retained. Where in decline, or absent, its restoration is encouraged according to best practice guidelines for riparian vegetation and flood management.

iii) Watercourses are generally not to be piped or otherwise constructed (ie concreted) or filled over, other than at discrete locations required for crossing the watercourse, ie culverts.

APPENDIX C: LIVING WITH FLOODS COMMUNITY BROCHURE

Moving Forward

Newcastle City Council is developing solutions to manage Newcastle's complex flooding problems with substantial grant assistance from the NSW Government.

Council's Flood Risk Management Committee is developing strategies and action plans to live with the risks in ways that balance environmental, social, and economic issues.

The Committee includes Council, community and government representatives and it is:

- Taking an overall approach
- Considering the consequences of all future flooding, from small to large floods
- Developing solutions to flood risk problems that, where feasible, will produce ecologically positive outcomes


4


5


7

Future Action

Actions include:

- Providing a Newcastle Flood Policy and development control based on present incomplete flood information
- Making judgements where investigations have not yet been carried out and updating this information as investigatons continue
- Increasing awareness
- Providing detailed flood information certificates
- Developing future flood management plans in conjunction with the community, which include:
  - Learning to live with flood risks
  - Community flood education and awareness programs
  - Flood emergency preparation, including flood refuges
  - Voluntary house-raising and property aquisiton schemes
  - Improved flood warning systems, especially for flash flooding
  - Restoration and preservation of areas needed for flood waters to escape
  - Restoration of natural creeks and water ways including removal of some concrete stormwater channels
- Implementation (subject to State and Federal Government funding)


6

What to do when it floods

The State Emergency Service (SES) responds to floods when they happen. The SES manages preparation measures and the coordination of immediate recovery.

The Newcastle SES Local Controller, with the assistance of Newcastle City Council, is responsible for ensuring Newcastle residents are aware of the flood threat in their area, and how to respond.

WHO TO CONTACT

Flood Warnings	Bureau of Meteorology	**Ph: 1300 659218**
In case of flooding	State Emergency Service	**Ph: 132500**
Flood Information	Customer Enquiry Centre	**Ph: 4974 2030**
Certificates	City Administration Centre 282 King Street, Newcastle	
S149 (Planning)	Customer Enquiry Centre	**Ph: 4974 2030**
Certificates	City Administration Centre 282 King Street, Newcastle	
Development & Planning	Customer Enquiry Centre	**Ph: 4974 2030**
enquiries	City Administration Centre 282 King Street, Newcastle	
Strategic Flood Management	City Strategist	**Ph: 4974 2000**
enquiries	Flood Risk Management	
Ironbark Creek floodgates	Hunter Catchment Management Trust	**Ph: 4930 1030**

The City of Newcastle

Newcastle City Council
PO Box 489
NEWCASTLE NSW 2300
Ph: 02 4974 2000
Fax: 02 4974 2222
Email: mail@ncc.nsw.gov.au
www.newcastle.nsw.gov.au

LIVING *with* FLOODS in Newcastle

2003

sustainableNEWCASTLE

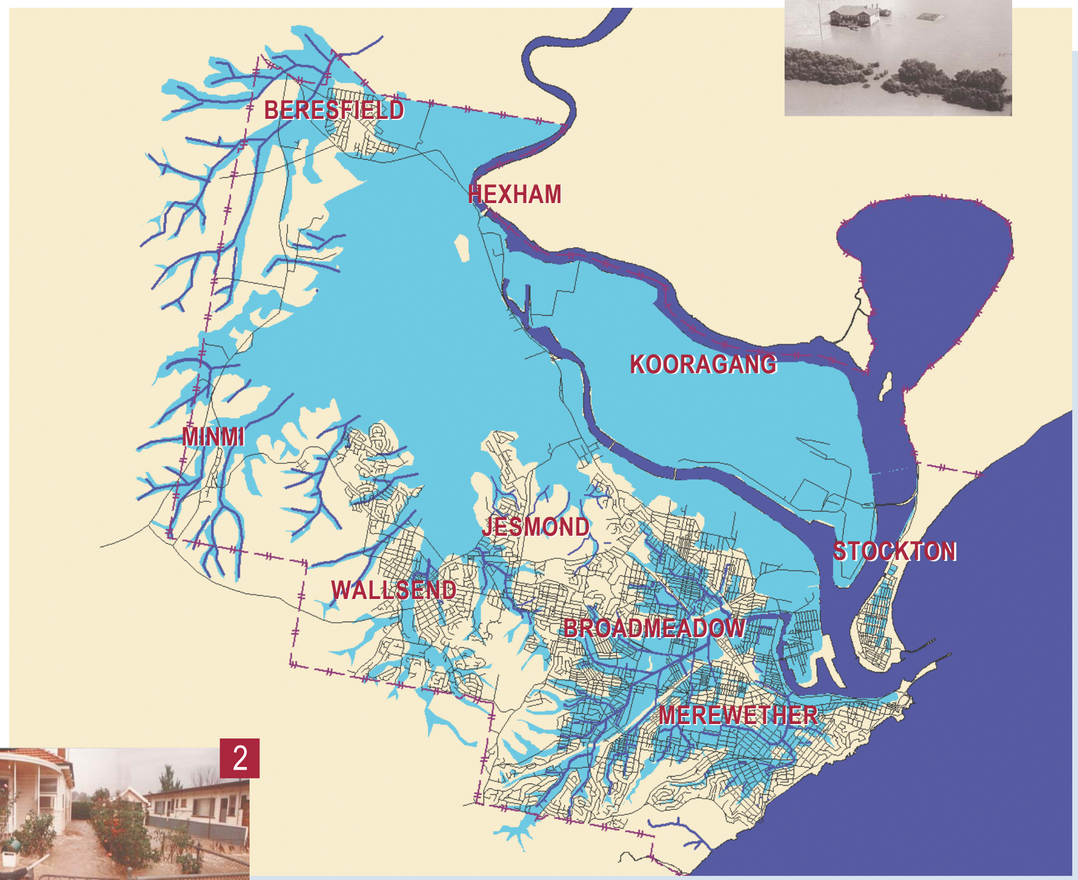
The City of Newcastle

Flooding in Newcastle

Many people will be unaware large parts of Newcastle could flood in the future, including the people who live in those areas.

The light blue areas on the map could flood in the future. Surprisingly many of these areas are in the suburbs away from the Hunter River Floodplain.

Half the properties in Newcastle (approx. 25,000) could be flooded in the future! Most of these properties are in the suburbs, outside of the Hunter River Floodplain.



This brochure

- Raises awareness of future flood risks
- Outlines how we can live with flood risks
- Says what Council is doing

What is flooding?

Flooding is a natural process caused by heavy rainfall. Flooding has always happened. It helped to shape the creeks, swamps and floodplains over which Newcastle has been superimposed.

Flooding will continue to happen throughout Newcastle. Generally it is a rare event.

In low lying areas heavy rainfall can occur in combination with high tides.

In large catchments including the Hunter, it takes a long time for widespread rainfall to 'fill' the catchment and come down the river. As a result, there is several day's warning that Newcastle can expect to be flooded in the Lower Hunter Floodplain. The flooding will also last for several days.

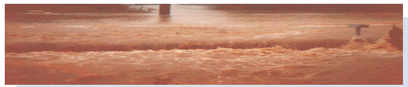
In smaller catchments, including most of Newcastle's suburbs, it only takes a short time for intense rainfall to 'rush' down the catchment, overwhelm drainage systems and cause flooding. This 'flash flooding' will happen so quickly there is presently no warning. It is estimated water could rise to several metres deep in less than an hour in some suburbs. Flash flooding lasts for only a few hours.

It is not possible to predict when the next flood will occur, where it will occur, or how big it will be. We can however, estimate the likelihood of different sizes of floods.

There is no such thing as a '**100 year flood**'. Each flood will be different. On average, larger floods are rarer than the smaller floods. The chance of a certain size flood happening in any given year is the same each year, even if a flood occurred the year before.

It is possible for extreme floods much larger than the '1 in 100' chance per year flood to occur. The largest flood that could occur is called the Probable Maximum Flood. Newcastle has not experienced such a flood in the last two hundred years.

1. Hexham, 1955 - Travellers' Rest Hotel (now McDonalds)
2. Jesmond, 1988 - Bluegum Road
3. Jesmond, 1988 - Fraser Street
4. Lambton, 1988 - Orlando Road
5. Mayfield, 1988 - Albert Street
6. Jesmond, 1988 - Fraser Street
7. Wallsend, 1988 - Croudace Road



Issues

There are many complex issues surrounding flooding in Newcastle including:

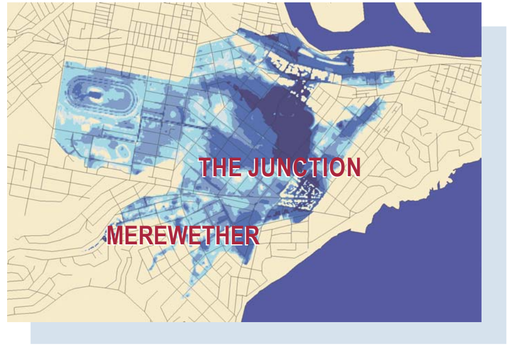
- Concerns about potential impacts on property values
- Low community awareness
- The affects of past and future development
- No effective warning for flash flooding
- The large numbers of properties that are at risk
- Exisitng development being in areas that should not have been developed
- What areas should not be developed in the future?
- What are the community's aspirations and priorities?
- Integration with social, environmental, economic and planning issues

Example of investigations so far

It is critical that flood management decisions are based on realistic undertandings of all possible future flooding in Newcastle.

Computer simulations of future flooding are being developed across the City. These simulations are based on the best available information of rain that can occur, tide and ocean levels, and accurate ground levels. The simulations are checked against records of previous flooding in Newcastle.

An example of estimated maximum flood depths in the Merewether/Junction areas (Cottage Creek catchment) is shown below:



The dark blue areas show simulated flooding up to about two (2) metres deep. The lightest blue areas are very shallow - less than 300 mm deep. The mid blue shades represent varying depths in between.

It is estimated that about 1,800 properties would have water above their floors if this flood occurred, and there would be about $23 million in direct economic damage.

APPENDIX D: ESTIMATION OF REDUCTION IN RISK TO LIFE AND RISK TO PROPERTY

Risks to Life

Maximum potential population:

Estimated population that resides within the floodplain (based on total population of 156,000 over 57,622 developed lots, of which 21,500 are within the PMF extents)	58,000
Estimated vehicles on vulnerable roads at the time of the event (based on the fact that there were about 5,000 cars written off during the June 2007 event). Range depends on time of day. Many people within cars would also reside in floodplain	0 - 20,000
Estimated number of people within businesses and shops (including shopping centres, business districts etc). Range depends on time of day. Many people within cars would also reside in floodplain	0 – 40,000
Total estimate	58,000 – 100,000 Say 80,000

Population Unmanaged under Current Management:

Estimated population within 2000 properties that are affected by flash flooding to depths > 1m in PMF and in floodways. River and ocean flooding would be evacuated, all properties < 1m flooding at PMF would be sufficient for existing shelter in place.	5,400
People on roads (minimal mitigation of risk to life on roads at present). Assumed value based on potential range (see above).	10,000
People within businesses and shops. Assumed value, but considered that most of these premises would be safe for refuge, or there would be nearby alternative refuge (especially within a business district)	0
Total estimate	15,400 Say 15,000

Additional population managed within First 5 Years:

Estimate that 2% of existing buildings are redeveloped per year (so 10% of 2000 properties over 5 years). These would be redeveloped to provide flood-free refuge	540
Construction of elevated refuges within 200 houses	540
Estimate that education, improved warning time and effective road signage would reduce risks to life on roads by 50%	5,000
Estimate that education and improved warning time would allow evacuation of 10% of people in houses at risk of collapse	540
Total estimate	6,620 Say 7,000

Additional population managed by complete Flood Plan:

Construction of elevated refuges within remaining 1,100 properties (note floodway properties still at risk)	3,000
Voluntary purchase in Merewether (Selwyn / Little Edward)	10
Voluntary purchase of additional 15 properties (assumed to be located within 1% AEP floodway and damaged before they are redeveloped)	40
Estimate that substantially improved flash flood warning time (using nowcasting techniques) would reduce risks to life on roads by an additional 20%	2,000
Estimate that education and improved warning time would allow evacuation of 10% of people in houses at risk of collapse	540
Total estimate	5,050 Say 5,000

Risks to Property

Current AAD: $21 million (refer Table 5-4*).*

Total Potential AAD:

Re-calculate Table 5-4 but assuming that all development is constructed at ground level. That is, above floor flooding occurs as soon as flooding occurs on the property	$49 million
Estimated ADD for vehicle damage (assuming 200 cars at 10% AEP; 1000 cars at 2% AEP; 5000 cars at 1% AEP and 15,000 cars at PMF: car damage at $15,000 each)	$3 million
Total estimate	$52 million

ADD after completion of First 5 Years:

Re-calculate Table 5-4 but assuming that: 2% of existing buildings below FPL are redeveloped per year (so 10% of 2500 properties over 5 years). These would be redeveloped to above FPL (and include 25 that are currently below 10% AEP flood level) Ocean flooding is abated by now one-way valves, preventing damage at 10% AEP Minor reductions in personal damage for river and ocean flooding due to improved warning times (< $2,000/property)	$20.5 million
Estimate that education, improved warning time and effective road signage would reduce ADD of vehicles by 50%	$1.5 million
Total estimate	$22 million

ADD after completion of whole Flood Plan:

Re-calculate Table 5-4 but assuming that: All ocean flooding is abated by levees up to 1% AEP Minor reductions in damages due to localised improvements	$17 million

in flowpath Voluntary purchase of about 40 houses in Hexham, currently below 10% AEP level Voluntary purchase of other isolated properties within flash floodways House raising of 100 properties in flash flood catchment, with floors above 1% AEP, currently below 10% AEP	
Estimate that substantially improved flash flood warning time (using nowcasting techniques) would ADD of vehicles by an additional 20%	$0.6 million
Total estimate	$17.6 million Say $18 million

APPENDIX E: BACKGROUND DISCUSSION PAPERS PREPARED BY THE CITY OF NEWCASTLE

Community and Cultural Background Paper (NCC, 2009)

The State Plan 2030; A New Direction for NSW is the principle strategic plan for delivering the vision for NSW. Social directions for the Hunter considered under this Plan include:

- Increase employment, community participation and multi-agency support for aged people and those with disabilities and mental illness.
- Support for vocational education and training through building better links between schools, TAFE and industry.
- Implementation of a Hunter Domestic Violence project reducing repeat domestic violence.
- Implementation of a Positive Ageing Strategy in the Hunter aimed at increasing the health and social well being of older people.

The NSW Government's **Lower Hunter Regional Strategy** has been prepared to ensure that adequate land is available and appropriately located to sustainably accommodate the projected housing and employment needs. This is being implemented primarily through council's local environment plans and development control plans.

Worldwide, the percentage of the population aged 60 years or older increased from 8 to 10 per cent in the second half of the twentieth century. During the first half of the twenty-first century, that percentage is projected to increase by 11 points, to 21 per cent.[1]

The physical characteristics of housing and communities play a major role in facilitating personal independence and community involvement as people grow older. A safe walking environment, access to shops and other businesses, as well at the availability of local services and recreational facilities are all important elements that have a positive effect on people's daily lives and assist in maintaining independence.

Newcastle is the second most populated council area in the Lower Hunter region. In 2006 the total population of Newcastle was 141,752, an increase of 3.2% from 2001. Despite this growth trend, the population remains less than its peak of 146,000 in 1971, prior to closure of BHP. This trend is set to continue with an anticipated regional population growth scenario of an additional 160,000 persons coming to the Lower Hunter by 2031.[2] The potential "share" for Newcastle is about 19,000-23,000 additional persons.

The Lowe Hunter Regional Strategy promotes in-fill development, which will centralise growth and in so doing, consolidate demand for services. Major urban renewal corridors in Newcastle will provide opportunities for economic renewal and/or housing renewal and intensification as they develop along strategic transport routes and link major centres. New residential development at higher densities in centres and corridors is likely to be inhabited by a range of household types including older people, couples, singles and households with children. Research indicates that the proportion of households

[1] *World Population Ageing 1950-2050. The Department of Economic and Social Affairs Population Division.*
[2] *Lower Hunter Regional Strategy 2006-31. NSW Department of Planning.*

with children living in apartments is increasing for a variety of economic and socio-cultural reasons. Service provision therefore needs to be planned for the range of households that will move into new urban areas.[3]

Challenges

- An increase in population will put pressure on existing community infrastructure including open space, facilities and services. The Community Plan 2006-2010 identified insufficient access to community services.
- Additional land and higher densities will be needed for more housing to provide for this growth. Overall, an anticipated 20,500 new dwellings in the Newcastle LGA will be required to meet the proposed population scenarios.
- The need to create employment opportunities to enable local people to get local jobs.
- An increased demand for, and the public expectation of, higher service provision in areas subject to significant urban renewal.

An ageing population

Newcastle is characterised by a population which is older than the NSW average.

- The 65+ age group in 2006 accounted for 15.8% of the total Newcastle population, compared to NSW average of 13.8%.[4]
- The aged population in the Newcastle LGA is projected to rise to 25% by 2031.[5]

However most older people are far from being frail and continue to be a major resource to their families and communities. If ageing is to be a positive experience, longer life must be accompanied by services that contribute to quality of life for the aged. An ageing population has implications for the social diversity and future infrastructure and servicing needs including health, housing and transport. A different approach to housing and infrastructure is required that positively influence access and inclusiveness.

Challenges

- Existing houses may need significant renovation and retro-fitting to meet the needs of ageing singles and couples, some of whom may eventually be mobility or cognitively impaired. Existing stock has limits to adaptability to meet the changing needs and preferences, but new construction offers the possibility to design-in greater adaptive capacity.
- Ensuring universal access in the public domain including footpaths, bus shelters, availability of seating and shade both on pedestrian routes and in passive and active recreation areas.
- Planning for the provision of increased medical, aged care and home support services.
- Improved public transport to ensure that older people can move around easily and safely.

[3] *Final Report: Urban development and the lower Hunter: understanding context, connections and flows, School of Environmental and Life Sciences, University of Newcastle, 2007*
[4] *Australian Bureau of Statistics 2006.*
[5] *Planning the Local Government Response to Ageing and Place. Local Government and Shires Association, 2004.*

Housing

Adequate and secure housing is one of the basic necessities of life. One of the major implications of the housing affordability problem is that fewer households can become purchasers. In 2006 the *ownership rate* (includes dwellings that are fully owned or being purchased) in Newcastle was 61%. This figure has fallen in the 10 years to 2006 by 2%.

In 2007 the median sales price for all dwellings in Newcastle was $326,000, an increase of 126% from the 2000 figure[6]. The median household income in Newcastle has failed to keep pace with sales price, increasing by 74% from $508 in 1996 to $886 per week in 2006.

In 2006 the proportion of low and moderate income households in Newcastle who are purchasing and were in housing stress was 45%, an increase of 18% on the 2001 figure. The proportion in stress in Newcastle is comparable with Maitland (43%), Cessnock (41%) and Lake Macquarie (46%). People are considered to be in housing stress when they are paying more than 30% of their income on housing.

In line with the national trend Newcastle has a significantly greater proportion of low to moderate income renters in housing stress than low to moderate income purchasers in housing stress. Low income households are those whose income is under 80% of the median household income. Moderate income households are those whose income is between 80% and 120% of the median household income. According to the 2006 Census, 50% of all low to moderate households renting in the private market in Newcastle were in housing stress, comparative to Cessnock (50%), Maitland (48%) and Lake Macquarie (51%).

In March 2007 the median rental for a 3 bedroom dwelling in Newcastle was $290 per week, representing an increase of 61% from the 2000 figure. Based on 2006 median household income figures, Newcastle was less affordable in terms of rental than Sydney. On average in Newcastle, 33% of income is expended on rent, representing a higher proportion then Sydney (27%) and NSW (26%).

Higher housing costs diminish the quality of life in Newcastle for many families struggling with rent and mortgage payments. The drift to the urban fringe where land prices are lower makes possible for many the ‘dream’ of home ownership. The longer term impacts of this are the transport costs incurred, poor access to services and lack of connectivity.

Challenges

- Provision of housing choice and affordability in the right locations. This will mean higher densities in-and-around major centres to maximise proximity to employment and services and the use of existing infrastructure.
- The changing face of the City as a result of increasing densities in some areas to accommodate the future population projections outlined in the Lower Hunter Regional Strategy.
- Falling occupancy rates in Newcastle (from 2.4 in 1996 to 2.3 in 2006[7]) with a marginal growth in lone person and single parent households will mean that a greater range of housing options will be required to satisfy different housing needs.

[6] *Rent and Sales Reports. Housing NSW*
[7] *ABS Census 2006*

- Addressing homelessness. According to the 2001 Census the homeless population in NSW was 26,676 with Newcastle accounting for 5.8% of the homeless (1,547 people).[8]

Reduced affordability

Reduced affordability for individuals and community organisations has been identified as a key issue.

According to Hunter Valley Research Foundation Wellbeing Watch, despite higher incomes, from 2006 to 2007 there was an increase in the proportion of people who were unable to pay their accommodation and utility expenses on time.[9]

Community services will be under pressure to move to the edges of Newcastle or outside the LGA due to affordability issues in the city centre and commercial areas.

Community services are further strained by the added role that Newcastle has as the regional hub of the Hunter, and the subsequent draw for people in need of services.

The opportunities

Newcastle and the Lower Hunter Region will face unprecedented population growth over the next two decades. The challenges will be to manage growth to ensure that the values attributed to Newcastle are retained, ensure adequate and appropriate social infrastructure to support growth and promote community connectedness.

Opportunities that might be pursued include:

- Asset based community development
- Extending and integrating existing transport networks
- Developing opportunities for youth engagement across the LGA (the PCYC Activity Van was a successful model)
- Creating multi-purpose community facilities providing for the co-location of services and recreation, cultural and community activities for all ages
- A university presence in the city
- Supporting and promoting affordable family-friendly events and programs in the outer suburbs e.g. street parties and BBQs
- Integrating universal access and safety by design principles into planning processes
- Developing major city precincts including retail, legal, cultural and sporting
- Identifying key areas for place making and place management
- Integrating housing affordability, adaptability and diversity into city planning processes
- Volunteer participation, utilising both the ageing population an young people as an asset
- Recognising and nurturing opportunities for social inclusion e.g. recreation opportunities for older people through Men's Sheds

[8] *Housing Market Analysis Explanatory Notes and Fact Sheets, NSW Department of Housing*
[9] *Wellbeing Watch: A monitor of health, wealth and happiness in the Hunter, Hunter Valley Research Foundation 2008 Edition: 2*

- Services and community hubs on transport corridors
- Shared pathways (pedestrian and cycle)
- "Smart Arts" program offering professional development opportunities to help resource, strengthen, build capacity and hopefully help create a more resilient and sustainable local cultural industry.

Further opportunities were identified at the Hunter Summit 2020. This summit was held in 2008 to explore locally the challenges facing Australia over the next decade and beyond, discuss major ambitions and identify policy levers to release them.

Opportunities identified at the Hunter Summit 2020 included:

- Newcastle has many opportunities for development and diversity through urban renewal.

Economic Background Paper (NCC, 2009)

Urban renewal and redevelopment is underway in important employment zones, specifically Honeysuckle and Steel River. A substantial and growing proportion of Newcastle's economy is based around education and health services with peak regional institutions including the University of Newcastle and John Hunter Hospital. Closely linked to these institutions are the Hunter Medical Research Institute and CSIRO Energy Research Centre, which are among Australia's leading biomedical and energy research and development agencies.

High value-added manufacturing activities and trade through the Port of Newcastle are still important economic drivers.

According to the Department of State and Regional Development, the Hunter Region's competitive advantages include:

- efficient, uncongested rail, air and sea transport network
- abundant supply of employment land
- easy access to Sydney
- Australia's biggest regional market
- worlds largest coal export port
- leading University, TAFE and education facilities.

The **NSW State Plan 2006** is the current strategic document within which all planning in NSW is contextualised. In respect to the region-specific economic direction, the Plan outlines a commitment to creating an aviation and defence related employment zone adjacent to the airport and development of the former BHP Billiton Site. Other directions considered in the Plan include increased employment opportunities for aged people and support for vocational education and training through better links between schools, TAFE and industry.

The **Lower Hunter Regional Strategy 2006-31** plans for the provision of sufficient new urban and employment land to cater for the expected 66,000 new jobs in the Lower Hunter. Ensuring that ongoing capacity is provided for both new and traditional job opportunities for the growing population is an important focus for the Strategy. The Regional Strategy identifies Newcastle City Centre as a regional city, with higher order administration, education, health services, cultural and recreational facilities and higher density commercial and residential. It aims to build on the economic activity within the large centres by creating capacity for a further 10,000 jobs in the Newcastle City Centre. The Strategy identified the following economic challenges for the Region:

- Maximise the economic opportunities associated with the Region's competitive advantage, in particular its economic infrastructure and specialised centres.
- Ensure sufficient employment lands are available in appropriate locations, including within centres and as traditional industrial land, to provide sufficient capacity to accommodate growth in existing and emerging industries and businesses.
- Maintain or improve the employment self sufficiency of the Region.

- Ensure that activity within the Lower Hunter complements rather than competes with the economies and communities of adjoining regions.

The **Regional Economic Development Strategy 2007-2027** commissioned by the Hunter Economic Development Corporation aims to provide direction in growing the regional economy. The Strategy aims to advance the Hunter's position through the seven priorities: education; training and employment; government and regulatory; industry and trade development; information; communications and technology; infrastructure; services and investment; innovation and emerging industries and land and resources management.

The **Hunter Region Strategic Tourism Plan 2005-2008** was developed for the Hunter Regional Tourism Organisation to boost visitation to the Hunter Tourism Region. The Plan recommends considering the region as five product zones, for the purpose of identifying experiences and to more effectively adopt a consumer-focused approach. Newcastle is identified as one of the five zones.

The NSW Government has identified six regional cities including Newcastle as critical to the economic growth of New South Wales. The **Newcastle City Centre Plan 2006** looks to stimulate the regional economy through fresh job and housing opportunities, new investment and designing a more dynamic liveable city.

Council is currently undertaking a number of initiatives in regards to economic development including:

- Implementation of the City Centre Plan to revitalise Newcastle City Centre.
- Development of a 10 year Asset Management Plan linked to the 10 year Community Strategic Plan and Long Term Financial Plan.
- Development of an Economic Development Strategy to encourage economically sustainable growth within the LGA.

Local trends

There are a number of key local trends that are likely to influence economic well-being in the Newcastle community over the next two decades;

- Unemployment levels have experienced significant decreases from 12.4% (Census 1996) to 7.3% (Census 2006). However it is predicted that unemployment will rise significantly over the next few years.
- Value added manufacturing (steel, boats) and export trade (coal, agriculture, and other bulk products and cargo) through the Port of Newcastle remain key economic drivers.
- The service sector has eclipsed manufacturing as a major employer with continued growth in health, tourism and retail.
- Manufacturing jobs continue to decrease 39.6% (Census 1971) to 9.8% (Census 2006).

Population

Newcastle's population of 141,753 (2006) continues to increase (3% since 1996) while remaining less than its peak of 146,000 in 1971. Population projections (3% growth) indicate a population of 145,000 is expected by 2011. The labour force participation rate (aged 15+) is 57%. A significant portion

(16%) is aged over 65 years.[10] The proportion of people over 65 years old is predicted to increase to 18% by 2015 and 25% by 2031.

Challenges

- The ageing population is an important economic driver, with the increasing demand for health, community care and related services. The demand for these services will also be increases as a result of the population growth projections from the Lower Hunter Strategy.[11]
- The economic growth potential of the region and the need to maintain a strong and diverse workforce.[12]

Employment

Newcastle's economic transition from an industrial city into a diversified economy is having wide reaching impacts on Newcastle's national identity, as it becomes increasingly valued for its lifestyle, cultural and environmental qualities. The State Government announced the Regional Cities Taskforce in February 2006. The Taskforce published an Economic and Financial Statement that identified six key regional cities that would underpin the States economic growth and create more local jobs. The City of Newcastle was identified as a key regional city as it is considered the economic, administrative and cultural centre of the Hunter region.

There has been a steady decline in the unemployment rate in the Hunter between 1998 and 2008, with the rate of decline in the Region greater than the State. Similarly the unemployment rate for Newcastle has dropped steadily from 11.6% in 2002 to 6.3% in 2006.

The recent financial crisis has brought about lower consumption and investment spending. However employment growth in the region remains higher than in the State as a whole, due in part to the robust economy, benefiting from extensive structural change and diversification over the past 20 years. Employment figures for Newcastle in the November 2008 quarter increased by 5.3% from the November 2007 quarter and unemployment dropped 1.9%. The unemployment rate for Newcastle and the Hunter rose by 0.6% to 5.2% and 5.3% respectively in December 2008. Employment growth in the Region is predicted to slow and unemployment rise through 2009 and probably 2010.[13]

Whilst some jobs have been lost over the year (August 2007 to 2008), expanding employment in others has offset the decline. The largest increase has been in manufacturing (27%), education and training (25%) and retail (16%). Newcastle along with Maitland and Lake Macquarie LGAs are the least industry dependent in the Hunter. In other words they are the least dependent on the ten major industries. Hospitals were the main employers in each of these LGAs (5.4% of the total employed).[14]

Challenges

- The need to increase economic diversity to provide for an employment capacity target of 10,000 new jobs and a population growth of 6,500[15]

[10] *Australian Bureau of Statistics, Census of Population and Housing, 2006, Cat. No. 2068.0*
[11] *Hunter Vision Regional Economic Development Strategy 2007 - 2027*
[12] *Lower Hunter Regional Strategy 2006-31, NSW Department of Planning.*
[13] *Hunter Regional Economic Indicators, Hunter Valley Research Foundation, December Quarter 2008*
[14] *Australian Bureau of Statistics, Census of Population and Housing, 2006, Cat. No. 2068.0*
[15] *Revitalising Newcastle City Centre Plan 2006, NSW Department of Planning.*

- Attracting new employment opportunities to the area particularly for youth and preferably employment that diversifies the economic base beyond coal and power industries.[16]
- Associated growth in employment sectors such as professionals (23.6% employed in 2006) compared with tradesperson and related workers (13.8% employed in 2006) is resulting in a 'creative class' with higher community expectations which are impacting on Council's ability to meet desired service levels.
- Maintain or improve employment self sufficiency of the region, ensuring an ongoing capacity is provided for both new and traditional job opportunities to meet the needs of the projected population growth.[17]
- Infrastructure to support employment opportunities e.g. the current Williamstown Aerospace Centre development will provide up to 6,000 jobs. However there is no transport or additional services being identified to support the growth.
- Employment within certain sectors of the economy will be effected by the introduction of a carbon trading scheme. The aluminium sector is the most emission intensive trade exposed sector within the Region. The values associated with the sector includes $1.7 billion of revenue and approximately 2,000 direct jobs, and a further flow on impact of $1.14 billion and approximately 4,650 employees.[18]

Tourism

Newcastle's world-renowned beaches, inner city art and cultural precincts and waterfront are the main tourist attractions. According to Tourism Research Australia[19], in 2006-07 Newcastle received 903,000 domestic overnight visitors (the total visitation number for the Hunter Region was 2.1 million). The purpose for the visit by the majority of international visitors to Newcastle was for holiday/leisure (50%) followed by visiting friends/relatives (30%). The majority of international visitors stayed at a friend's or relative's property (36%).

In 2006-07 Newcastle received 59,000 international overnight visitors, compared to 29,000 to Cessnock and 27,000 to Port Stephens. In comparison with the rest of the Hunter, the length of stay and expenditure per visitor were highest in Newcastle LGA, with an average of an 18 day visit. The average spend per trip was $1,249 with a total spend of $74 million.

Domestic overnight visitation continues to be the dominant form of tourism in the Hunter. Despite regular flights between Newcastle Airport, Melbourne and Queensland, only 5% of domestic overnight visitors came from Melbourne and 6% from Queensland. The strongest domestic market for Newcastle is Sydney, accounting for 43% of visitors. Research would suggest that the purpose of most domestic visits to Newcastle is to visit friends/ relatives (53%) with the majority staying at a friends/family's property (57%).

[16] *A New Direction for NSW, NSW State Plan 2006*
[17] *Lower Hunter Regional Strategy 2006-31, NSW Department of Planning.*
[18] *Hunter Valley Research Foundation, Sydney Luncheon Address to Sponsors, W.E.J Paradice, March 2009*
[19] *Tourism Research Australia; Tourism Profiles for Local Government Areas in Regional Australia, New South Wales, June 2007.*

In 2006, 23% of the 2,364 manufacturing establishments were in Newcastle, a reflection of the proximity to important transport links in the Region; the Port of Newcastle, the F3 Freeway to Sydney and the juncture of the Pacific and New England Highways.[20] Whilst, in general businesses have tended to become smaller in terms of employment over the past two decades, manufacturing represents a relatively high proportion of large employers in the Hunter.

The majority of new jobs have been generated in the tertiary sectors such as health, education, financial and personal services, as well as tourism. This trend is expected to continue and strengthen such that in the future much of the jobs growth will remain in the tertiary sectors and be located in the Region's major centres.[21]

Port

Newcastle is the world's largest exporter of coal, shipping almost 89 million tonnes of coal in 2007-08, representing 95% of the Port's total tonnage. Other cargo includes agricultural and timber products and containerised cargo. Management of commercial activity in the Port is the responsibility of the Newcastle Port Corporation, a statutory corporation of the NSW Government.

The Port has the advantage of a stable and competitive labour market and a skilled local industry base backed by a good sea, road, rail and air transport network. The Port is diversifying with a recently signed 20 year lease agreement with a Super Yacht Builder.

The NSW's Port Growth Plan identifies Newcastle as the state's next major container facility as Port Botany reaches capacity, envisaged in the plan to occur in about 2025.[22] The Lower Hunter Regional Strategy outlines the need to 'identify and preserve land for a Freight Hub' as well as recognising the need to investigate transport infrastructure to support the hub and 'improve the efficiency of freight movements in the rail network'. Crucial to the success of the Freight Hub will be the opportunity to transport containers between the Hub and the Port and the capacity of the rail/road network to transport both containers and non containerised freight to and from shipping companies, including critical Sydney markets.

Port Waratah Coal Services is currently spending $170 million improving its coal loading capacity from 89 million tonnes per annum (mtpa) to 102 mtpa. Further expansion worth $458 million will be spent improving capacity to 113mtpa. Newcastle Coal Infrastructure Group is building a third coal loader at a cost of $922 million.

Transport

Newcastle is served by all major modes of transport however the dominant form is private car. According to the data from the Transport and Population Data Centre of the Department of Planning; 88 per cent of work trips and 68 per cent of all trips to Newcastle City Centre are made using private vehicles. Only 5 per cent of all trips are made using buses or train.[23]

[20] *Hunter Valley Research Foundation, Manufacturing, Newcastle and the Hunter Region 2008-2009.*
[21] *Lower Hunter Regional Strategy 2006-31, NSW Department of Planning.*
[22] *Freight Hub Hunter, Part 1 – Executive Summary Report; 7 October 2008. Strategic Design and Development Pty Limited*
[23] *Revitalising Newcastle City Centre Plan 2006, NSW Department of Planning.*

Services are located throughout the Newcastle LGA, not just in the city centre. Planned new development in centres and corridors are likely to continue to generate flows of people across and through the LGA and thus transport from these centres to a range of other locales within Newcastle LGA will need to be adequate.

Development

There were 3,400 residential approvals in the Hunter for the 12 months to June 2008, 18 percent lower than the ten-year average. Both proportionally and by the number of dwellings, the inner city of Newcastle contained the majority of higher density proposals (83 per cent and 462 respectively)[24].

In 2006-07 the majority of commercial construction activity was concentrated in the Newcastle (25%) and Lake Macquarie (32%) LGAs. Public sector proposals had a greater concentration in the Newcastle LGA, consistent with the city's role as a regional hub for public sector administration.

The stock of office space in the Newcastle CBD has increased by 39,580 square metres over the last 10 years. New development and tenants have been attracted to the harbourside Honeysuckle area away from Hunter Street and the traditional office core.

A total of $1.4 billion of large development was approved 1997-2004: 44% in Newcastle (inner city) predominantly residential, 17% in Kotara/New Lambton predominantly retail/health and 11% in Mayfield predominantly industrial.

Since 2004, Council has approved $213M of residential/mixed use development across the City Centre and $14.5M of new office development. There have been a number of larger projects occurring across the Newcastle LGA including:

- Newcastle Port Corporation projects including the coal loader extension;
- Mirvac "Royal Newcastle Beach" mixed-use development of the former The Royal Newcastle Hospital site; and
- The Mater Hospital redevelopment.

According to the Lower Hunter Regional Strategy Newcastle LGA will absorb over 17% of planned future residential development in the Lower Hunter. 60% of new urban development in the Newcastle LGA will take place in centres and corridors with a little over 10% as urban infill, while new release areas will constitute less than 30% of development.[25]

Challenges

- Ensure sufficient employment land is available in appropriate locations to accommodate growth in existing and emerging industries and businesses.[26]
- Future development in Newcastle will need to support both developments in the City Centre and to ensure continued and enhanced access to the diverse locations of facilities across the

[24] *Hunter Valley Research Foundation; Construction, property markets and housing, Newcastle and the Hunter Region 2008-2009.*
[25] *Final Report: Urban development and the lower Hunter: understanding context, connections and flows, School of Environmental and Life Sciences, University of Newcastle, 2007*
[26] *Lower Hunter Regional Strategy 2006-31, NSW Government Department of Planning.*

Newcastle LGA. These are critical drivers of existing population and household flows as well as business links currently sustaining Newcastle's central positioning in the region.

- The higher cost of finance and the risk of retail proposals remaining on hold until the economic and financial outlook improves.
- Continued expansion of larger shopping centres such as Charlestown Square and the subsequent impact on the retail offer in Newcastle City Centre.
- In the short to medium term, uncertainty in the value of end sales and higher development finance costs will constrain further industrial supply and/or place downward pressure on industrial site values.[27]
- The ability of our city to perform, innovate and remain competitive in the revised globalisation agenda of carbon constraint, adaptation and mitigation.[28]

The Hunter Summit 2020 identified the following opportunities:

- A Regional Infrastructure Plan to be linked to a national strategy including land zonings, schools/educational facilities, hospitals, complete communities, cultural heritage and transport (public and private).

[27] *Hunter Valley Research Foundation; Construction Property Markets and Housing, Newcastle and the Hunter Region 2008-2009.*
[28] *Innovation and the City: Challenges for the Built Environment Industry, City Futures UNSW, July 2008*

Environmental Background Paper (NCC, 2009)

The Lower Hunter Regional Strategy is intended to work with the Government's **Regional Conservation Plan** to ensure that the future growth of the Hunter makes a positive contribution to the protection of sensitive environments and biodiversity.

The **Hunter Catchment Action Plan 2006-2015** is currently being implemented and will guide investment to protect and improve the natural resources of the Hunter-Central Rivers region.

Only a few areas in the west of the City remain undeveloped. Estuarine wetlands and mangroves, most protected in reserves, cover approximately 20% of the LGA. The remainder has largely been developed for urban uses, with the exception of two significant bushland reserves - Blackbutt Reserve and Glenrock State Recreation Area. Current pressures on the Newcastle environment include:

- Beach and dune erosion
- Development of rural and "greenfield" lands for residential and industrial purposes
- Stormwater runoff from developed areas impacting on remnant creeks, riparian zones and downstream wetlands
- Invasion of noxious and environmental weeds into remnant bushlands, wetlands and conservation reserves
- The expanding footprint of urban areas, transport and utility service infrastructure in areas of conservation value
- Growing recreational pressures on urban bushlands and conservation areas
- Fragmentation of habitat as a result of limited integration in planning
- Changes to the hydrology in the Hunter river estuary as a result of increased tidal flows, dredging, reclamation, filling, sea level rise and water extraction.

As a coastal city located within the estuary of the State's second largest catchment, Newcastle has a wealth of biodiversity including coastal environments, the Hunter River, estuarine wetlands of international significance, creeks and forested areas. These natural areas are home to a wide variety of native plants and animals, including over 40 species listed as threatened under Commonwealth and State legislation.

Land use and development has substantially affected biodiversity values in the Newcastle LGA, with approximately 70% of the LGA currently urbanised (industrial, residential, recreational, commercial and mining uses). While land clearing has slowed, continuing development pressure exists on remnant natural areas. Further loss and fragmentation is a major concern.

In 2006 Council adopted the Newcastle Biodiversity Strategy to guide planning and management for biodiversity within the LGA. The Newcastle Urban Forest Policy, adopted by Council in 2007, complements the Biodiversity Strategy by providing principles for managing the urban forest (woody vegetation) within Newcastle.

Challenges

- Accommodate significant population growth whilst maintaining or improving the biodiversity value of the region.[29]
- Manage, and where feasible, mitigate the likely major impacts on biodiversity of rising sea levels including erosion, salt water inundation of water tables and increased sedimentation on the floodplains.[30]
- Collation of site-specific data, data on threatened species, threatening processes and marine and aquatic biodiversity for management and monitoring purposes.

Land Use

The most significant pressure on land use in Newcastle continues to be the demand for land suitable for residential development. The 1996 and 2006 Census data showed 137,307 residents and 141,753 residents in the Newcastle LGA respectively. This continues an upward trend in population that commenced in 1986, however, this growth has not yet exceeded the total Newcastle population in 1971 (146,009 persons).

Responsible environmental management is an important consideration in Council's land use planning and land management functions. The Newcastle Local Environmental Plan 2003 identifies land use zones and incorporates controls for activities within those zones through guidelines and approvals. Council is currently developing the Newcastle Local Environmental Plan 2011 (LEP 2011) in accordance with the Standard Instrument (Local Environmental Plans) Order gazetted in March 2006.

Challenges

- Ensure future development, particularly residential development is located within areas not affected by natural hazards[31].
- Accommodate significant population growth whilst protecting and managing the biodiversity and conservation values of the key green corridors.[32]
- Accommodate population growth and the demand for new housing and employment whilst managing the increasing pressure on the Region's environment including a greater demand for drinking water and recreational opportunities.

The Urban Water Cycle Policy 2004, together with the Stormwater Management Plan 2004, Flood Policy 2004 and associated components of the Newcastle Development Control Plan 2005 provide the framework for urban water cycle management in Newcastle.

Flooding

Much of Newcastle has been built on natural flood plains which can present significant risks to life and property. It is not feasible to remove the flooding from the floodplains, and so ways must be found to manage the continuing risks.

[29] *Lower Hunter Regional Strategy 2006-31, NSW Department of Planning.*
[30] *Summary of Climate Change Impacts Hunter Region, NSW Climate Change Action Plan, Department of Environment & Climate Change NSW*
[31] *Lower Hunter Regional Strategy 2006-31, NSW Department of Planning.*

Dependant on the level and pattern of rainfall more than 20,000 properties (around one third of properties) in the LGA could experience flooding. In major and extreme flood events, the dominant risk is to life.

Flooding in Newcastle can occur from three mechanisms, (and sometimes in combination):

- River flooding, as a result of backwater inundation from the adjacent Hunter River (aka 1955)
- Flash flooding, as a result of intense rainfall within the local catchment (aka June 2007)
- Oceanic inundation, as a result of high ocean tides, storm surges etc. (aka king tides and sea level rise).

The severity and scale of the flood risks (partially evidenced by the June 2007 flood event) and the expectations of the community demand that flood management planning be completed as quickly as practicable, and that actual implementation of strategies occur.

Over several years Newcastle City Council has been collecting information and building essential computer flood models to enable accurate scenario testing of flood events and management options.

The Hunter Summit 2020 identified the following opportunities:

- Include adaptation measures in land use planning and infrastructure design to address the possible impacts of climate change i.e. rising sea levels and extreme weather events.

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