Cardno
Shaping the Future

Brisbane Water Foreshore
Floodplain Risk Management Plan

LJ2828/R002
Gosford City Council
November 2015

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Cover photograph shows a view of Empire Bay from Cockle Channel (taken 30 June, 2008).

Document Control

Version	Status	Date	Author		Reviewer	
1	Preliminary Draft	13 March 2015	Shani Archer	SCA	Emma Maratea	ERM
2	Draft	10 April 2015	Shani Archer	SCA	Emma Maratea	ERM
3	Final Draft	22 April 2015	Shani Archer	SCA	Emma Maratea	ERM
4	*Working Draft*	11 May 2015	Shani Archer	SCA	Emma Maratea	ERM
5	Revised Final Draft	14 May 2015	Shani Archer	SCA	Emma Maratea	ERM
6	Revised Final Draft	21 July 2015	Shani Archer	SCA	Emma Maratea	ERM
7	Final	16 November 2015	Shani Archer	SCA	Emma Maratea	ERM
8	Revised Final	30 November 2015	Shani Archer	SCA	Emma Maratea	ERM

Executive Summary

Overview and Purpose

This *Floodplain Risk Management Plan* (FRMP) for the Brisbane Water estuary foreshore floodplain has been prepared by Cardno for Gosford City Council in accordance with the New South Wales (NSW) *Flood Prone Land Policy* (NSW Government, 2001) and the principles of the *Floodplain Development Manual* (NSW Government, 2005).

The Brisbane Water FRMP has been developed to direct and co-ordinate the future management of flood prone land around the Brisbane Water Foreshore. It also aims to educate the community about flood risks so that they can make more informed decisions regarding their individual exposure and responses.

The preparation of this FRMP follows on from previous documents which have been prepared to assist in addressing flood risk for the Brisbane Water foreshores (namely the *Brisbane Water Flood Study* (Cardno, 2013b) and the *Brisbane Water Floodplain Risk Management Study* (Cardno, 2015)).

Study Area

The Brisbane Water estuary is a wave dominated barrier estuary and tidal tributary of the Lower Hawkesbury River system. It is located approximately 50km north of Sydney within the City of Gosford Local Government Area (LGA).

This FRMP relates primarily to the potential risk of floodwaters that rise up from the ocean (and into the estuary) and overtop seawalls and the foreshore. This type of flooding is referred to as *coastal flooding* and is often the result of severe coastal storm events. It is the dominant type of flooding affecting the majority of the foreshore and low lying areas of Brisbane Water (Cardno, 2013b). Major historical flood events at Brisbane Water include the severe ocean storm of 1974 and a more recent but less severe events in 2007 (when the *Pasha Bulker* ran aground in Newcastle) and April 2015.

This FRMP does not address the flood risk associated with the flooding of tributaries from catchment flows. This flood risk is dealt with in the relevant FRMPs for these catchments.

Floodplain Risk Management Study

The Brisbane Water FRMS (Cardno, 2015) was completed in March 2015. It assessed the flood risk across the Brisbane Water floodplain and identified, assessed and compared various management options to address the risk. It provided information and tools to allow strategic assessment of the impacts of management options for existing, future and continuing flood risk on flood behaviour and hazard. It also allowed for a robust assessment of the social, economic, environmental and cultural issues and costs and benefits of all options. The key findings of the FRMS were that the existing flood risk across Brisbane Water floodplain is relatively low and can be managed to an acceptable level primarily through the implementation of development controls, emergency response measures and minor works. Of key importance is the appropriate implementation of warnings and evacuation directions. It was also noted that the potential for increased flood risk as a result of sea level rise was identified as a significant concern. The uncertainty associated with this risk provided impediments to Council's ability to manage this risk. As such, the FRMS made recommendations for the development of detailed management strategies to adapt to the impacts of projected sea level rise on tidal inundation.

The outcomes of the FRMS form the basis for the Brisbane Water FRMP.

Since the completion of the FRMS, Gosford Council has resolved (March 2015) to adopt sea level rise planning levels based on projections for the Representative Concentration Pathway Scenario RCP 8.5 (Appendix B), utilising the medium sea level rise projection (see Figure 1 in April Council Agenda in Appendix B). This resolution has had implications for the outcomes of the FRMS and the recommendations in this FRMP have considered this revised position on sea level rise. It should be noted that the FRMS looked at the impact of 0.4m and 0.9m of sea level rise, however, the state policy (now repealed) from which this was derived was based upon an estimate of sea level rise from 1990 sea levels. The recent Council resolution has aimed to resolve this and has incorporated predictions of sea level rise from 2015 mean sea level (the full Council report is provided in Appendix B).

Flood Behaviour

Flooding behaviour around the Brisbane Water foreshore was investigated as part of the *Brisbane Water Foreshore Flood Study* (Cardno, 2013b). This study concluded that tidal / ocean flooding is dominant for the majority of the foreshore areas, i.e. severe ocean storms cause the highest water levels rather than catchment floods of the same average recurrence interval (ARI).

The impacts of wind and swell induced waves were found to have an impact beyond the flood levels identified in the Flood Study. Waves may have impacts up to 20 metres from the foreshore edge for the majority of the waterway, with some areas near the entrance to Brisbane Water potentially being impacted up to 40 metres from the foreshore edge due to the influence of ocean swell on these locations.

The focus of this Floodplain Risk Management Plan is to identify and address the existing flood risk. However, due to the nature of flooding and the urbanised nature of the foreshore of Brisbane Water, it is important to also consider the impacts of sea level rise on flooding. In general, most foreshore areas would be impacted by flooding more regularly, with more properties affected and greater flooding depths experienced in those locations already impacted by flooding under existing conditions.

Consultation

Consultation is an important element in the Floodplain Risk Management process. The program of consultation undertaken as part of the FRMS (Cardno, 2015) and this FRMP not only canvassed the community and stakeholders for information and opinions, it also sought to improve awareness and understanding of flooding risks within the local community, and to initiate commitments from the relevant stakeholders with respect to the subsequent stages of the process, being the implementation of the FRMP.

Council adopted a Community Engagement Strategic Framework in May 2014. The goals of this framework were to inform, consult, involve, collaborate and empower the community. Consultation with the community included (and will include) the following components:

- Resident brochure and survey;
- Consultation with the Catchments and Coast Committee (CCC);
- Public exhibition of the Draft FRMS and associated community engagement activities; and
- Public exhibition of the Draft FRMP and associated community engagement activities.

Outcomes and Recommendations

It is impractical to eliminate all flood risks from the Brisbane Water floodplain. Instead, the aim of the recommendations of this FRMP is to ensure that existing and future development is exposed to an 'acceptable' level of risk. Overall it is considered that existing risks to the floodplain can be managed appropriately through the implementation of development controls, emergency response measures and minor works. The effective implementation of development controls will be of key importance in reducing the damages and risk to life associated with flooding into the future through the construction of flood compatible buildings and assets.

Flood Planning Outcomes

Flood planning relates to the application of planning rules 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. At the same time appropriate planning provisions also recognise the benefits from the use, occupation and development of flood prone land.

This FRMP provides planning recommendations for the Brisbane Water Foreshore Floodplain. The key planning recommendations made by the FRMP are outlined below.

Flood Planning Levels
The Flood Planning Levels within the floodplain are recommended to be set at 100 year ARI flood level + projection of sea level rise + 0.5m freeboard.
Sea level rise should be incorporated into the planning levels in accordance with Council's Resolution (March 2015 or any subsequent amendment). Sea level rise should be commensurate to the asset life and planning horizons of the development proposed. A minimum planning horizon of 35 years should apply to all development types.
Development Controls
In February 2014, Gosford City Council's Development Control Plan (DCP) came into effect. Development in the Brisbane Water floodplain is assessed in a manner consistent with the DCP. Whilst the DCP has common elements for the management of flooding with respect to development across the entire LGA, this FRMP has provided recommendations for development controls which are specific to the flood behaviour in Brisbane Water. These recommendations can be found in Action PM7 (Appendix C) and the DCP Matrix provided in Appendix A.
Some of the key recommendations include: • Allow filling on a lot-by lot basis within the Brisbane Water foreshore floodplain (but not within catchment floodways or catchment flood storage areas); • Restrict subdivision within the Brisbane Water flood planning area where the proposed subdivision does not have suitable emergency access or the development is likely to have adverse impacts on flood behaviour; • Make provisions for wave run-up protection designs for dwellings and infrastructure; and • Flood compatible design requirements for dwellings, garages, commercial buildings and other development types (e.g. flood levels, flood proofing and access).
Voluntary House Raising Program
The worst flood affected residential properties on the floodplain will be assessed for their suitability for voluntary raising so that the flood risk can be reduced. This action can only be applied to houses that are not of slab-on-ground construction and do not lie within a high hazard location. The following criteria have been established to identify properties potentially suitable for voluntary house-raising:

- Over floor flooding in the existing 5 year ARI event;
- Not located within a high hazard area; and
- Comprises a residential dwelling/building of construction type suitable for house-raising.

It is estimated that there are 38 properties that fulfil this criteria. These properties will be reviewed via ground truthing. Property owners will then be notified of their eligibility to apply for house raising subsidies. Allocation of subsidies will be dependent on availability of funding from OEH and a detailed assessment of the subject property.

Emergency Management Outcomes

One of the key considerations for the Brisbane Water Foreshore Floodplain is the issue of access during a flood event. The recommendations of the FRMP focus on ensuring effective flood access for dwellings, emergency services and other facilities in the floodplain.

There are several locations within the floodplain where critical infrastructure, access routes or properties may become isolated as a result of rising floodwaters. These locations have been identified and liaison with the SES is important to ensure these areas are managed appropriately during a flood event.

In addition, several recommendations have been made to improve effective access during flood events. These include:

- Installation or deployment of flood related signage at key locations (EM2);
- Enhance road evacuation through the forward planning of alternative routes (EM8);
- Review evacuation centre locations to ensure that they are appropriate located outside of the floodplain and provide effective access to those dwelling requiring evacuation (EM7); and
- Relocate Critical Infrastructure and Facilities out of the floodplain (this may be done via the use of temporary facilities during a flood event) (PM6).

It is also the recommendation of this FRMP that Council should coordinate with the SES to ensure all of the relevant flood information from the Flood Study (Cardno, 2013b), FRMS (Cardno, 2015) and this FRMP are incorporated into Flood Plans and response arrangements (EM3). This would include not only flood extents, but duration of inundation, road flooding and any known locations of people with special needs that might hinder evacuation or appropriate response to flooding conditions. This information can also be utilized to ensure that SES and emergency services are located out of the floodplain for current and future sea level rise scenarios.

Communication of Flood Risk

A crucial component of the floodplain risk management process is ensuring that the outcomes of the Flood Study (Cardno, 2013b), FRMS (Cardno, 2015) and FRMP are communicated to the community. This has been and will be achieved through the following:

- Public exhibition of the FRMS and FRMP draft documents and the associated community engagement programs;
- S149 Certificates will be updated in accordance with the outcomes of the FRMS and FRMP;

- Council's website provides flood information and will be updated as required based on the outcomes of the FRMS and FRMP;
- Council can provide property specific flood information upon request; and
- Flood education programs will be implemented as per relevant management actions (EM1 and PM4).

Flood Modification Outcomes

Although the key findings of the FRMS were that the existing flood risk across Brisbane Water floodplain is relatively low and can be managed to an acceptable level primarily through the implementation of development controls and emergency response measures, there are some minor works that can effectively be implemented to reduce the impacts of flooding on properties and infrastructure.

Wave run-up can increase the impacts associated with flooding from ocean storm events. In addition, some properties around the periphery of the floodplain are not identified as flood affected. However, depending on swell and wind conditions, these properties may be impacted by wave run-up. This FRMP recommends the preparation of wave run-up management guidelines to assist foreshore property owners in understanding the risks to their property from waves and providing guidance on appropriate management strategies to reduce the impacts on their property.

Some low-lying areas are protected from direct coastal flooding due to a naturally higher portion of land that lies along the foreshore (between the location of interest and the estuary, basically functioning like a natural levee). However, many of these locations are connected to Brisbane Water by the stormwater system. As estuary water levels rise, the stormwater system is inundated and effectively 'backs up' into the previously unaffected areas and inundates them. Flap-type valves or small floodgates fitted to the outlets of stormwater pipes can be used in these instances to minimise surcharge of the stormwater system in a flood event. This action is floodplain-wide, as required. One area that may be of particular note is East of Lemon Grove Park, Ettalong. The foredune at Ettalong is likely to provide protection from the direct impacts of coastal flooding in this area. However, stormwater surcharge may be an issue for properties on low-lying land behind the dune.

Seawalls do not necessarily provide protection in large flood events (due to their generally discontinuous nature) but may assist in reducing the impact of smaller flood events and wave run-up. This action does not propose the introduction of additional seawalls around Brisbane Water but rather the maintenance, and in some areas raising, of existing seawalls to improve flood protection. It is noted that an investigation of the existing quality of seawalls (e.g. construction type, evidence of slumping or other failures) was not undertaken and further investigation is necessary prior to implementation. Seawall maintenance and raising could be done in conjunction with or instead of wave run-up protection works outlined above.

Future Flood Risk Management Outcomes

A key outcome of the FRMP is the identification of the potential increase in flood risk as a result of sea level rise. Some management actions are therefore geared towards preparing for the potential impacts of sea level rise. It is important to consider the potential impacts of sea level rise at an early stage so that planning and some degree of readiness can commence prior to any impacts occurring.

To address the tidal and flooding risks associated with sea level rise this FRMP recommends that that Climate Change Adaptation Plans (CCAPs) are prepared to ensure an integrated approach to dealing with the risks associated with climate change. These CCAPs would seek to establish a framework for

the management of projected climate change, subject to funding resources available to Council. Tidal inundation in addition to storm events would be considered as a component of the CCAPs. Recommendations set out in the CCAPs would then flow into the periodic review of the Brisbane Water FRMS and FRMP documents, Gosford City Council policy, Local Environmental Plans and Development Control Plan documents.

It is envisaged that a LGA-wide CCAP would be prepared in the first instance as an overarching document for subsequent plans. Projected sea level rise priority areas would then be identified (based on both flood affectation and the relevance of strategies and plans) and more location-specific plans would be formulated.

The projected impacts of sea level rise on the following assets could be incorporated into the investigations:

- Residential areas, both existing and proposed (i.e. identified growth areas) and the long term viability of these areas for development both with and without adaptation strategies.
- Public infrastructure – investigate the long term viability of the infrastructure servicing potentially affected areas. Strategies should be identified for works to protect these assets from the impacts of sea level rise and how this may be incorporated into the existing maintenance regime. Trigger levels should be identified when infrastructure is no longer viable (e.g. tidal levels at which road surfaces need to be upgraded / raised due to increasing frequent inundation).
- Heritage items and places – Investigate the impacts of future flooding and emergency response arrangements on heritage buildings, structures, items and places This should include a field survey of historic infrastructure and archaeological items and review of known heritage database records for both Aboriginal and non-Aboriginal heritage. Recommendations for the mitigation of negative impacts on heritage items should also be formulated.
- Flora, fauna and other natural resources – Investigate the impacts of projected sea level rise on flora and fauna, with particular emphasis on changes in foreshore vegetation. Reference can be made to Appendix D of Cardno (2010b) Sea Level Rise and the Estuarine Intertidal Zone – Discussion Paper.

Flood risk mitigation works should be assessed within the context of the findings of these studies. This may include reviewing some of the options presented in the FRMS which resulted in minimal flood benefits under existing sea levels but that may provide flood benefits for flooding conditions as a result of sea level rise.

Implementation and Funding

In order to achieve the implementation of relevant recommendations of this FRMP, a program of implementation has been developed. The steps in progressing the floodplain risk management process from this point onwards are:

- The Catchment & Coasts Committee (CCC) will consider and support relevant recommendations of this Plan for adoption by Council;
- Council will consider the CCC's recommendations;
- The draft FRMP will placed on public exhibition and community comment will be sought;
- Public comment will be considered, the FRMP will be modified if required, and the final Plan will be submitted to Council;
- Council will adopt the final Plan and submit applications for funding assistance to relevant State and Commonwealth agencies, as appropriate;

- The prioritisation and implementation of the management actions will be considered as part of Council's Integrated Planning and Reporting Process.
- As funds become available from OEH, the Commonwealth, other state government agencies and/or from Council's own resources, recommended management actions will be implemented in accordance with the established priorities.

Each of the recommended actions (outlined in **Section 6**) has been given a relative implementation timing (immediate or staged) and priority (high, medium or low).

The estimated costs of implementing the Plan by Council and relevant State Agencies include approximately $1.5 Million is capital costs and $350,000 in recurrent costs for four years. Some actions would require ongoing funding beyond the first five years of the Plan implementation (e.g. periodic analysis of sea level rise) and others may be fully complete after only one year.

Several options also identify potential works that could be undertaken by private land owners (e.g. upgrades to private seawalls). The costs associated with these options have not been included in the implementation strategy, but are referenced in Appendix C.

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Glossary

Australian Height Datum (AHD)	A common national surface level datum approximately corresponding to mean sea level.
Average Recurrence Interval (ARI)	The long-term average number of years between the occurrence of a flood as big as or larger than the selected event. For example, floods with a discharge as great as or greater than the 20 year ARI flood event will occur on average once every 20 years. ARI is another way of expressing the likelihood of occurrence of a flood event.
BoM	Australian Bureau of Meteorology
Catchment	The area draining to a site. It always relates to a particular location and may include the catchments of tributary streams as well as the main stream.
Catchment flooding	The overtopping of creek banks causing flooding, usually associated with heavy or prolonged rainfall events in the catchment.
CCC	Catchments and Coast Committee, established by Gosford City Council to oversee the FRMS. The CCC includes community members, NSW State Emergency Service representatives and OEH representatives. The CCC has direct involvement and assisted in guiding the direction of the FRMS.
Coastal flooding	Flooding along the coastal foreshores due to an increase in ocean or estuarine water levels and associated with storm surge.
DCP	Development Control Plan
Design flood	A significant event to be considered in the design process; various works within the floodplain may have different design events e.g. some roads may be designed to be overtopped in the 1 year ARI or 100%AEP flood event.
Design Still Water Level (DSWL)	The modelled water surface elevation for a design flood events, excluding local variation due to waves and wave set-up, but including the effects of tides, storm surges and long period seiches.
Development	The erection of a building or the carrying out of work; or the use of land or of a building or work; or the subdivision of land.
Discharge	The rate of flow of water measured in terms of volume over time. It is to be distinguished from the speed or velocity of flow, which is a measure of how fast the water is moving rather than how much is moving.
OEH	Office of Environment and Heritage
Flood	Relatively high stream flow which overtops the natural or artificial banks in any part of a stream, river, estuary, lake or dam, and/or overland runoff before entering a watercourse and/or coastal inundation resulting from super elevated sea levels and/or waves overtopping coastline defences.
Flood hazard	Potential risk to life and limb caused by flooding.

Flood planning area	The area of land below the flood planning level and thus subject to flood related development controls.
Flood planning levels	Flood levels selected for planning purposes, as determined in floodplain management studies and incorporated in floodplain management plans. Selection should be based on an understanding of the full range of flood behaviour and the associated flood risk. It should also take into account the social, economic and ecological consequences associated with floods of different severities. Different FPLs may be appropriate for different categories of land use and for different flood plains. As FPLs do not necessarily extend to the limits of flood prone land (as defined by the probable maximum flood), floodplain management plans may apply to flood prone land beyond the defined FPLs.
Floodplain	Area of land which is subject to inundation by floods up to the probable maximum flood event, i.e. flood prone land.
Floodplain management options	The measures that might be feasible for the management of a particular area.
Flood prone land	Land susceptible to inundation by the probable maximum flood (PMF) event, i.e. the maximum extent of flood liable land. Floodplain Risk Management Plans encompass all flood-prone land, rather than being restricted to land subject to designated flood events (such as the 100 year ARI).
Freeboard	A factor of safety that is usually expressed as the difference in height between the level of the floodwaters and the adopted flood planning level. Provides a factor of safety to compensate for uncertainties in the estimation of flood levels across the floodplain such as wave action and localised hydraulic behaviour.
FPA	Flood Planning Area
FPL	Flood Planning Level
FRMP	Floodplain Risk Management Plan
FRMS	Floodplain Risk Management Study
GCC	Gosford City Council
High hazard	Flood conditions that pose a possible danger to personal safety; evacuation by trucks difficult; able-bodied adults would have difficulty wading to safety; potential for significant structural damage to buildings.
Hydraulics	The term given to the study of water flow in a river, channel or pipe, in particular, the evaluation of flow parameters such as stage and velocity.
IPCC	Intergovernmental Panel on Climate Change
LEP	Local Environment Plan
LGA	Local Government Area
Low hazard	Flood conditions such that should it be necessary, people and their possessions could be evacuated by trucks; able-bodied adults would have little difficulty wading to safety.

Management plan	A document including, as appropriate, both written and diagrammatic information describing how a particular area of land is to be used and managed to achieve defined objectives. It may also include description and discussion of various issues, special features and values of the area, the specific management measures which are to apply and the means and timing by which the plan will be implemented.
Model (e.g. hydraulic model)	The mathematical representation of the physical processes involved in flooding. These models are often run on computers due to the complexity of the mathematical relationships.
MSL	Mean Sea Level
NSW	New South Wales
Planning horizon	The period of time into the future over which factors associated with a development are considered at the present time.
Probability	A statistical measure of the expected frequency or occurrence of flooding.
Probable maximum flood (PMF)	The flood calculated to be the maximum that is likely to occur.
RCP - Representative Concentration Pathways	Representative Concentration Pathways (RCPs) are four greenhouse gas concentration (not emissions) trajectories adopted by the IPCC for its fifth Assessment Report (AR5) in 2014. It supersedes Special Report on Emissions Scenarios (SRES) projections published in 2000.
RCP8.5	This RCP is characterized by increasing greenhouse gas emissions over time, representative of scenarios that lead to high greenhouse gas concentration levels.
Risk	Chance of something happening that will have an impact. It is measured in terms of consequences and likelihood. For this study, it is the likelihood of consequences arising from the interaction of floods, communities and the environment.
RMS	NSW Roads and Maritime Services
Sea wall	Wall built parallel to the shoreline to assist in protecting the shoreline from erosion.
SEPP	State Environmental Planning Policy
SES	State Emergency Service
SLR	Sea Level Rise
Stormwater	Urban stormwater is mainly rainfall that runs off roofs, roads, footpaths and car parks. Rainfall run-off also occurs from gardens, parks and other open space areas in larger storms. Stormwater has been traditionally collected by stormwater drains and transported through pipes and channels to creeks, rivers, the harbour and ocean.

Storm Surge	The increase in coastal water level caused by the effects of storms. Storm surge consists of two components: the increase in water level caused by the reduction in barometric pressure (barometric setup) and the increase in water level caused by the action of wind blowing over the sea surface (wind setup).
Topography	A surface which defines the ground level of a chosen area.
Tides	The regular rise and fall of the sea level in response to the gravitational attraction between the sun, moon and Earth.
Tidal inundation	Inundation of coastal areas in alignment with the tidal cycle. Currently, this type of inundation occurs once or twice a year, during spring or king tides. This inundation mechanism is likely to increase in severity with projected sea level rise
Wave Run-Up and Overtopping	Wave run-up is the maximum vertical extent of wave uprush on a beach or foreshore structure above the design still water level. Wave overtopping is the distance over which the wave will extend beyond the foreshore. This is limited by the wave behaviour and the topography of the land. Wave run-up and overtopping for the Brisbane Water foreshore identifies the height and extent of impacts of waves beyond the design still water level.

1 Introduction

This *Floodplain Risk Management Plan* (FRMP) for the Brisbane Water estuary foreshores has been prepared by Cardno for Gosford City Council. This document has been prepared in accordance with the New South Wales (NSW) *Flood Prone Land Policy* (NSW Government, 2001) and the principles of the *Floodplain Development Manual* (NSW Government, 2005).

1.1 Purpose of the Plan

The objectives of this Floodplain Risk Management Plan are to:

- Provide a practical framework and implementation plan for managing existing, future and continuing flood risk within the study area;
- Formulate a cost effective Plan for the study area based on the findings of the *Floodplain Risk Management Study* (Cardno, 2015);
- Provide a priority program for implementation of the recommended works and measures in accordance with Appendix H of the *Floodplain Development Manual* (NSW Government, 2005);
- Provide governance and leadership direction for floodplain risk management that is in accordance with the *Gosford 2025 – Community Strategic Plan* vision for the community;
- Ensure that intergenerational equity is maintained through achieving a balance between reducing flood vulnerability for the current and future generation, without overly burdening the current generation with costs and avoiding the transfer of costs or risk to future generations;
- Disseminate the outcomes of the Plan to state agencies including those directly impacted by the decisions identified e.g. police and emergency services; and
- Provide for the management of flood risks to public assets (such as services and utilities) and private property.

1.2 Plan Context

The Brisbane Water estuary is a wave dominated barrier estuary and tidal tributary of the Lower Hawkesbury River system. It is located approximately 50km north of Sydney within the City of Gosford Local Government Area (LGA). In the past, flooding of the Brisbane Water foreshore has caused property damage, restricted property access and has been a general inconvenience to the community. These flooding issues have prompted Gosford City Council, through an established Catchment and Coast Committee to prepare a comprehensive and integrated *Floodplain Risk Management Plan* for the Brisbane Water foreshore area.

The preparation of this FRMP follows on from the *Foreshore Flood Study* (Cardno, 2013b) and the *Floodplain Risk Management Study* (Cardno, 2015) and forms the fifth stage of the floodplain risk management process as defined by the *Floodplain Development Manual* (NSW Government, 2005):

1. Establish a Floodplain Risk Management Committee (now called Catchments and Coast Committee);
2. Data Collection;
3. Flood Study;
4. Floodplain Risk Management Study;
5. **Floodplain Risk Management Plan**;
6. Plan Implementation; and
7. Review of Plan.

The preceding fourth stage, the *Floodplain Risk Management Study* (FRMS), was prepared by Cardno as a separate document (Cardno, 2015). It assessed the flood risk across the Brisbane Water floodplain and identified, assessed and compared various management options to address the risk. It provided information and tools to allow strategic assessment of the impacts of management options for existing, future and continuing flood risk on flood behaviour and hazard. It also allows for a robust assessment of the social, economic, environmental and cultural issues and costs and benefits of all options. The key findings of the FRMS were that the existing flood risk across Brisbane Water floodplain is relatively low and can be managed to an acceptable level primarily through the implementation of development controls, emergency response measures and minor works. However, the potential for increased flood risk as a result of sea level rise was also identified as a significant concern. The uncertainty associated with this risk provided impediments to Council's ability to manage this risk. As such, the FRMS made recommendations for the development of detailed management strategies to adapt to the impacts of projected sea level rise on tidal inundation.

The outcomes of the FRMS form the basis for the Brisbane Water FRMP. The FRMP also reflects policy changes subsequent to the exhibition of the Study. This FRMP is to be utilised in conjunction with the FRMS (Cardno, 2015).

1.2.1 Related Plans of Management and Strategies

In addition to those documents associated with the floodplain risk management process, a number of relevant plans and strategies were considered during the preparation of this Plan. These include:

- Brisbane Water Estuary Management Study (Cardno 2011);
- Brisbane Water Coastal Zone Management Plan (Cardno, 2013a);
- Gosford 2025 – Community Strategic Plan (GCC, 2013a);
- Resource Strategy Gosford 2011/12 (GCC, 2011);
- Delivery Program 2013/14 - 2016/17 incorporating the Operational Plan 2014/15 (GCC, 2014a);
- Gosford Development Control Plan (GCC, 2013b);
- Gosford Local Environment Plan (GCC, 2014b);
- Gosford City Centre Local Environment Plan (GCC, 2007);
- Gosford Planning Scheme Ordinance (GCC, 2013c); and
- Gosford City Displan (Gosford LEMC, 2009).

1.3 Document Structure

This Plan covers the following:

- Study Area (**Section 2**);
- Flood Behaviour, Issues and Management Objectives (**Section 3**);
- Flood Planning (**Section 4**);
- Consultation (**Section 5**);
- Floodplain Risk Management Actions (**Section 6**);
- Implementation Program (**Section 7**); and
- Conclusions (**Section 8**).

2 Study Area

The study area encompasses the foreshores of Brisbane Water and is defined as the land that is affected by coastal flooding up to the PMF event. Sea level rise of up to 0.9m has also been considered as a part of the study area. The study area is shown in **Figure 2.1**.

2.1 Study Limits

This FRMP relates primarily to potential floodwaters that rise up from the ocean (and into the estuary) and overtop seawalls and the foreshore. This type of flooding is referred to as *coastal flooding* and is often the result of severe coastal events such as storm surge. This FRMP considers the management of risks associated with coastal flooding because it is the major type of flooding that affects the foreshores of Brisbane Water (Cardno, 2013b).

This FRMP does not relate to floodwaters that originate from heavy or prolonged rain causing stormwater to travel downslope towards the estuary. This type of flooding is referred to as *catchment flooding,* which is associated with increased creek and stormwater channel flows. This flooding mechanism is not dominant in the study area. The Brisbane Water Flood Study (Cardno, 2013b) undertook some limited modelling of catchment events. A comparison of this modelling with the floor level data collected for the Floodplain Risk Management Study (Cardno, 2015) show that very few properties on the foreshore of Brisbane Water are likely to experience over floor flooding as a result of catchment flooding alone. However, some inundation of property outdoor areas along the immediate foreshore could be expected.

The hydrological investigations for the FRMS covered the whole of the Brisbane Water Estuary catchment, however hydraulic modelling was limited to cover the body of the estuary and the foreshore areas. While the effects of catchment flooding on tributaries have not been included in the study, the downstream end of some of the tributaries and some low lying areas beyond the immediate foreshore have been included in the hydraulic model to assess the impacts of storm surge only on these areas. The Hydraulic model limits are shown on **Figure 2.1**.

It should also be noted that the hydraulic model does not include hydraulic structures such as culverts and pipes. As such, some areas not shown as being impacted by storm surge may in fact experience inundation as a result of the stormwater system “backing up”. For example the culverts under the railway bridge at Tascott have not been included in the modelling and as such the area to the west of the railway line in Tascott is only shown to experience inundation in events when the railway line is overtopped by the water level within Brisbane Water. In reality the impact of Brisbane Water levels on this area will be driven by the functionality of the culverts (design and blockage) and catchment flows. No catchment flows were assessed at this location.

The estimation of flood behaviour in the tributaries beyond the main body of the estuary (such as Kincumber Creek, Woy Woy Creek, Erina Creek and Narara Creek) was not addressed in the *Brisbane Water Foreshore Flood Study* (Cardno, 2013b), and consequently the FRMS *(Cardno, 2015)* and this FRMP are also confined to the estuary foreshore areas. Separate management studies have been prepared for these tributaries and can be found on Council’s website (currently http://www.gosford.nsw.gov.au/environment-and-waste/water-and-sewer/floodplain-risk-management-planning).

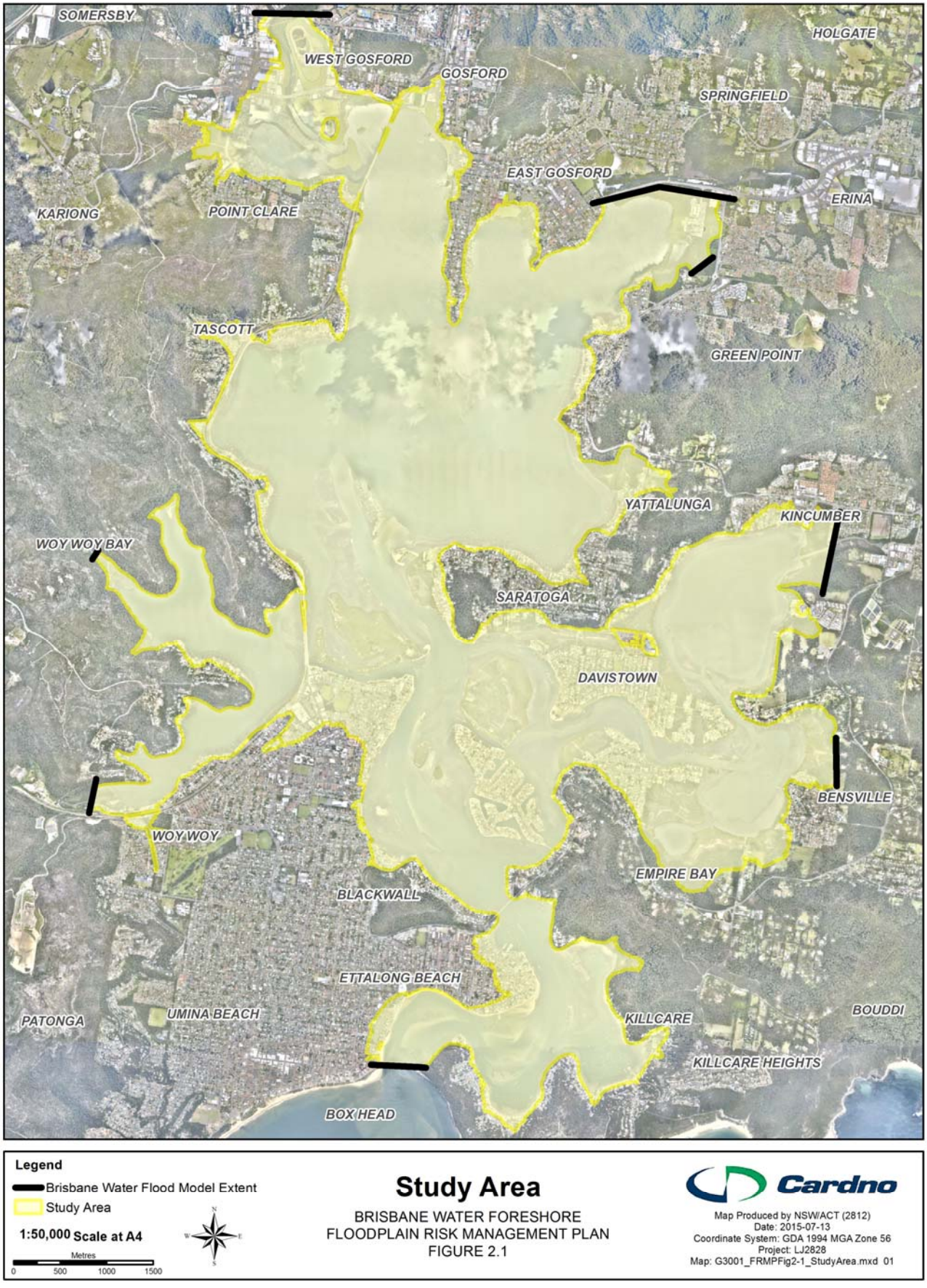


Figure 2.1: Study Area showing Hydraulic Model Extents

3 Flood Behaviour, Issues and Objectives

3.1 Flood Behaviour

Flooding behaviour around the Brisbane Water foreshore was investigated as part of the *Brisbane Water Foreshore Flood Study* (Cardno, 2013b). This study concluded that tidal / ocean flooding is dominant for the majority of the foreshore areas, i.e. severe ocean storms cause the highest water levels rather than catchment floods of the same average recurrence interval (ARI). The exception was found to be within Fagans Bay, which is dominated by catchment flooding in less frequent events. This is due to large catchment flows from Narara Creek and the local hydraulic control (the northern railway bridge) which reduces the rate of discharge of catchment flows into the estuary.

Flood levels were found to vary across the floodplain as a result several factors including the distance from the ocean, the influence of catchment flows in the upper reaches, the hydraulic influence of the entrances to embayments, the local wind effects and losses across the estuary bed.

The impacts of wind and swell induced waves were found to have an impact beyond the flood levels identified in the Flood Study (Cardno, 2013b). Waves may have impacts up to 20 metres from the foreshore edge for the majority of the waterway, with some areas near the entrance to Brisbane Water (Management Areas 11 and 12) potentially being impacted up to 40 metres from the foreshore edge due to the influence of ocean swell on these locations.

3.1.1 Historical and Existing Flood Behaviour

Past flooding of the Brisbane Water foreshore has caused property damage, impeded emergency access and inconvenienced residents. Major historical flood events at Brisbane Water include the severe ocean storm of 1974 and a more recent but less severe events in 2007 (when the Pasha Bulker ran aground in Newcastle) and April 2015. The April 2015 event was estimated to be between a 5 and 10 Year ARI event, depending on the location within the floodplain (photos of this event are shown below). The variation in levels around the foreshore was primarily due to the wind direction. A comparison of the Flood Study (Cardno, 2013b) results and the recent events, shows that the Flood Study provides a good representation of flood behaviour within Brisbane Water.

20 – 21 April 2015 Coastal Storm Event

Woy Woy Public Wharf

Brisbane Water Drive Koolewong

Gosford Waterfront

A summary of the existing key flooding issues on a location-by-location basis is provided in **Table 3.1**. To assist the management process, the floodplain has been separated into 15 management areas which were established in the FRMS. Flood behaviour varies across the floodplain and as such, each management area contains locations with similar flood characteristics. Management areas are shown in **Figure 3.1**.

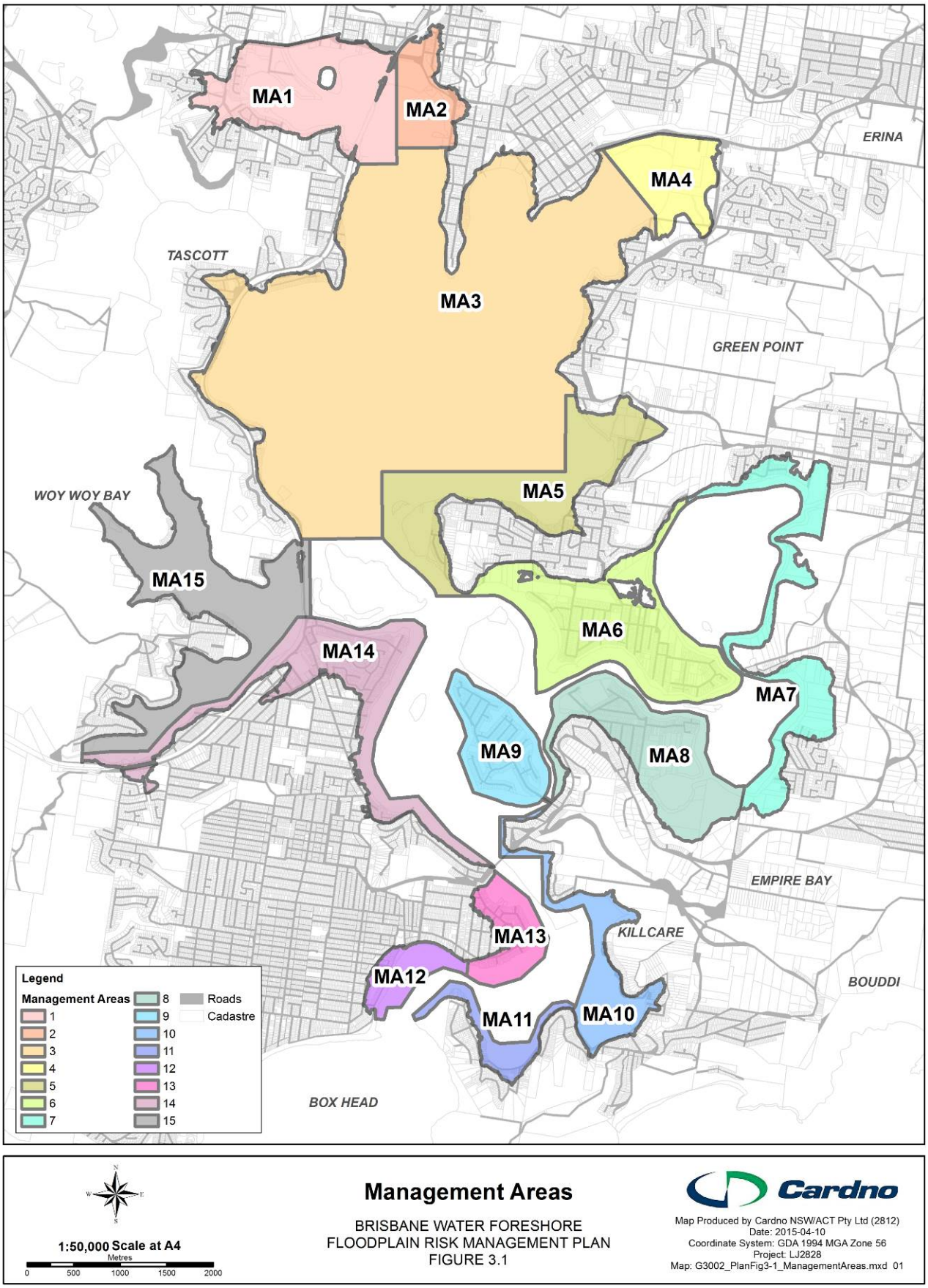


Figure 3.1: Management Areas

Table 3.1: Existing Flood Behaviour, Issues and Properties Affected by Flooding (i.e. any part of the ground of the property is affected) for each Management Area

Management Area	Description of Flooding Issues	Dominated By	Predominantly Affected Land Uses	Number of Properties Affected in 100yr ARI (Existing)[#]
MA1 West Gosford and Point Clare	➢ Fagans Bay is dominated by catchment flooding in events greater than the 100 year ARI event. This is due to large catchment flows from Narara Creek and the local hydraulic control (the northern railway bridge). The bridge reduces the rate of discharge of catchment flows into the estuary. ➢ The *Review of the Narara Creek Flood Study* (Golder Associates, 2012) provides more detailed analysis of catchment flooding in this location. ➢ Storm surge from coastal events for events less than the 100 year ARI event results in relatively shallow flooding of foreshore properties within Fagans Bay. ➢ The retirement village on Yallambee Avenue represents a potential flood island issue.	➢ Catchment flows in lower probability events. ➢ Coastal flooding in higher probability events.	➢ Open Space ➢ Residential ➢ Special Uses / Infrastructure	162
MA2 Gosford	➢ The foreshore of this location is likely to experience some flooding in less frequent events. ➢ Coastal flooding would affect mainly commercial properties, but only in less frequent events such as the 100 year ARI, 200 year ARI and PMF. ➢ Wave overtopping over the sea wall has occurred in past storm events. ➢ Existing high tides in the Gosford area may result in foreshore inundation, especially with joint occurrence of storm conditions.	➢ Coastal flooding in all events.	➢ Commercial ➢ Special Uses / Infrastructure ➢ Open Space	47

Management Area	Description of Flooding Issues	Dominated By	Predominantly Affected Land Uses	Number of Properties Affected in 100yr ARI (Existing)[#]
MA3 Point Frederick, East Gosford, Green Point, Koolewong and Tascott	➢ Some localised areas of flooding in more frequent flood events likely to occur, mainly overground flooding for residential properties. ➢ Some areas of Tascott are also affected by catchment flows from the creek at Tascott. These issues are assessed in a separate study; *Tascott Basin Floodplain Management Study* (WMA, 1992) ➢ Existing high tides in this area can cause foreshore inundation, especially high tides with joint occurrence of storm conditions.	➢ Coastal flooding in all events.	➢ Residential ➢ Open Space	540
MA4 Erina	➢ High tides and higher probability events may cause foreshore inundation in this area. ➢ Some areas are affected by catchment flows from Erina Creek. ➢ Emergency services (SES) affected by flood island issue.	➢ Coastal flooding in all events.	➢ Open Space. ➢ Special Uses / Infrastructure. ➢ Industrial	13
MA5 Yattalunga and Saratoga	➢ Residential properties affected by coastal flooding. ➢ Existing high tides in these areas can cause foreshore inundation, especially with joint occurrence of storm conditions.	➢ Coastal flooding in all events.	➢ Residential ➢ Open Space	253

Management Area	Description of Flooding Issues	Dominated By	Predominantly Affected Land Uses	Number of Properties Affected in 100yr ARI (Existing)[#]
MA6 Davistown	➢ A large number of residential properties are affected, even in more frequent flood events. ➢ Inland penetration of flood waters is larger due to very flat terrain. ➢ Existing high tides in this area can cause foreshore inundation, especially with joint occurrence of storm conditions. ➢ Longer term asset deterioration may occur.	➢ Coastal flooding in all events.	➢ Residential ➢ Open Space	1099
MA7 Kincumber, Kincumber South and Bensville	➢ Relatively small areas of residential properties in these suburbs are affected, and mostly in less frequent events. ➢ Existing high tides in this area can cause foreshore inundation, especially high tides with joint occurrence of storm conditions.	➢ Coastal flooding in all events.	➢ Open Space. ➢ Residential ➢ Special Uses / Infrastructure	116
MA8 Empire Bay	➢ Residential properties are affected even in higher probability events. ➢ Existing high tides in this area can cause foreshore inundation, especially with joint occurrence of storm conditions.	➢ Coastal flooding in all events.	➢ Residential ➢ Open Space	435

Management Area	Description of Flooding Issues	Dominated By	Predominantly Affected Land Uses	Number of Properties Affected in 100yr ARI (Existing)[#]
MA9 St Huberts Island	➢ Flooding is generally limited by ground levels on the island having been historically filled to above the 100 year ARI event, and only a very small portion of waterfront properties are generally affected. ➢ High tide events in conjunction with storms can cause surcharge of the stormwater system which affects local roads. ➢ Over-floor flooding is unlikely to occur for most residential properties, however, over-ground flooding may be experienced. ➢ Storm surge events greater than 100 year ARI have the potential to inundate this area.	➢ Coastal flooding in all events.	➢ Residential	432*
MA10 Daleys Point, Killcare and Hardys Bay	➢ Flooding is limited by fairly steep terrain at Killcare and Hardys Bay and very steep terrain at Daleys Point. ➢ Over-floor flooding is unlikely to occur for most residential properties, however, over-ground flooding may be experienced. ➢ Flooding may effect evacuation.	➢ Coastal flooding in all events.	➢ Open Space ➢ Residential	79
MA11 Pretty Beach and Wagstaffe	➢ Existing high tides in this area can cause foreshore inundation, especially high tides with joint occurrence of storm conditions. ➢ Storm surge affects local drainage and flood islands may be present.	➢ Coastal flooding in all events.	➢ Residential	105

Management Area	Description of Flooding Issues	Dominated By	Predominantly Affected Land Uses	Number of Properties Affected in 100yr ARI (Existing)[#]
MA12 Ettalong	➢ Residential properties are generally not affected by flooding in more frequent events. ➢ In the existing 100 year ARI event, the foredune protects properties from direct inundation, however, properties are inundated instead due to surcharge of the stormwater system whereby elevated waters in Brisbane Water "back up" the stormwater system. ➢ High tides do not generally result in foreshore inundation within Ettalong.	➢ Coastal flooding in all events.	➢ Open Space ➢ Residential	10^
MA13 Booker Bay	➢ Some water-front residential properties in this location are likely to be subject to over-ground flooding in more frequent events such as the 5 and 20 year ARI. ➢ Existing high tides in this area can cause foreshore inundation, especially high tides with joint occurrence of storm conditions. In these instances, roads and some residential properties are affected.	➢ Coastal flooding in all events.	➢ Residential	207
MA14 Woy Woy and Blackwall	➢ Residential and commercial properties are affected by flooding even in more frequent flood events such as the 5 year ARI and 20 year ARI. ➢ Existing high tides in this area can cause inundation, especially with joint occurrence of storm conditions. ➢ Flooding likely to affect evacuation. ➢ Flood island issues. ➢ Longer term asset deterioration may occur.	➢ Coastal flooding in all events.	➢ Residential ➢ Commercial ➢ Special Uses / Infrastructure ➢ Open Space	704

Management Area	Description of Flooding Issues	Dominated By	Predominantly Affected Land Uses	Number of Properties Affected in 100yr ARI (Existing)#
MA15 Horsfield Bay, Phegans Bay and Woy Woy Bay	➢ Coastal flooding is confined to small areas within these three bays and is limited in its extent by steep terrain. ➢ Some overground flooding may be experienced but over-floor flooding is unlikely due to floor levels. ➢ Flooding affects arterial and local roads which affect evacuation. The underpass of the railway line is a key example of this.	➢ Coastal flooding in all events.	➢ Open Space ➢ Residential	102

These numbers indicate all properties that intersect with the flood extent for each respective event, even when flooding occurs only on a very small portion of the foreshore land of the property, with no over-floor flooding. Numbers include all properties (residential, commercial, industrial, open space etc.).

* St Huberts Island is not substantially affected by flooding in the existing 100 year ARI event (see # note above).However, a large number of properties has been picked up because most properties have a very small waterfront potion that is affected by flooding. A more realistic number of affected properties for the existing 100 year ARI event (i.e. where a substantial portion of the property is affected) is 10.

^ An increase in affected properties occurs if indirect flooding (via surcharge of the stormwater system) is considered (86 properties instead of 10).

3.1.2 Future Flood Behaviour

The focus of this Floodplain Risk Management Plan is to identify and address the existing flood risk. However, due to the nature of flooding and the urbanised nature of the foreshore of Brisbane Water, it is important to also consider the impacts of sea level rise on flooding. As such, in addition to existing flood risks, projected future flood risks were also assessed in the FRMS, including the consideration of sea level rise of 0.4 and 0.9 metres. The sea level rise benchmarks of 0.4 and 0.9 metres were selected for inclusion in the assessment undertaken in the FRMS (Cardno, 2015) in response to the *NSW Sea Level Rise Policy Statement* (DECCW, 2009). This policy statement was later repealed in 2012 but the benchmarks still provided a sound basis for understanding the likely impacts of sea level rise. When these benchmarks are compared against Gosford Council's existing sea level rise policy (**Appendix B**) they correspond to planning horizons of approximately 55 years and 90 years respectively.

To provide an indication of future flood behaviour, the 0.9m scenario was assessed (in preference to the 0.4m scenario) as this is the maximum sea level rise scenario within current predictions. As such, the results of future flood behaviour give an indication of the potential long term sea level rise impacts with respect to current predictions.

In general, most foreshore areas would be impacted by flooding more regularly, with more properties affected and greater flooding depths experienced in those locations already impacted by flooding under existing conditions. A summary of the number of properties affected by flooding is provided in **Table 3.2**. The numbers in **Table 3.2**:

- Include all residential and commercial properties affected by flooding, even when flooding of the structure or building contained on that property is not affected;
- Include all residential and commercial properties affected by flooding, even when the land of the property is only marginally affected;
- Are not representative of whether the structure or building contained on that property is flood affected; and
- Were calculated based on the property ground and floor levels obtained by a surveyor as part of the FRMS (Cardno, 2015) and were used for the purposes of the flood damages calculations. It is noted that industrial properties were not included in the survey. This data is included in Appendix E (Confidential).

Table 3.2: Properties Affected by Flooding

Flood Event	Properties affected	
	Existing	0.9m Sea Level Rise
5 Year ARI	3,182	5,777
20 Year ARI	3,828	5,963
100 Year ARI	4,304	6,111
200 Year ARI	4,512	6,187
PMF	5,213	6,554

The number of properties affected by over-floor flooding only is provided in **Table 3.3**. The numbers in **Table 3.3** include all residential and commercial properties as per the aforementioned floor level survey data. It can be seen that over-floor flooding affects far fewer properties, particularly in the existing case, and this is due to minimum floor level requirements for properties in the floodplain.

Table 3.3: Properties Affected by Over-floor Flooding

Flood Event	Properties affected by flooding above floor level only	
	Existing	0.9m Sea Level Rise
5 Year ARI	77	1,972
20 Year ARI	202	2,409
100 Year ARI	473	3,003
200 Year ARI	616	3,236
PMF	1,198	3,945

A discussion paper was also included in the FRMS (Cardno, 2015) that outlined the anticipated tidal inundation as a result of sea level rise (i.e. the day to day effects, rather than the effects occurring concurrently with a coastal flood event). A summary of the potential impacts of tidal inundation as a result of 0.9m of sea level rise has been summarised for each Management Area in **Table 3.4**.

Table 3.4: Future Tidal Behaviour with 0.9m of Projected Sea Level Rise

Management Area	Description of Future Tidal Inundation Issues
MA1 West Gosford and Point Clare	➢ High tides are likely to affect lower-lying and foreshore roads in the area and some open space and foreshore areas. Private properties are unlikely to be inundated in regular tidal events.
MA2 Gosford	➢ High tides may affect foreshore roads and open space but private properties are unlikely to be significantly affected. ➢ Some further inundation will occur in high water level events, but would generally be restricted to areas in close proximity to the foreshore due to the topography of the area.
MA3 Point Frederick, East Gosford, Green Point, Koolewong and Tascott	➢ High tides in this area are likely to cause inundation of some foreshore properties, sections of some lower-lying roads, and foreshore open space areas.
MA4 Erina	➢ High tides are likely to cause inundation predominately in open space and wetland areas only.
MA5 Yattalunga and Saratoga	➢ High tides are likely to impact some foreshore properties and local roads.
MA6 Davistown	➢ A large number of residential properties are likely to be affected by high tides. ➢ Key access roads may also be impacted by high tides, with some long term asset deterioration. ➢ Inundation by tides is more extensive due to very flat terrain.
MA7 Kincumber, Kincumber South and Bensville	➢ High tides are likely to cause inundation predominately in open space and wetland areas. Some small areas of private properties may be affected.
MA8 Empire Bay	➢ A moderate number of residential properties are likely to be affected by high tides. ➢ Local roads are likely to be affected, and longer term asset deterioration likely.
MA9 St Huberts Island	➢ A small number of properties and roads likely to be affected by high tides.

Management Area	Description of Future Tidal Inundation Issues
MA10 Daleys Point, Killcare and Hardys Bay	➢ Foreshore inundation from high tides is likely to only affect small areas in these locations. ➢ Inundation by tides is limited by moderately steep terrain at Killcare and Hardys Bay and very steep terrain at Daleys Point.
MA11 Pretty Beach and Wagstaffe	➢ High tides in this area are likely to affect some foreshore roads and properties.
MA12 Ettalong	➢ High tides are unlikely to affect properties or roads.
MA13 Booker Bay	➢ High tides in this area are likely to cause inundation of properties and roads, and longer term asset deterioration.
MA14 Woy Woy and Blackwall	➢ Roads and a large number of residential and commercial properties are likely to be affected by high tides. ➢ Longer term asset deterioration likely. ➢ Inundation by tides is more extensive due to very flat terrain.
MA15 West Gosford and Point Clare	➢ Some foreshore properties are likely to be impacted by high tides. ➢ Inundation is limited by steep terrain.

Whilst the management actions recommended in the Plan (**Section 6**) primarily relate to management of the existing flood risk, it can be seen that the flood risk and tidal inundation may be significantly exacerbated over the coming decades as a result of sea level rise. Management of this risk has been considered in the FRMS (Cardno, 2015) and this FRMP through the following:

- The analysis of likely flood impacts under sea level rise scenarios of 0.4m and 0.9m.
- The analysis of likely impacts on tidal inundation as result of sea level rise scenarios of 0.4m and 0.9m.
- The development of an interim development control matrix that can be adapted to include consideration of the best available science on sea level rise available over time (**Appendix A**).

A key recommendation of this FRMP is that Climate Change Adaptation Plans should be prepared for the Brisbane Water area. This forms Action PM9, which will need to consider the floodplain risk management process and other planning mechanisms so that potential sea level rise can be adequately planned for. It is recommended that the CCAPs review the best available climate change science available and develop strategic policies, frameworks and management strategies for the LGA as a whole and for key areas affected by climate change. The information contained within the Floodplain Risk Management Study will be used to inform these strategies. Further details regarding the proposed Climate Change Adaptation Plans are provided in **Section 6.5** of this FRMP.

3.2 Flood Extents

Flood extents for the Brisbane Water Foreshore were prepared as part of the FRMS (Cardno, 2015). Flood extents for the existing 100 year ARI event and PMF event are provided as **Figure 3.2**. Projected flood extents for the 0.4m SLR and 0.9m SLR scenarios are provided in **Figures 3.3 and 3.4** respectively.

More detailed figures showing flood extents for these and other ARIs can be found in Appendix C (existing scenario) and Appendix F (sea level rise scenarios) of the FRMS (Cardno, 2015).

It is noted that the mapping prepared for the FRMS was undertaken prior to the Council resolution on sea level rise (GCC, 2015), provided in **Appendix B**. The mapping therefore provides an indication of sea level rise values that are based on previous bench marks. However, it is noted that these values are relevant within the next 100 years with regards to the sea level rise predictions adopted by Council.

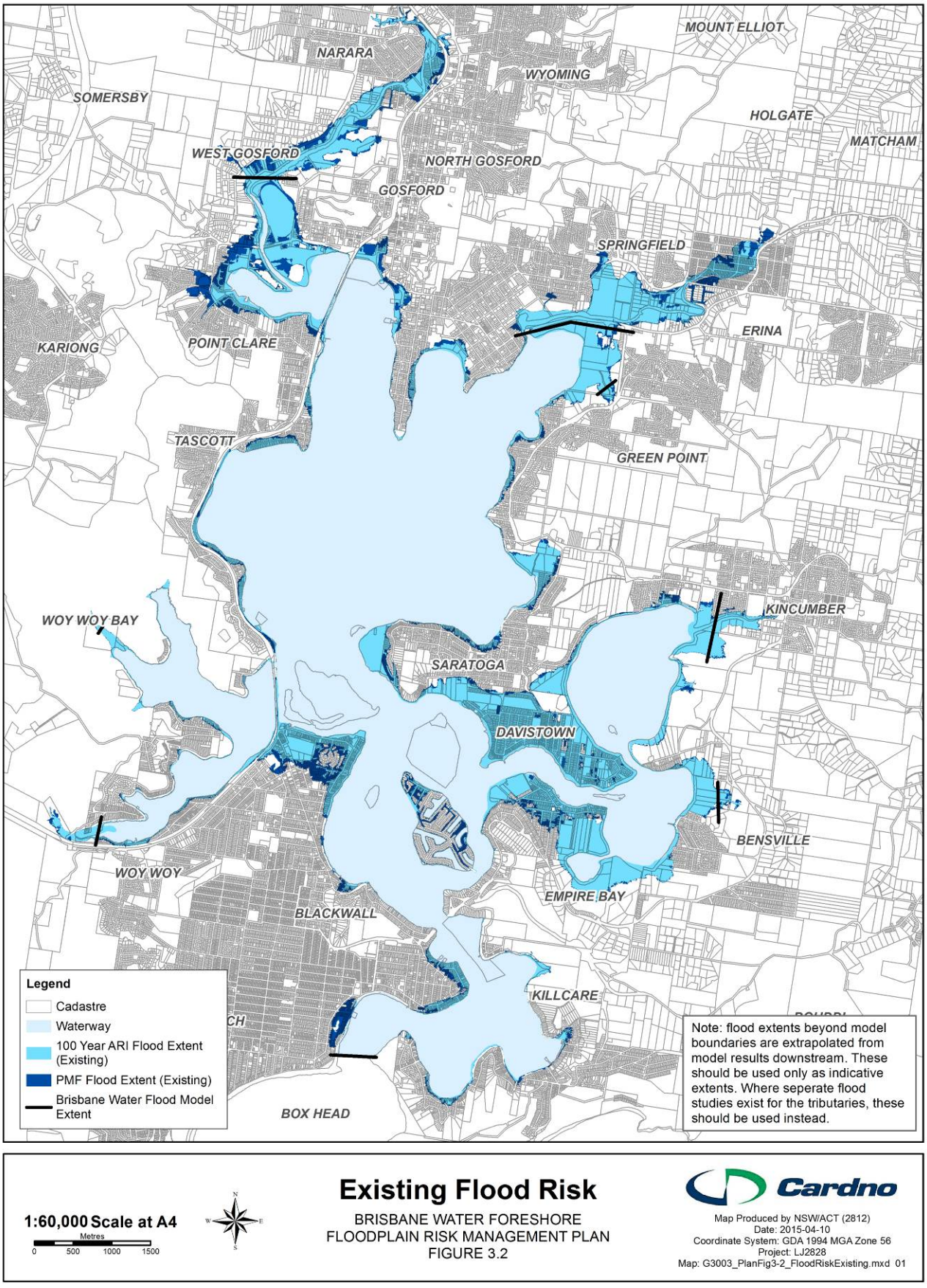


Figure 3.2: Existing Flood Extents

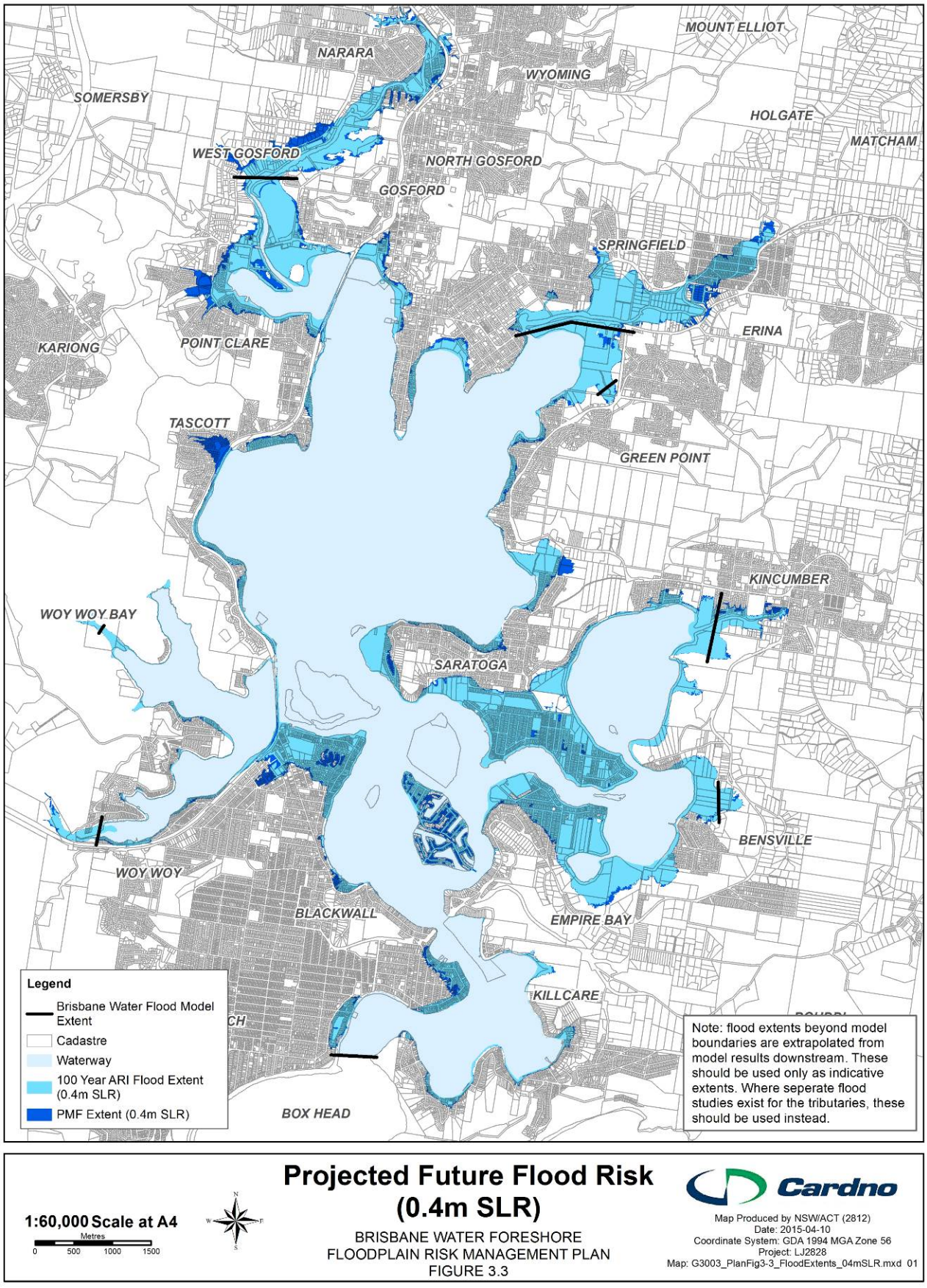


Figure 3.3: Flood Extents with 0.4m Sea Level Rise

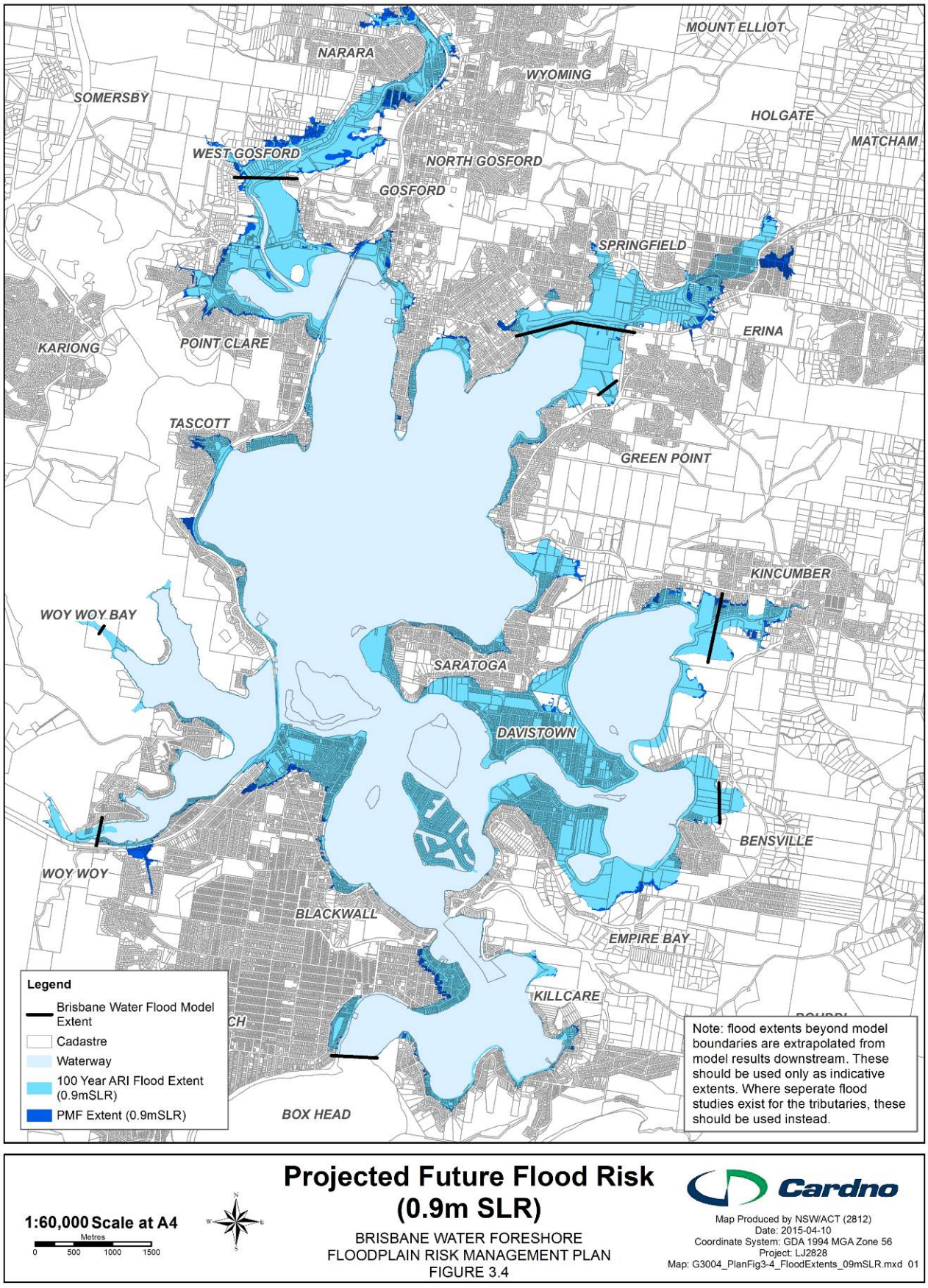


Figure 3.4: Flood Extents with 0.9m Sea Level Rise

3.3 Floodplain Issues

Flooding issues relevant to the Brisbane Water Floodplain as a whole include:

- Flooding of existing developed areas (residential and commercial) and the economic and social effects (e.g. damage to property, social disruption);
- The dominance of coastal flooding in the floodplain (as distinct from catchment flooding);
- The impacts of waves in addition to the flood level itself;
- Evacuation during this type of flood event (i.e. generated by sea storm surge, often with a high tide and generally at night). This can make evacuation more difficult than during a catchment flood event even though there is a longer warning period than other catchments in the Gosford local government area;
- Projected sea level rise impacts likely to exacerbate flooding;
- Development pressures likely to exacerbate flooding;
- Damage to public assets;
- More frequent flood events and tidal inundation; and
- The transition of low flood hazard areas to areas of high hazard as a result of increased flood depths due to sea level rise.

More specific issues were identified through a review of estuary flood behaviour, and raised by the Catchment and Coast Committee and the community. These issues form the basis of the options assessment presented in the FRMS (Cardno, 2015), and this FRMP seeks to address these issues through the implementation of identified actions (**Section 6**).

3.4 Floodplain Risk Management Objectives

The objectives of floodplain management for the Brisbane Water foreshore are in accordance with the overarching NSW *Flood Prone Land Policy.* 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 and within the constraints of available funding.

The floodplain management objectives for the Brisbane Water floodplain are:

- Reduce the flood damage (and associated losses) to property, and danger to personal safety in the existing community;
- Minimise the disruption that results from flooding;
- Ensure future development is controlled in a manner consistent with the flood risk and associated danger to personal safety;
- Protect and where possible enhance the estuary and floodplain environment;
- Ensure compatibility with the objectives of relevant State government policies include the Flood Prone Land Policy and the ecological objectives identified through the *Brisbane Water Coastal Zone Management Plan*;
- Satisfy the objectives and requirements of the *Environmental Planning and Assessment Act 1979* (EP&A Act);
- Ensure the management plan is fully integrated with the local flood and catchment plans, Council's existing corporate, business and strategic plans and proposed environmental

planning instruments, and Council's obligations under the Local Government Act 1993 (LG Act);
- Ensure that the management plan has the support of the local community;
- Ensure actions arising out of the management plan are sustainable in social, environmental, ecological and economic terms and maximise positive and minimise negative impacts; and
- Establish a program for implementation of the management plan including a mechanism for funding that should include priorities, staging, funding and responsibilities.

The focus of these objectives for the Brisbane Water floodplain has been on the current flood risk. However, the FRMS (Cardno, 2015) identified the potential increase in flood risk as a result of sea level rise within the Brisbane Water floodplain to be a significant issue for consideration. As a result the objectives above have also been considered, where possible, within the context of this future flood risk.

Council has undertaken the floodplain risk management process in accordance with the *Floodplain Development Manual* (NSW Government, 2005) to ensure that these objectives are achieved. This will occur through implementation of the proposed floodplain risk management actions that are set out in Section 6 of this FRMP. The implementation program set out in **Section 6.2** provides the framework for implementing the proposed management actions.

4 Flood Planning

Flood planning relates to the application of planning rules 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. At the same time appropriate planning provisions also recognise the benefits from the use, occupation and development of flood prone land. The planning issues assessed as part of the *Brisbane Water FRMS* (Cardno, 2015) were undertaken in order to achieve these objectives and the objectives of Gosford Council DCP (2013), including:

- To reduce private and public losses resulting from floods.
- To enable safe access or evacuation of people to the existing public road network during flooding.
- To maintain the existing flood regime.
- To limit land uses to those compatible with flood hazard.

The following sections within this chapter provide planning considerations and recommendations with regards to flood hazard, emergency response and development controls. Consideration is also given to future development within the floodplain and the likely impacts of sea level rise.

4.1 Floodplain Hazard

Flood hazard can be defined as a threat to life and potential damage associated with a flood event. The hazard caused by a flood varies both in time and place across the floodplain. The 100 Year ARI high hazard extent forms the basis within Council's planning framework for the land identified as having the highest risk to life and property and has relevant development controls applied (see **Section 4.3** for further details).

4.1.1 Provisional Flood Hazard

Provisional flood hazard is defined by the *Floodplain Development Manual* (NSW Government, 2005) using a relationship between the depth and velocity of floodwaters (Figure L2 in the Manual). Based on this relationship, there are two categories for provisional hazard – high and low.

The provisional flood hazard for the Brisbane Water floodplain was defined as part of the Flood Study (Cardno, 2013b) and mapped as part of the FRMS (Cardno, 2015). Mapping has been based on the design still water level and wave setup (but not wave run-up). Flood hazard mapping for the 100 Year ARI is provided in **Figure 4.1**.

It is noted that with projected sea level rise, areas currently mapped as low hazard are likely to transition over time to high hazard, which has implications for planning and development. This may have planning implications where the high hazard extent is used for defining appropriate development controls.

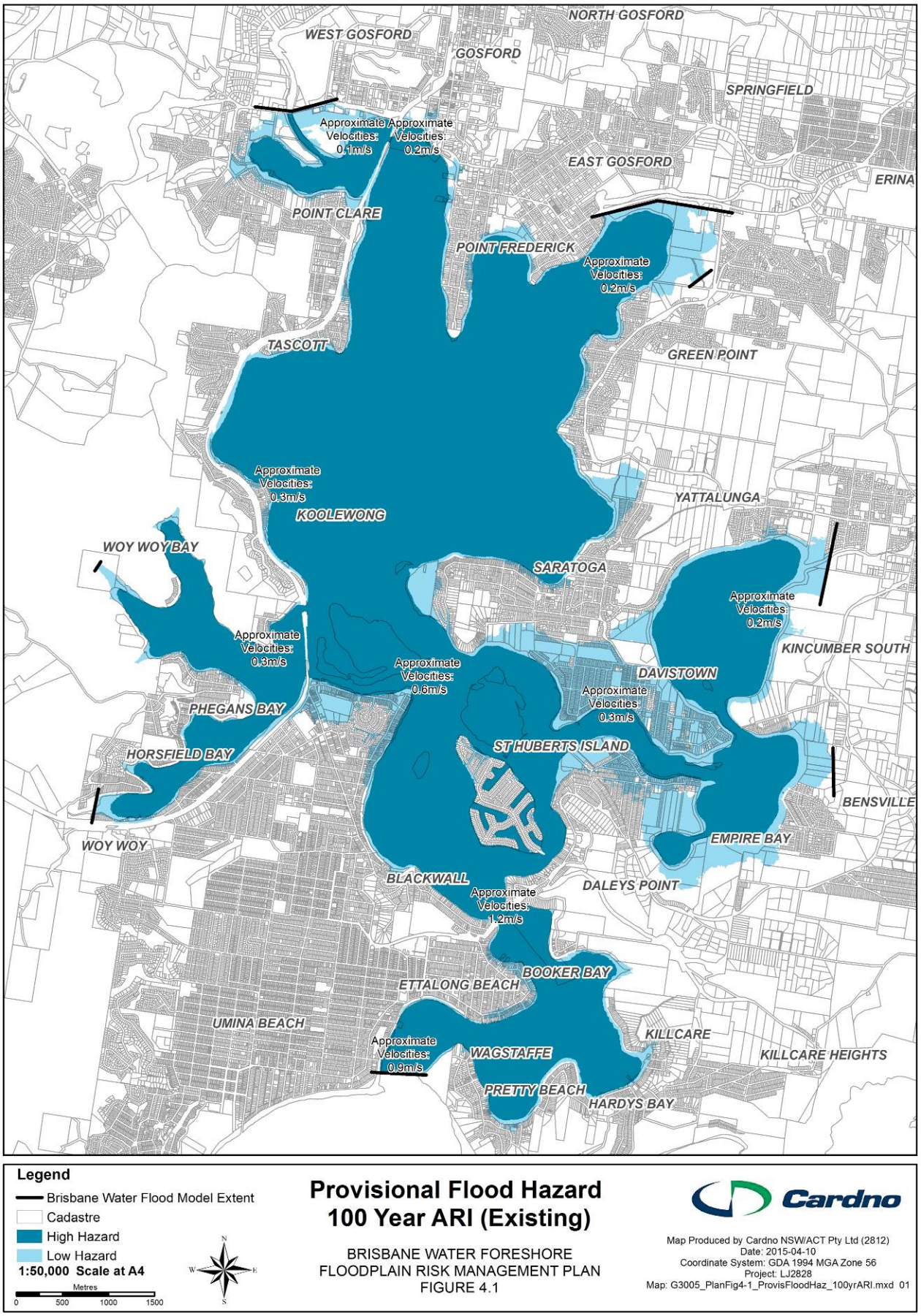


Figure 4.1: Provisional Flood Hazard – 100 Year ARI

4.1.2 True Hazard

The definition of provisional flood hazard is based purely on hydraulic mechanisms and does not consider the range of additional factors that influence flood hazard. Provisional hazard was therefore assessed as part of the FRMS (Cardno, 2015) in the context of a range of other factors so as to provide an indication of the "true hazard" associated with the floodplain. These factors and a brief summary of the assessment results are provided below:

- **Size of flood** – The 100 year ARI hazard mapping forms the basis of the development controls for the floodplain. The hazard extents for the other events provide a useful indication of areas where larger water level depths are experienced, and this may be useful information for the NSW SES in emergency response;
- **Effective warning time** – This can be defined as the time it takes for people to undertake appropriate actions prior to a flood occurring (such as transporting belongings and/or evacuating). Effective warning time for the floodplain is not considered of such a significant duration that it would enable areas of high hazard to be reduced to low hazard. However, it has been considered when developing appropriate development controls related to emergency management;
- **Flood readiness** – This is generally influenced by the time elapsed since the last severe flood event and the regularly and effectiveness of flood education campaigns. The outcome of the community consultation combined with the substantial amount of time elapsed since the 1974 flood event (and the limited nature of more recent events), suggests that it is not appropriate to alter the flood hazard definition to reflect a high level of flood readiness;
- **Rate of rise of floodwaters** – Based on the results of the Flood Study (Cardno 2013b), the rate of rise for the floodplain is relatively low and so no areas have been identified as being at high risk of fast rising floodwaters. Conversely, the rate of rise is not considered sufficiently low such that high hazard areas could be reduced to low hazard;
- **Depth and velocity of floodwaters** – Based on the results of the Flood Study (Cardno 2013b), flood velocities are relatively small and high hazard areas for the majority of the Brisbane Water floodplain are largely dependent on depth;
- **Duration of flooding** – In a 100 year ARI event, the majority of the floodplain is likely to be inundated for approximately 5 hours, with a likely maximum duration of flooding of 9 hours. Because provisional hazard definition within the Brisbane Water estuary is primarily depth-driven, areas that are flooded for longer durations are already defined as high hazard;
- **Evacuation problems** – Evacuation problems are an important factor in floodplain management and future planning controls, however as a true hazard factor it does not affect the hazard categorisation of the Brisbane Water floodplain;
- **Effective flood access** – Rather than modifying the provisional hazard mapping, the NSW SES need to be informed that some areas along the Brisbane Water foreshore would require prioritisation during evacuation from a flood event, e.g. some areas in Woy Woy and the lower portion in the north of St Huberts Island (see **Section 4.1.3**); and
- **Type of development** – Existing development in the floodplain is largely residential, with some areas of open space, commercial, industrial and special land uses. Much of the development has been present for some time; however, Council's existing and future planning controls seek to restrict new development types to be more flood-compatible.

Similar to provisional hazard, the true hazard associated with the floodplain may change over time as sea levels rise. For example isolation issues may change in location and risk.

4.1.3 Emergency Response Planning

When considering flood resilience, a community at risk needs to understand their role in minimising the impacts of disasters, and have the relevant knowledge, skills and abilities to take appropriate action (Council of Australian Governments, 2011).

A preliminary assessment was undertaken to identify locations within the floodplain (PMF extent) that are likely to be particularly sensitive to flooding. In general, substantial areas of the floodplain have relatively good rising access. Good rising access is generally located in areas where the topography rises continuously with increasing distance from the estuary and roads are located appropriately such that access to higher ground can be achieved as floodwaters rise. For example, although some properties along the Point Frederick peninsular are at risk of inundation, the topography rises towards the middle of the peninsular. Albert Road would not be cut off by floodwaters and would provide rising access such that residents would have sufficient access to evacuate if needed, even in the PMF event. Areas where rising access is likely to be limited include very flat areas (such as Davistown, Woy Woy and Empire Bay) and areas where topography may rise and then decline again with increasing distance from the estuary. This issue is illustrated diagrammatically in Appendix B of the FRMS (Cardno, 2015) as several example cross sections of selected locations around the floodplain.

Locations where critical infrastructure, access routes or properties may become isolated as a result of rising floodwaters have been considered and are presented in **Table 4.1**, along with recommended emergency response arrangements. These locations are mapped in **Figure 4.2**.

Where relevant, it is recommended that Council liaise with the SES to ensure that relevant organisations (such as the retirement village on Yallambee Avenue, West Gosford) have appropriate emergency response plans and that these are updated in accordance with the findings of this FRMP.

In addition, Council should coordinate with the SES to ensure all of the relevant flood information from the Flood Study (Cardno, 2013b), FRMS (Cardno, 2015) and this FRMP are incorporated into Flood Plans and response arrangements. This would include not only flood extents, but duration of inundation, road flooding and any known locations of people with special needs that might hinder evacuation or appropriate response to flooding conditions. This information can also be utilized to ensure that SES and emergency services are located out of the floodplain for current and future sea level rise scenarios.

Table 4.1: Potentially Isolated Locations

Location	Description	Recommended Emergency Response
Several residential properties in the vicinity of Camellia Circle, Woy Woy	As floodwaters rise, access to and from these properties is likely to be cut off prior to the properties being inundated.	Vehicle evacuation must be completed before access routes become inundated. After this time access will then be limited to air or boat. It should be noted that evacuation during a storm event can be inhibited by many factors, included time of day, power and phone outages and general confusion. However, it is also noted that due to the nature of flooding around the Brisbane Water Foreshore there are likely to be several hours prior to significant flooding occurs within which warnings could be distributed. This available time is primarily due to the long term forecasting for coastal storms.

Location	Description	Recommended Emergency Response
Properties along Yallambee Avenue, West Gosford	Road access is likely to be limited due to flooding of roads to this area (including the nursing home/retirement village, which is above the floodplain but is likely to be surrounded by floodwaters).	Vehicle evacuation must be completed before access routes become flooded. After flooding of roads occurs, resupply may not be required, but should be assessed depending on the severity of the flood.
Some areas in Davistown and Empire Bay	Filling in Davistown and Empire Bay means that some properties are located on higher ground. During flood events, this leads to a series of "islands" – areas surrounded by floodwaters and isolated. The inhabitants of these properties may decide to shelter-in-place but will then have limited emergency access once flooding of the surrounding area occurs.	
Properties along Boyd Close and Beachfront Parade, St Huberts Island	These properties are located on higher ground but would be surrounded by floodwaters and isolated during flood events. Road access is also likely to be cut off. The inhabitants of these properties may decide to shelter-in-place but will then have limited emergency access once flooding of the surrounding area occurs.	
Properties along Lara Street and Marloo Road, Koolewong (to the west of the Spike Milligan Bridge)	These properties have the potential to become isolated during flood events when access under the railway bridge is cut off by floodwaters.	
NSW SES Headquarters (Gosford), Erina	This property is located on higher ground but would be surrounded by floodwaters and isolated during flood events. Road access is also likely to be cut off. However, it should be noted that the existing PMF event does not inundate whole area.	Emergency response from this location is unlikely to be efficient in a severe flood event, and alternative arrangements should be made.

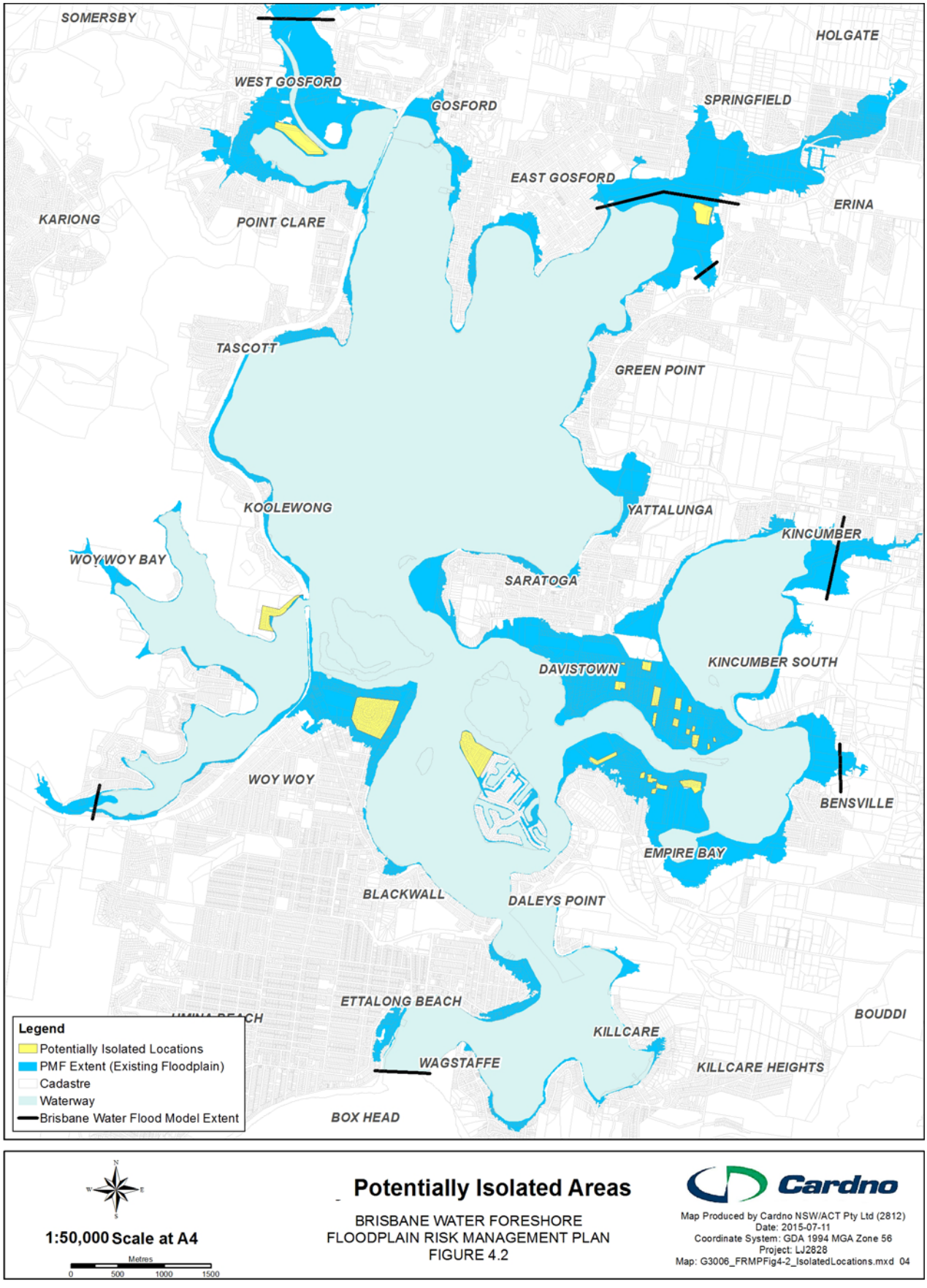


Figure 4.2: Potentially Isolated Locations

4.2 Flood Planning Levels

The Flood Planning Level (FPL) for the majority of flood prone areas across New South Wales has been traditionally based on the 100 year ARI flood level plus a freeboard. The *Guideline on Development Controls on Low Risk Areas – Floodplain Development Manual* (DoP, 2007) states that unless there are 'exceptional circumstances', councils should adopt the 100 year ARI (plus an appropriate freeboard) for residential development. A variety of factors are worthy of consideration in determining an appropriate FPL and whether 'exceptional circumstances' exist for the selection of a FPL other than the 100 year ARI. Most importantly, the flood behaviour and the risk posed by the flood behaviour to life and property in different areas of the floodplain and different types of land use need to be accounted for in the setting of a FPL.

As part of the review of the FPL undertaken in the FRMS (Cardno, 2015), the following elements were considered:

- The current FPL applied to the Brisbane Water foreshore;
- Factors influencing FPLs;
- The potential consequences of adopting the Probable Maximum Flood (PMF) as the FPL (the upper bound of flood risk);
- The effect of climate change projections on FPLs; and
- Potential options for freeboard selection.

Gosford City Council currently uses the existing 100 year ARI flood level associated with observations from an historical event in the absence of detailed flood modelling as the basis for determining the FPL for the Brisbane Water foreshore. The flood event used to determine the existing FPL for the Brisbane Water foreshore floodplain was the May 1974 severe ocean storm which resulted in a range of flood levels being recorded across the floodplain. A single recorded flood level from one of these locations of 1.92m AHD (taken as 1.95 mAHD for planning purposes) was used to develop flood planning levels. The current flood planning level is set at 2.45m AHD. This planning level incorporates the 1.95m AHD observed 1974 level, with the addition of 0.5m freeboard to account for uncertainty (e.g. additional flood impacts resulting from wave and wind set-up, wave run-up and potential climate change).

4.2.1 Recommendations of the Floodplain Risk Management Study

The FRMS was completed in March 2015. Due to the uncertainties associated with applying the risk of sea level rise into planning considerations, it was recommended that a short term approach to considering sea level rise be adopted as part of an interim FPL until the outcomes of the CCAPs (PM9) are known.

It was identified that the adoption of a 2050 sea level rise prediction would account for the predicted increases in flood levels over the next 35 years. Whilst this does not fully account for the typical lifespan of a residential building (approximately 50 years), it does afford some protection against sea level rise until the outcomes of the CCAPs (PM9) are known. The FRMS recommended that the FPL should be reviewed at that stage, or before if relevant information becomes available.

Therefore the interim FPL for the Brisbane Water foreshore floodplain was recommended in the FRMS to be:

FPL = 100 year ARI DSWL + 2050 Projection of SLR + 0.5m Freeboard.

In addition, it was also recommended in the FRMS that vulnerable or longer term development types such as critical infrastructure and assets consider the application of the 2100 projected sea level rise as part of the FPL.

The CCC (25 February 2015) supported the adoption of a flood planning level based on these components (CCC Minutes were received and noted at Council meeting 28 April 2015 - Appendix B).

4.2.2 Changes in Sea Level Rise Policy

The FRMS assessed the potential impacts of sea level rise based on 0.4m and 0.9m of sea level rise. These increases in sea level were applied to the flood study results and in effect represented an increase in sea level from the present day levels. However, it is noted that the (now repealed) state policy from which these values were derived, considered the increase of 0.4m by 2050 and 0.9m by 2100 to be based on 1990 mean sea level.

Since the completion of the FRMS (Cardno, 2015), Gosford Council has revised its sea level rise policy with regards to planning levels. In March 2015 Council resolved to adopt sea level rise planning levels based on projections for the *Representative Concentration Pathway Scenario* RCP 8.5 (**Appendix B**), utilising the medium sea level rise projection. This projection has been provided from 2015 mean sea level. It should be noted that this projection represents a projection of sea level rise based on carbon emissions where little effort has been made to reduce emissions and emissions are not curbed by 2100. The selection of the 'medium line' for this projection results in a projection which has a 50 percent chance of being exceeded.

As a result of this policy review, a further report was prepared for Council's consideration (28 April 2015) of FPLs within Brisbane Water. The report recommended:

- The Flood Planning Level (FPL) for Brisbane Water floodplain should be based on a derived flood level applicable to the development as determined by the Brisbane Water Flood Study (2013b) or any subsequent updated study adopted by Council.
- The FPL will also include a freeboard of 0.5 Metres
- The FPL will include an allowance for projected sea level rise based upon the Representative Concentration Pathway Scenario RCP 8.5 as adopted by Council (Minute 2015/86) commensurate to the asset life and planning horizons or the type of development or land use.
- Within every Council term or within two years of a new IPCC report, Council review the Sea level Rise Planning level.

Figure 1 in April Council Agenda in Appendix B was included in the recommendations provided to Council. This shows diagrammatically the RCP8.5 sea level rise predictions within the context of the current year (2015) and various asset life spans and planning horizons.

The planning horizon adopted for the purposes of sea level rise considerations should be relative to the development type or asset proposed. For example a bus shelter or playground would have a relatively shorter planning period (possibly close to 20 years) than a sewerage system (possibly up to 100 years).

4.2.3 Flood Planning Level Recommendations

The recommendations of the FRMS (Cardno, 2015), the resolution made by Council with regards to sea level rise (March 2015) and the recommendations made by the Catchments & Coast Committee to Council (February 2015) and considered by Council (April 2015) have been incorporated into the recommendations provided below.

The recommended FPL for the Brisbane Water foreshore floodplain is:

FPL = 100 Year ARI DSWL + SLR + 0.5m Freeboard

- SLR should be incorporated in accordance with Council's Resolution (March 2015 or any subsequent amendment). SLR should be commensurate to asset life and planning horizons. A minimum planning horizon of 35 years should apply to all development types. The graph provided in **Appendix B** gives an indication of various design life estimates and the associated sea level rise planning level. It would be appropriate to consider a longer planning horizon when applying SLR for vulnerable or longer term development types, such as:
    - Critical infrastructure, vulnerable development types (e.g. aged care, seniors living, child care) and emergency services;
    - Road raising for critical infrastructure; and
    - Construction of levees.
- At locations where the adopted FPL is higher than the existing PMF, the adopted FPL should still be used.
- Within the floodplain, where the PMF is higher than the FPL, it is not unreasonable for the PMF level to be used as a planning level when considering:
    - Critical infrastructure, vulnerable development types (e.g. aged care, seniors living, child care) and emergency services;
    - Road raising for critical infrastructure; and
    - Construction of levees.

Specific recommendations for design levels for all development types are provided in the Draft Development Control Matrix provided in **Appendix A**.

4.2.4 Applying Flood Planning Levels

To determine the FPL for a particular development, the following would be applied:

- Identification of 100 Year ARI level for 2015 from the Brisbane Water Flood Study (Cardno, 2013b) plus any SLR that may have occurred since 2015 to the date of the development application.
- Addition of an allowance for SLR relevant to the development type (i.e. planning horizon) and the year of the application (it should be noted that an average value of each 5 year period would be applied for all years within that period).
- Addition of 0.5m freeboard.

Two examples are provided below for the same type of development at the same location where the development application was submitted in 2015 and 2020 respectively.

Example 1 – Residential Development Application in Davistown in 2015

- 100 Year ARI Level (in 2015) = 1.45 mAHD
- SLR for 35 year planning horizon from 2015 = 0.2m (see Figure 1 in April Council Agenda in Appendix B)
- Freeboard = 0.5m

FPL = 2.15 mAHD

Example 2 – Residential Development Application in Davistown in 2020

- 100 Year ARI Level = 1.47 mAHD
  - In 2015 = 1.45 mAHD (from Flood Study, Cardno 2013b)
  - Plus SLR occurred since Flood Study = 0.02m (see Figure 1 in April Council Agenda in Appendix B)
- SLR for 35 year planning horizon from 2020 = 0.22m (see Figure 1 in April Council Agenda in Appendix B)
- Freeboard = 0.5m

FPL = 2.19 mAHD

A conceptual diagram showing the application of the FPL to a proposed dwelling is shown in **Figure 4.3**.

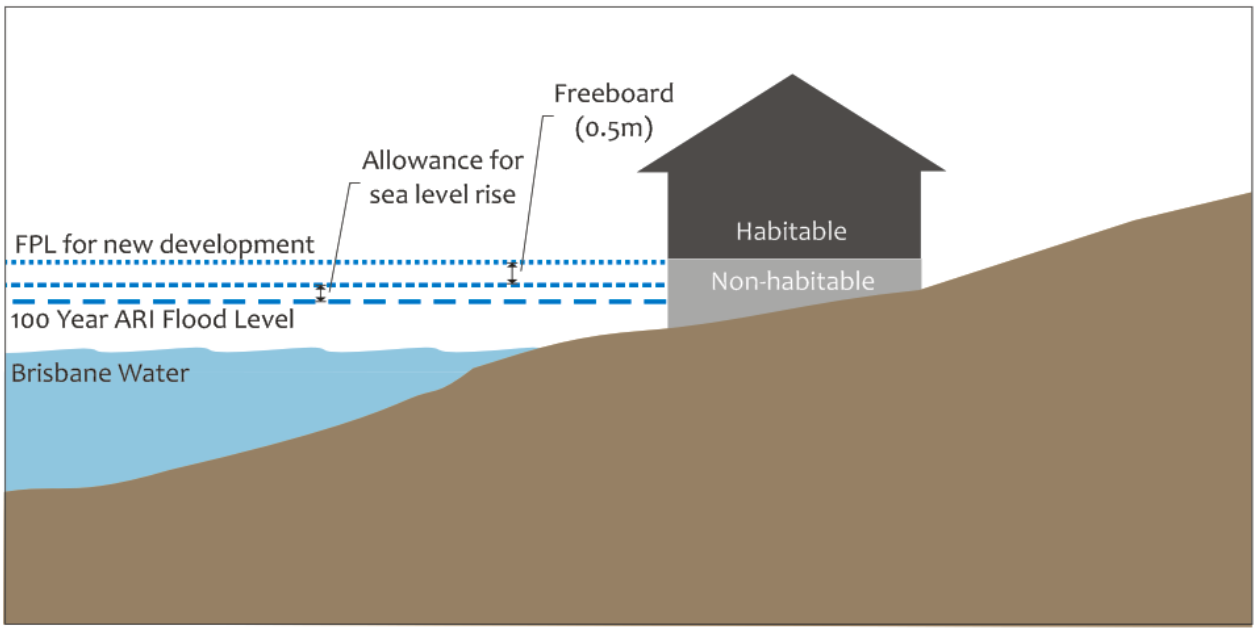


Figure 4.3: Flood Planning Level Conceptual Diagram

4.3 Development Controls

In February 2014, *Gosford City Council's Development Control Plan* (DCP) came into effect. *Section 6.7.7.6* of the DCP outlines development controls relating to floodplain management. Development in the Brisbane Water floodplain is assessed in a manner consistent with the DCPs. Whilst the DCPs have common elements for the management of flooding with respect to development across the entire LGA, this Plan has provided recommendations for development controls which are specific to the flood behaviour in Brisbane Water. These recommendations can be found in Action PM7 (**Appendix C**) and the DCP Matrix provided in **Appendix A**.

It should be noted that these recommendations are for use in developing appropriate flood related controls for the Brisbane Water floodplain within Council's DCP and are likely to require review and modification to ensure consistency with Council's planning approaches and other relevant legislation and plans. For example it should be recognised that the any suggested development controls are guidelines only and where controls are inconsistent or incompatible with the provision of an environment planning instrument the DCP has no effect.

It is the objective of the suggested development controls to:

- Encourage adaption to address future effects of SLR without maladaptation;
- Ensure that occupant's risk is minimised during a storm event is considered carefully while still considering the development on a merit basis;
- Ensure that damage to property is minimised during a storm event; and
- Be consistent with environment planning instruments.

The development control matrix contains development controls specific to various development types within the following flood risk areas:

- 100 Year ARI High Hazard Extent. This extent is defined in **Section 4.1.1** and is considered to contain the highest flood risk. It is predominantly contained to the immediate foreshore areas.
- Flood Planning Area (FPA). This extent is defined as the land below or equal to the Flood Planning Level which is defined in **Section 4.2**. This area forms the majority of the land affected by flood related development controls. For the purposes of this study, the FPA has been defined at the area below 100 Year ARI + SLR + 0.5m Freeboard.
- Probable Maximum Flood (PMF) Extent. This extent is defined as the areas at or below the PMF level. This area is generally considered to contain the lowest flood risk. It should be noted that the PMF extent used in the DCP Matrix does not have any allowance for sea level rise at this time. As such, the proposed FPL (**Section 4.2**) is higher than the PMF at all locations within the floodplain. Therefore, the PMF development controls do not apply to any development type within the floodplain at this point in time. If the FPL or inclusion of climate change in the PMF extent is revised, this position may change.

The planning areas are shown in **Figure 4.4**.

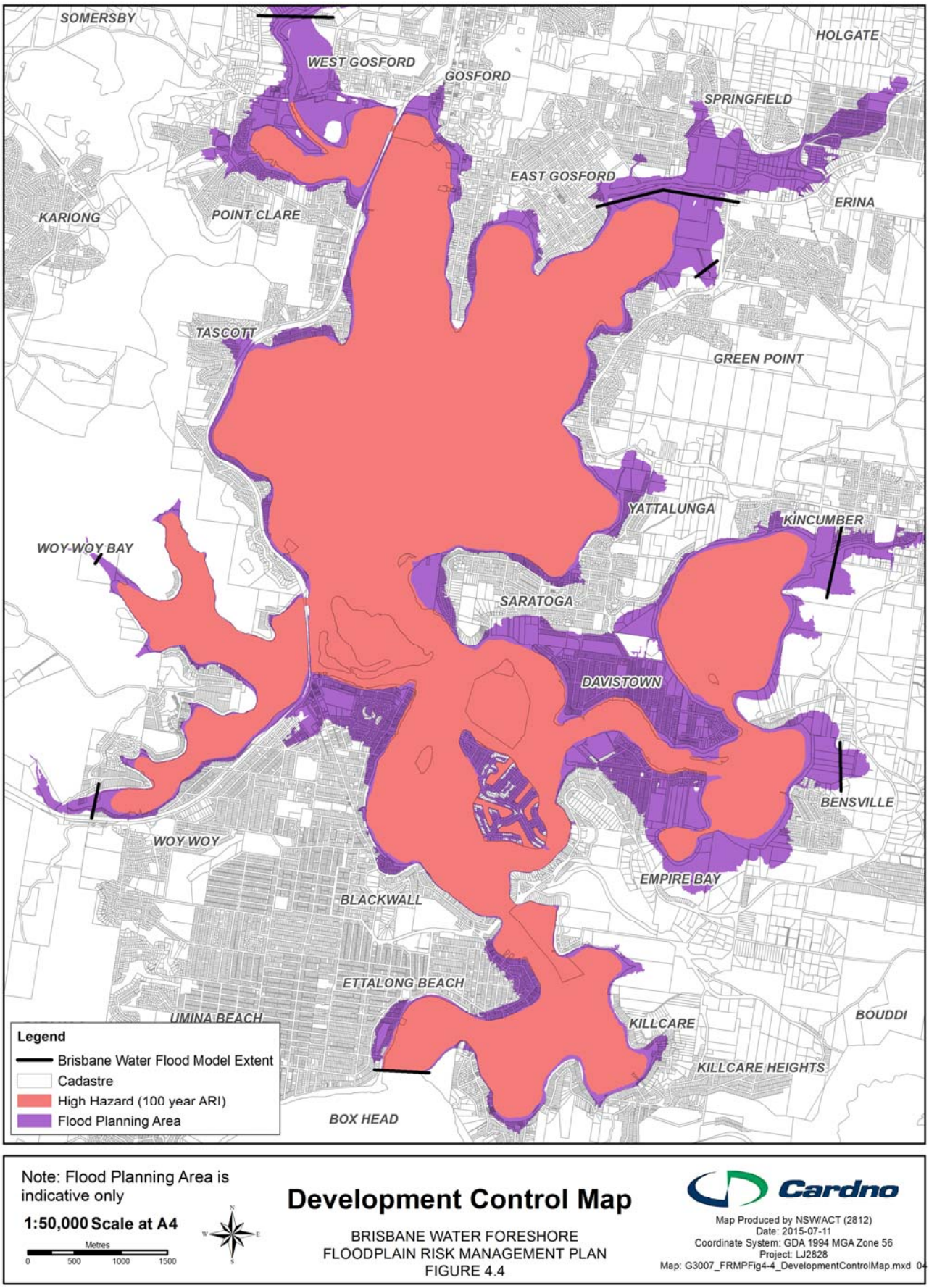


Figure 4.4: Development Control Map

4.3.1 Hazard Notations on Section 149 Planning Certificates

Under Section 149 of the Environmental Planning & Assessment Act 1979 (EPA Act) application can be made for a planning certificate in respect of land. Certain prescribed information must be included on a planning certificate under s149(2), and a council can include advice on other relevant matters regarding the land under s149(5).

The Department of Planning released a draft Planning Circular (PS 14-003 November 2014) regarding notations on s149 certificates in respect of coastal hazards. Specifically, the circular stated that:

- A planning certificate under s149(2) will disclose matters relating to the land, including whether or not the land is affected by a policy that restricts the development of land. These policies can be based on identified risks (Environmental Planning and Assessment Regulation 2000, schedule 4, clause 7), and whether development on land is subject to flood related development controls (EP&A Regulation, schedule 4, clause 7A). Inclusion of this information under s149(2) is a mandatory part of the conveyancing process.
- A planning certificate may also include information under s149(5). This allows a council to provide advice on other relevant matters affecting the land. This can include past, current and future coastal risks. The conveyancing process does not mandate the inclusion of information under section 149(5).
- Where a relevant policy or development control does relate to the land and the policy or development control arises due to a coastal hazard, then notations should:
    - Clearly identify the type of hazard(s); and
    - For each hazard identified, classify whether that hazard is a current or future hazard.

All properties that lie within the Brisbane Water Foreshore Flood Planning Area (FPA) will be notified on the S149 certificate. The FPA is defined as the area below the Flood Planning Level (FPL). As an outcome of the recommendations in this Plan, the FPL includes an allowance for sea level rise. As such, the FPA will include properties affected by both current and future flood risk.

4.4 Future Development – Sea Level Rise

As discussed in the previous sections of this report the proposed development controls have been primarily based on the existing flood risk. The exception to this is the inclusion of SLR in the Flood Planning Level and associated Flood Planning Area (the land below the FPL). This inclusion aims to ensure that development can with stand the predicted short term effects of sea level rise on storm events (i.e. flood proofing below the FPL and appropriate floor levels).

In March 2015 Council resolved to adopt an FPL that will include a projected sea level rise based upon the Representative Concentration Pathway Scenario RCP 8.5. The amount of sea level rise would be commensurate to the asset life and planning horizons for the type of development or land use, Figure 1 in April Council Agenda in Appendix B was included in the recommendations provided to Council (April 2015). This shows diagrammatically the RCP8.5 sea level rise predictions within the context of the current year (2015) and various asset life spans and planning horizons.

In March 2015 Council also resolved to review the sea level rise planning level within every Council term or within two years of a new IPCC report.

It is expected that Council will further address issues associated with the impacts of sea level rise as a part of the Climate Change Adaptation Plans. These plans will report directly back into the Floodplain

Risk Management process with some of the likely outcomes related to the planning recommendations in this FRMP to include:

- The revision of the high hazard extent (which determines appropriate development controls for affected properties) to incorporate sea level rise. This will result in greater depths of flooding and hence a greater area affected by high hazard.
- The revision of the sea level rise component of FPL and hence FPA (which determines appropriate development controls for affected properties).
- The revision of the PMF extent (which determines appropriate development controls for affected properties) to incorporate sea level rise. This will result in greater depths of flooding and hence a greater area affected by PMF.
- The determination of appropriate 'trigger' controls related to the planning horizon of a development.
- The revision of development controls to put more emphasis on adaptable design and resilient construction.

5 Consultation

Consultation is an important element in the Floodplain Risk Management process. The program of consultation undertaken as part of the FRMS (Cardno, 2015) and this FRMP not only canvassed the community and stakeholders for information and opinions, it also sought to improve awareness and understanding of flooding risks within the local community, and to initiate commitments from the relevant stakeholders with respect to the subsequent stages of the process, being the implementation of the FRMP.

Council adopted a Community Engagement Strategic Framework in May 2014. The goals of this framework were to inform, consult, involve, collaborate and empower the community. Consultation with the community included the following components:

- Consultation with the Catchments and Coast Committee (CCC);
- Public exhibition of the Draft FRMS and associated community engagement activities; and
- Public exhibition of the Draft FRMP.

The program of consultation described below primarily consisted of actions throughout the duration of the preparation of the FRMS (Cardno, 2015). A variety of consultation methods were used in order to maximise the potential for consultation and engagement.

5.1 Catchments and Coast Committee

Regular consultation with the Catchment and Coast Committee (which includes community representatives) was undertaken throughout the flood risk management process.

The Catchments and Coast Committee (CCC) was established by Gosford City Council to oversee the FRMS. The CCC includes community members, NSW State Emergency Service (NSW SES) representatives and OEH representatives. The CCC has direct involvement and assisted in guiding the direction of the FRMS.

Cardno attended the following meetings of the CCC in the preparation of the FRMS and this draft FRMP:

- **17 December 2009: Information Session** – Cardno presented a summary of the previous Foreshore Flood Study (Cardno, 2013b) results, and a forward direction for the FRMS.
- **26 August 2010: Management Options Workshop** – Cardno presented the preliminary list of management options to the Committee and requested feedback on these options.
- **7 September 2011: Management Options Workshop 2** – Cardno presented a refined list of management options in response to Council and Committee comments and requested feedback on these options.
- **14 August 2013: Presentation at Committee Meeting** – Cardno presented the Management Study to the Committee with emphasis on the existing flooding scenario, updated options and development control matrix. The Committee were able to express their views and ask questions of Cardno and Council.
- **1 October 2014: Public Exhibition Period – Sub-committee Planning Workshop:** Cardno presented additional information to the Committee regarding the planning recommendations in the FRMS. Committee members provided input regarding planning matters to be used in the development of the FRMP.

- **3 February 2015: Sub-committee Workshop –** Cardno presented a status update on the FRMS, with an emphasis on planning controls and the proposed flood planning level options for discussion and comment.
- **29 April 2015: Sub-committee Workshop** – Cardno presented a summary of the outcomes of the Draft FRMP and any significant changes from the Final FRMS. The committee made recommendations for amendments prior to the document being recommended to the CCC for adoption for public exhibition.
- **21 October 2015: Sub-committee Workshop** – Cardno presented the outcomes of the public exhibition of the FRMP.

5.2 Public Exhibition and Community Engagement Strategy

5.2.1 Floodplain Risk Management Study

The draft version of the Floodplain Risk Management Study was made available for comment via a period of public exhibition. Due to the nature and significance of the study, the exhibition period allowed for a longer than usual period of time and was on public exhibition from 27 August to 12 November 2014. Responses received from the community during the public exhibition period were considered and addressed in the final FRMS (Cardno, 2015). To enable and encourage greater participation from the community, a variety of community engagement methods were used throughout the exhibition period. This included most utilised and successful methods were the Information Sessions with the Community Forum and the online web presence. A summary of engagement tools is presented in **Table 5.1**, with reference to the engagement types fulfilled as per the Council adopted Community Engagement Strategic Framework.

Table 5.1: Engagement Tools – Floodplain Risk Management Study

Engagement Tool	Date	Inform	Consult	Involve	Collaborate	Empower
Media Release	18 August 2014	■	■			
GCC Website 'On Exhibition ' launch	18 August 2014	■	■			
Gosford Have Your Say website launch	18 August 2014	■	■	■		
Public Notice Gosford Connect	20 August 2014	■				
Media Release NBN News	20 August 2014	■				
Scheduled Facebook/Twitter post	22 August 2014	■	■			
Scheduled Facebook/Twitter post	25 August 2014	■	■			
Media Release Gosford Connect	27 August 2014	■	■			
Information Session 1 – Erina Centre (afternoon) Feedback loops, Interactive Mapping, Information Packs, Presentation	27 August 2014	■	■	■		
Scheduled Facebook/Twitter post	29 August 2014	■	■			
Drop-in Session – Davistown (afternoon) One on One Session, Information Packs	3 September 2014	■	■	■		
Radio interview and project overview (ABC radio)	3 September 2014	■				
Information Session 2 – Erina Centre (evening) Feedback loops, interactive mapping, information packs, presentation	4 September 2014	■	■	■		
Progress Association's newsletter update	9 September 2014	■	■			
Information Session 3 – Erina Centre (midday) feedback loops, interactive mapping, information packs, presentation	10 September 2014	■	■	■		

Engagement Tool	Date	Inform	Consult	Involve	Collaborate	Empower
Community Forum invite letterbox drop	17-24 September 2014	■				
Catchments & Coast Committee	7 May 2014 17 September 2014	■	■	■		
Information Session 4 – Woy Woy (afternoon) feedback loops, interactive mapping, information packs, presentation	18 September 2014	■	■	■		
Letter to utilities	25 September 2014	■				
Catchments & Coast Technical Subcommittee Workshop	18 December 2013 27 November 2013 13 February 2014 17 July 2014 1 October 2014	■	■	■	■	
Community Forum – Erina (evening)	8 October 2014	■	■	■	■	
Progress Association meetings	24 September 2014 7 October 2014 23 October 2014	■	■	■		
Report to Council Strategy & Policy	20 May 2014	■	■	■		
Report to Council for Adoption	28 April 2015	■	■	■	■	■
Newsletters (6) sent to all participants who registered interest as the exhibition progressed	27 August - 12 November 2014	■				
Technical Committee Meeting	3 February 2015	■	■			
Catchments & Coast Committee Meeting	10 February 2015	■	■	■	■	
Catchments & Coast Committee Meeting	**25 February 2015**	■	■	■	■	
Catchments & Coast Technical Subcommittee Workshop	**29 April 2015** **10 June 2015**	■	■	■	■	
Report to Council Strategy & Policy	**21 July 2015**	■	■	■		
Report to Council for Adoption for Public Exhibition	**28 July 2015**	■	■	■	■	■

5.2.2 Floodplain Risk Management Plan

A draft version of this Floodplain Risk Management Plan (FRMP) was made available for comment via a period of public exhibition (from August to October 2015). Details of the engagement strategy employed for the public exhibition period is provided in **Table 5.2**. Some examples of consultation materials are provided in **Appendix D**.

Responses received as part of the public exhibition period have been considered and addressed in this final version of the FRMP. The submissions in reply document in **Appendix D** provides a summary of the submissions and the responses provided.

Table 5.2: Engagement Tools – Floodplain Risk Management Plan

Engagement Tool	Date	Inform	Consult	Involve	Collaborate	Empower
Media item directly following the council meeting sent out to all media outlets (over 200 on the list)	August 2015	■	■			
Media release sent out to all media outlets	August 2015	■	■			
Article in the Express Advocate (quarter page)	14 August 2015	■	■			

Engagement Tool	Date	Inform	Consult	Involve	Collaborate	Empower
Front page of Gosford Connect in the Express Advocate	August 2015	■	■			
Article in the online Gosford Connect newsletter (sent out to approx. 1700 inboxes)	August 2015	■	■	■		
CEO message in Gosford Connect AND the Gosford Connect eNewsletter	August 2015	■	■			
CEO blog post on the website	August 2015	■	■			
Facebook event	August 2015	■	■	■		
Website event page	August 2015	■	■			
Latest news item on the front page of the website	August 2015	■	■			
Catchments & Coast Committee Workshop	25 August 2015	■	■	■	■	
Public Exhibition period	22 August to 2 October 2015	■	■			
Information Session 1	9 September 2015	■	■	■		
Information Session 2	15 September 2015	■	■	■		
Information Session 3	23 September 2015	■	■	■		
Catchments & Coast Committee Workshop	21 October 2015	■	■	■	■	
Catchments & Coast Committee Meeting	5 November 2015	■	■			
Report to Council Strategy & Policy	17 November 2015	■	■	■		
Report to Council for Adoption	TBA December 2015	■	■	■	■	■

6 Floodplain Risk Management Actions

6.1 Overview

To manage existing flood risks and issues and achieve the objectives outlined in **Section 3.4**, a range of flood risk management options were considered as part of the FRMS (Cardno, 2015). These options were broadly defined within the following categories:

- **Flood Modification (FM) measures** – Flood modification measures are options aimed at preventing / avoiding or reducing the likelihood of flood risks. These options reduce the risk through modification of the flood behaviour in the catchment.
- **Property Modification (PM) measures** – Property modification measures are focused on preventing / avoiding and reducing consequences of flood risks. Rather than necessarily modify the flood behaviour, these options aim to modify properties (both existing and future) so that there is a reduction in flood risk.
- **Emergency Response Modification (EM) measures** – Emergency response modification measures aim to reduce the consequences of flood risks. These measures generally aim to modify the behaviour of people during a flood event.

These options were subject to a multi-criteria analysis as part of the FRMS and those identified to be the most effective in reducing the incidence of property flooding with specific regard to over-floor flooding, whilst providing social and environment benefits (or at least minimal impacts) have been selected for inclusion as management actions in this FRMP. The key focus of recommended management actions is to address existing risks that currently affect the floodplain. However, the longer term risks associated with the expansion of the floodplain and the transition of low hazard areas to high hazard with projected sea level rise has also been acknowledged as an important consideration in asset planning which needs to start taking place now.

The full list of management options identified for assessment comprises Appendix J of the FRMS (Cardno, 2015). The in-depth process that was undertaken to investigate management options and assess them is described in Section 10 and Section 11 of the FRMS (Cardno, 2015). This included an assessment of the ecological and social impacts / benefits as well as the flooding benefits and costs of implementation. It is noted that several options have been modified since the FRMS was adopted. These modifications have occurred in response to submissions received during the public exhibition period and liaison with relevant agencies and the Catchment and Coast Committee.

It should be noted that whilst many of the options assessed as part of the FRMS (Cardno, 2015) showed flood benefits, they did not rank highly enough against the options recommended in the plan to allow them to be included for implementation. However, the flood benefits associated with these options could be reviewed within the context of other funding or works. For example foreshore sea walls or levees may be incorporated into cycleway or foreshore improvement works being funded separately to the Floodplain Risk Management Program. In addition, many options which only have minimal flood benefits under existing sea levels, may have increased benefits as a result of sea level rise. These options will be reconsidered as part of the CCAPs (PM9).

Those management options that have been recommended to be implemented as part of this FRMP are henceforth referred to as “management actions”. Recommended management actions are listed in **Table 6.1**. Detailed descriptions of management actions are provided in **Appendix C**. Where management actions are proposed for particular management areas, these are shown in **Figures 6.1 to 6.3**.

Table 6.1: Management Actions Recommended

Option ID	Management Strategy	Action Timeline	Capital Cost	Annual Cost	Tidal/Flood Event Addressed										Properties Protected (Existing)	Properties Protected (0.9m SLR)	GCC Responsibility	Private Responsibility	State Responsibility	Feasibility / Integrated Planning R'qd	To be Included in CCAP?
					Tidal			Flood													
					MHWS	+SLR (0.4m)	+SLR (0.9m)	5 yr ARI (20%)	100 yr ARI (1%)	PMF	100 yr ARI (0.4m SLR)	5 yr ARI (0.9m SLR)	100 yr ARI (0.9m SLR)	PMF (0.9m SLR)							
Floodplain-Wide																					
FM3	Develop guidelines for wave run-up management.	Immediate	$30,000	$500	Likely to assist in reducing wave run-up only.										Unkn.	Unkn.	Y	N	N	N	N
FM4	Install flood gates on stormwater pipe outlets as required.	Staged	$100,000	$35,000	Depends on location										Unkn.	Unkn.	Y	N	Y	N	N
FM5	Develop guidelines for sea wall design and maintenance.	Immediate	$30,000	$500	✓	✓	✓	✓	✓						Unkn.	Unkn.	Y	N	N	N	N
PM2a	Develop a voluntary house raising policy	Immediate	$10,000	$500	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	Unkn.	Unkn.	Y	Y	Y	Y	Y
PM2b	Ongoing monitoring of most at risk houses with regards to Voluntary House Raising	Staged	$0	$2,000	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	Unkn.	Unkn.	Y	Y	Y	Y	Y
PM2c	Voluntary House Raising (38 Properties Over 16 Years)	Staged	$80,000	$80,000	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	38	38	Y	Y	Y	Y	N
PM4	Conduct a program of strategic, balanced and socially sensitive education to advise the local community and prospective property purchasers about the risk and effects of coastal flooding.	Staged	$20,000	$4,000	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	0	0	Y	N	Y	Y	N
PM5	Periodic analyses of sea level data to ascertain the rate of sea level rise relevant to Brisbane Water. Periodically communicate results to the community.	Immediate	$0	$5,000		✓	✓				✓	✓	✓	✓	0	0	Y	N	N	N	Y
4_PM6	Review Functionality of NSW SES (Gosford) headquarters during a flood event.	Immediate	$20,000	$0					✓	✓	✓	✓	✓	✓	0	0	Y	N	Y	Y	Y
14_PM6	Review Functionality of Woy Woy Police Station during a flood event.	Immediate	$20,000	$0				✓	✓	✓	✓	✓	✓	✓	0	0	Y	N	Y	Y	Y
PM7	Review and amend planning instruments and development controls across the floodplain to ensure consistency with coastal flooding. Review every five years.	Immediate	$50,000	$10,000	✓	✓	✓	✓	✓		✓	✓	✓		All	Unkn.	Y	N	N	N	Y
PM9	Develop management strategies (as part of Climate Change Adaptation Plans for each management area) to adapt to the impacts of projected sea level rise on tidal inundation.	Staged	$480,000	$72,000		✓	✓				✓	✓	✓	✓	Unkn.	Unkn.	Y	N	N	N	Y
PM10	Evaluate utilities infrastructure relative to flood risk and projected sea level rise benchmarks. Partner with private utilities managers to better understand the risks to assets and formulate a plan of management over the long term for integration into Council's planning objectives.	Staged	$100,000	$7,500		✓	✓	✓	✓		✓	✓	✓		0	0	Y	N	N	Y	Y
PM11	Undertake overland flow investigations for key areas around the foreshore to better understand the combined impacts of coastal and catchment flooding and to provide inputs to masterplanning of floodplain areas.	Staged	$100,000	$100,000											0	0	Y	N	Y	N	Y
EM1	Conduct targeted flood education programs for flood-affected residents.	Staged	$250,000	$25,000	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	Unkn.	Unkn.	Y	N	Y	Y	N
EM2	Purchase of 8 Portable Variable Message Signage units to be deployed to flooded roads during a flood event.	Immediate	$80,000	$4,000					✓	✓	✓	✓	✓	✓	0	0	Y	N	N	N	N
1_EM2	Install and maintain "Road Floods" signs at the Central Coast Highway, and Yallambee Avenue, West Gosford. Signs could display “Salt water flooding over road.”	Immediate	$2,400	$400	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	0	0	Y	N	Y	Y	N
14_EM2	Install and maintain "Road Floods" signs at Blackwall Road, Brick Wharf Road and North Burge Road, Woy Woy. Signs could display “Salt water flooding over road.”	Immediate	$3,600	$600	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	0	0	Y	N	Y	N	N
EM3	Review the Gosford Local Flood Emergency Sub-Plan (Gosford LEMC, 2013) with regards to the updated Brisbane Water Floodplain Risk Management Study results.	Immediate	$20,000	$0				✓	✓	✓	✓	✓	✓	✓	0	0	Y	N	Y	Y	N
EM4	Review flood warning systems on a periodic basis and update as necessary.	Immediate	$35,000	$7,000				✓	✓	✓	✓	✓	✓	✓	Unkn.	Unkn.	Y	N	N	N	N
EM7	Review evacuation centre locations with a view to upgrading key evacuation centres that lie outside the floodplain.	Immediate	$50,000	$2,500				✓	✓	✓	✓	✓	✓	✓	0	0	Y	N	Y	Y	Y
EM8	Enhance road evacuation through the development of an alternative route plan for implementation during flood events.	Immediate	$40,000	$2,000				✓	✓	✓	✓	✓	✓	✓	0	0	Y	N	Y	N	N

Notes:

Action Timeline: Immediate – Short term, minimal further investigations required Staged – Short/medium term, further investigations required

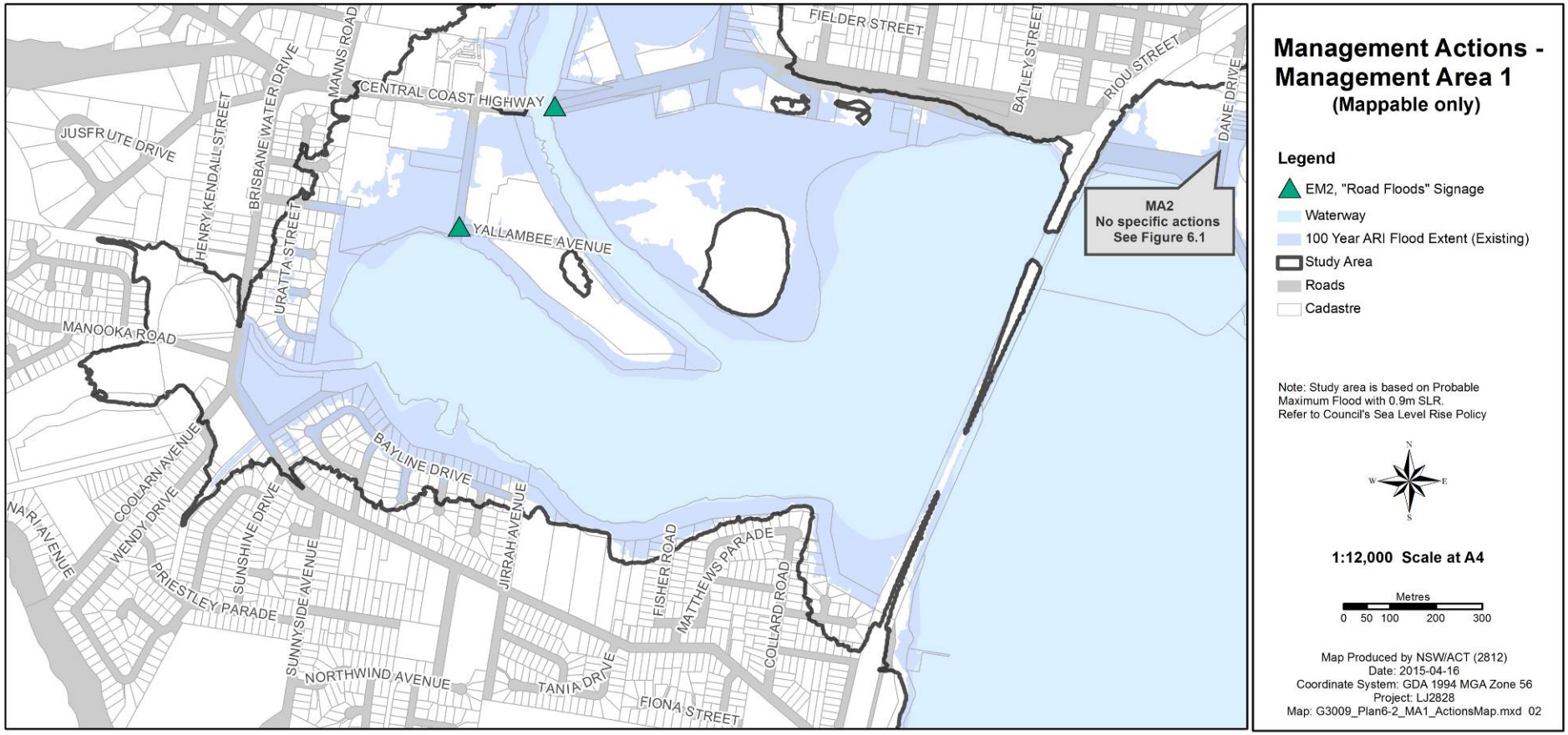
Legend

✓ Water level addressed by option

✓ Stage / trigger level response

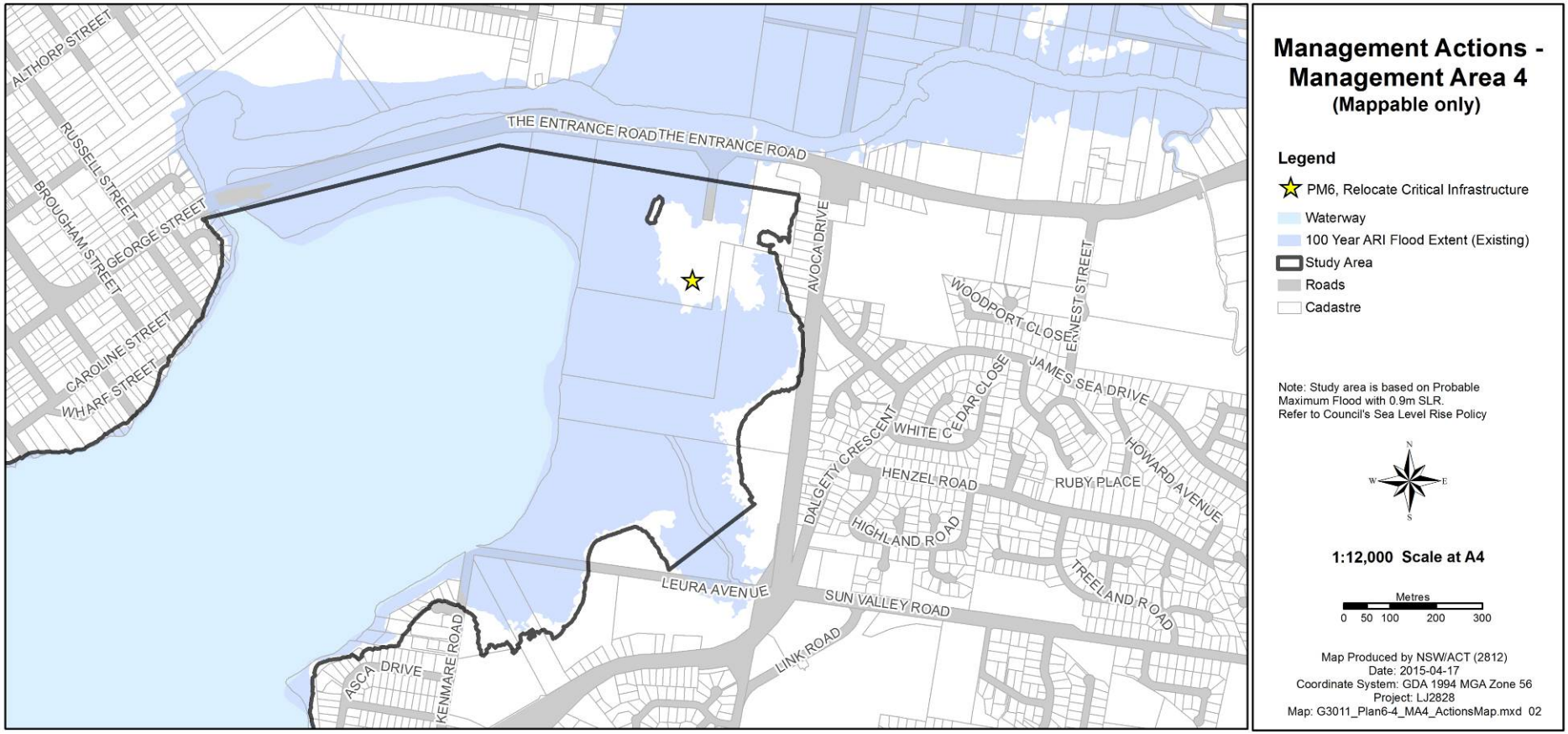
Y - Yes N - No

Unkn. Unknown



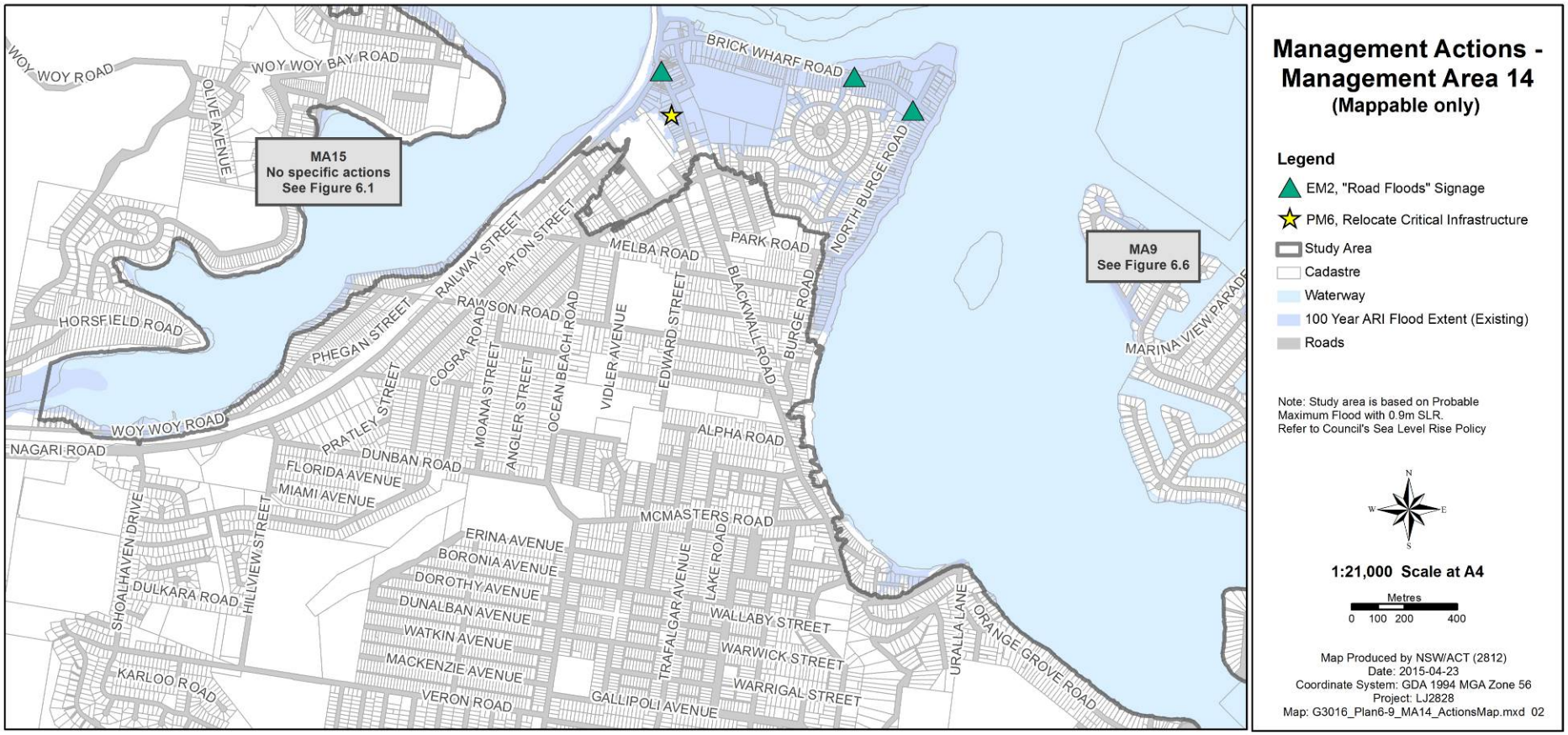
Recommended Actions – Management Area-Specific	Implementation
1_EM2: Install and maintain flood related signage at the Central Coast Highway, and Yallambee Avenue, West Gosford . Flood signage along roads that are liable to flood allow residents to be aware of whether it is dangerous to traverse a particular section of road during a flood event. Signs could display "Salt water flooding over road."	**Immediate**

Figure 6.1: Management Actions – MA1 Fagans Bay



Recommended Actions – Management Area-Specific	Implementation
4_PM6: Review Functionality of NSW SES (Gosford) headquarters during a flood event. This critical infrastructure is currently located in an area that is cut-off by floodwaters during the PMF event. Relocating this infrastructure or developing an alternative operational centre at a location outside the floodplain would provide access to and from the station so that more reliable assistance could be provided to those in need of SES assistance during a flood event. This options proposes for Council to provide advice and assistance to NSW SES in this matter.	**Staged**

Figure 6.2: Management Actions – MA4 Erina



Recommended Actions – Management Area-Specific	Implementation
14_EM2: Install and maintain flood related signage signs at Blackwall Road, Brick Wharf Road and North Burge Road, Woy Woy. Flood signage along roads that are liable to flood allow residents to be aware of whether it is dangerous to traverse a particular section of road during a flood event. Signs should be permanent in these locations since this is a regular occurrence. Signs could display "Salt water flooding over road."	**Immediate**
14_PM6: Review Functionality of Woy Woy Police Station during a flood event. This facility is likely to be subject to coastal flooding in events greater than the 20 year ARI (existing case). Relocating this infrastructure or developing an alternative operational centre at a location outside the floodplain would provide access to and from the station so that more reliable assistance could be provided to those in need of police assistance during a flood event. This options proposes for Council to provide advice to NSW Police in regards to this matter.	**Staged**

Figure 6.3: Management Actions – MA14 Woy Woy and Blackwall

6.2 Implementation Program

The actions listed in **Table 6.1** are recommended for implementation as an outcome of the Floodplain Risk Management process. In order to achieve the implementation of relevant management actions, a program of implementation has been developed. The steps in progressing the floodplain risk management process from this point onwards are:

- Council will adopt the final Plan and submit applications for funding assistance to relevant State and Commonwealth agencies, as appropriate;
- As funds become available from OEH, the Commonwealth, other state government agencies and/or from Council's own resources, recommended management actions will be implemented in accordance with the established priorities.
- Implementation will be require in some cases more detailed cost benefit analysis, assessment and mitigation of environmental impacts and / or detailed design. A number of proposed flood mitigation options involve foreshore modification or alteration to local hydrology. Such management actions may have a detrimental impact on ecological values of Brisbane Water estuary. To minimise impact the design phase should consider environmentally friendly options and ensure environmental impacts (and opportunities) are fully assessed prior to implementation.

Table 6.2 provides the following information relevant to the implementation of the management actions:

- An estimate of capital and recurrent costs for each action (this may, in some cases, include existing staff and funding);
- The agency or organisation likely to be responsible for the action;
- The timeline for implementation (immediate or staged) and priority for implementation (high, medium or low).

Several options also identify potential works that could be undertaken by private land owners (e.g. upgrades to private seawalls). The costs associated with these options have not been included in **Tables 6.1 and 6.2**, but are referenced in Appendix C.

The following provides further detail on the implementation timelines:

- **Immediate** – this indicates actions that could be implemented in the short term if funding and resourcing permits. Feasibility of the action is generally high and additional investigations or further development of the management strategy would be minimal;
- **Staged** – this indicates actions that could be undertaken in the short to medium term. However, additional investigations, feasibility studies or further development of the management strategy are likely to be required. Where appropriate, interim policy and planning measures could be employed in the intervening time.

The following provides further detail on the priorities:

- **High –** A total score in the multi-criteria matrix assessment of greater than 8;
- **Medium –** A total score in the multi-criteria matrix assessment of between 3 and 8; and
- **Low –** A total score in the multi-criteria matrix assessment less than 3.

Table 6.2: Implementation Action List

Option ID	Action	Indicative Costs		Potential Funding Sources/ Responsibility	Implementation Timeframe[1]	Priority	Performance Measures
		Capital	Recurrent				
Emergency Management							
EM1	Conduct targeted flood education programs for flood-affected residents.	$250,000	$25,000	GCC / NSW SES	Staged	Medium	Flood education program is undertaken and documented.
EM2	Purchase 8 Portable Variable Message Signage units to be deployed to flooded roads during a flood event.	$80,000	$4,000	GCC / State	Immediate	High	8 portable variable message signage units are purchased
1_EM2	Install and maintain "Road Floods" signs at the Central Coast Highway, and Yallambee Avenue, West Gosford	$2,400	$360	GCC / State	Immediate	High	Signs are installed and maintained.
14_EM2	Install and maintain "Road Floods" signs at Blackwall Road, Brick Wharf Road and North Burge Road, Woy Woy.	$3,600	$540	GCC / State	Immediate	High	Signs are installed and maintained.
EM3	Review the Gosford Local Flood Emergency Sub-Plan (Gosford LEMC, 2013) with regards to the updated Brisbane Water Floodplain Risk Management Study results.	$20,000	$0	GCC / NSW SES	Immediate	High	The Gosford Local Flood Emergency Sub-Plan is updated.
EM4	Review flood warning systems on a periodic basis and update as necessary.	$35,000	$7,000	BoM / NSW SES	Immediate	High	Documented review of flood warning systems is completed.

Option ID	Action	Indicative Costs		Potential Funding Sources/ Responsibility	Implementation Timeframe[1]	Priority	Performance Measures
		Capital	Recurrent				
EM7	Review evacuation centre locations with a view to upgrading key evacuation centres that lie outside the floodplain.	$50,000	$2,500	GCC/ State / NSW SES	Immediate	High	List of evacuation centres suitable for flood emergency evacuation is prepared and added to SES protocols. Any evacuation centres in need of upgrade are recommended to Council.
EM8	Enhance road evacuation through the development of an alternative route plan for implementation during flood events.	$40,000	$2,000	GCC / NSW SES	Immediate	High	Alternative route plans for evacuation are completed.
4_PM6	Review Functionality of NSW SES (Gosford) headquarters during a flood event. Council to provide advice to NSW SES to assist in this process.	$20,000	$0	GCC / NSW SES / State	Immediate	Medium	Council has advised SES of the flood risk to the existing location and provide assistance with any action taken by SES to improve functionality during a flood event.
14_PM6	Review Functionality of Woy Woy Police Station during a flood event. Council to provide advice to NSW Police Force to assist in this process.	$20,000	$0	GCC / State	Immediate	Medium	Council has advised Police of the flood risk to the existing location and provide assistance with any action taken by Police to improve functionality during a flood event.
Planning and Development Controls							
PM4	Conduct a program of strategic, balanced and socially sensitive education to advise the local community and prospective property purchasers about the risk and effects of coastal flooding.	$20,000	$4,000	GCC / NSW SES	Staged	High	Education program is undertaken and documented.

Option ID	Action	Indicative Costs		Potential Funding Sources/ Responsibility	Implementation Timeframe[1]	Priority	Performance Measures
		Capital	Recurrent				
PM5	Perform periodic analyses to ascertain the rate of sea level rise relevant to Brisbane Water. Council to periodically communicate results to the community.	$0	$5,000	Council	Staged	Medium	Data analysis and a program of community education undertaken and documented.
PM7	Review and amend planning instruments and development controls across the floodplain to ensure consistency with coastal flooding. Review every five years.	$50,000	$10,000	GCC / State	Immediate	High	Changes to planning instruments and development controls made.
PM9	Develop Climate Change Adaptation Plans to adapt to the impacts of projected sea level rise on tidal inundation.	$480,000	$72,000	GCC / State	Immediate	Medium	Climate Change Adaptation Plans are prepared for the LGA and key areas.
PM10	Evaluate utilities infrastructure relative to flood risk and projected sea level rise benchmarks. Partner with private utilities managers to better understand the risks to assets and formulate a plan of management over the long term for integration into Council's planning objectives.	$100,000	$7,500	GCC / State (utilities) / Private (utilities)	Immediate *The assessment of sea level rise impacts on assets may be staged in accordance with PM9.*	High	A plan of management is prepared in collaboration with utilities providers. Total audit of Council assets completed with sea level rise sensitivity.
PM11	Undertake overland flow studies for key areas impacted by both overland flows and storm surge.	$100,000	$100,000	GCC / State	Immediate	High	Overland flows have been undertaken.

Option ID	Action	Indicative Costs		Potential Funding Sources/ Responsibility	Implementation Timeframe[1]	Priority	Performance Measures
		Capital	Recurrent				
Property and Asset Modifications							
PM2a	Develop a voluntary house raising policy.	$10,000	$500	GCC	Immediate	High	Policy has been prepared.
PM2b	Ongoing monitoring of most at risk houses with regards to Voluntary House Raising.	-	$2,000	GCC	Staged	Medium	Periodic evaluation of at risk houses completed in conjunction with sea level rise review.
PM2c	Voluntary House Raising	$80,000	$80,000	GCC / State	Immediate	Medium	House raising of most at risk houses undertaken (approximately 38 properties).
FM3	Develop guidelines for wave run-up management.	$30,000	$500	GCC	Immediate	Low	Guidelines have been prepared.
FM4	Install flood gates on stormwater pipe outlets as required.	$100,000	$35,000	GCC	Staged *The construction of flood gates is staged due to the need for investigation and prioritisation.*	Medium	Investigation is undertaken to identify and prioritise propose flood gate locations. Flood gates are installed.
FM5	Develop guidelines for sea wall design and maintenance.	$30,000	$500	GCC	Immediate	Low	Guidelines have been prepared.

[1] 'Immediate' timeframes identify options that could be implemented in the short term if funding and resources permit.

The anticipated timeline and costs for implementation over the first five stages of the strategy are shown in **Table 6.3**. However, all management actions will need to be programed by the relevant agencies and this will affect the timing of implementation (i.e. not all 'stage 1' actions will be completed in immediately after adoption of the Plan). In some cases, further feasibility, design or impact assessment may be required prior to work commencing (e.g. foreshore works). It is recommended that Council undertake a risk assessment against its own policies and guidelines to more appropriately develop a timeframe for execution of the individual aspects of this plan.

It is noted that the majority of the actions presented are funded at least in part by the State Government. Where Council funding is noted against ground works (i.e. as opposed to education, policies and plans), it should be noted that this only relates to works on Council land.

Significant cost saving could be made by combining relevant studies or works within this Plan and across other Council programs. For example combining EM7 (review of evacuation centres) with EM3 (review of Local Flood Plan) could reduce the overall costs and allow for a better outcome.

Table 6.3: Timeline and Public (GCC and State) Costs for Implementation for First Five Years of Strategy

ID	Action	Indicative Costs		Stage				
		Capital	Recurrent	1	2	3	4	5
	Emergency Management							
EM1	Conduct targeted flood education programs for flood-affected residents.	$250,000	$25,000	$100,000	$100,000	$50,000	$25,000	$25,000
EM2	Purchase of 8 Portable Variable Message Signage units to be deployed to flood roads during a flood event.	$80,000	$4,000	$80,000	$4,000	$4,000	$4,000	$4,000
1_EM2	Install and maintain "Road Floods" signs at the Central Coast Highway, and Yallambee Avenue, West Gosford	$2,400	$360	$2,400	$400	$400	$400	$400
14_EM2	Install and maintain "Road Floods" signs at Blackwall Road, Brick Wharf Road and North Burge Road, Woy Woy.	$3,600	$540	$3,600	$600	$600	$600	$600
EM3	Review the Gosford Local Flood Emergency Sub-Plan (Gosford LEMC, 2013) with regards to the updated Brisbane Water Floodplain Risk Management Study results.	$20,000	$0	$20,000	-	-	-	-
EM4	Review flood warning systems on a periodic basis and update as necessary.	$35,000	$7,000	$35,000	$7,000	$7,000	$7,000	$7,000
EM7	Review evacuation centre locations with a view to upgrading key evacuation centres that lie outside the floodplain.	$50,000	$2,500	$50,000	$2,500	$2,500	$2,500	$2,500
EM8	Enhance road evacuation through the development of an alternative route plan for implementation during flood events.	$40,000	$2,000	$40,000	$2,000	$2,000	$2,000	$2,000
4_PM6	Review Functionality of NSW SES (Gosford) headquarters during a flood event. Council to provide advice to NSW SES to assist in this process.	$20,000	$0	$20,000	-	-	-	-

ID	Action	Indicative Costs		Stage				
		Capital	Recurrent	1	2	3	4	5
14_PM6	Review Functionality of Woy Woy Police Station during a flood event. Council to provide advice to NSW Police Force to assist in this process.	$20,000	$0	$20,000	-	-	-	-
	Planning and Development Controls							
PM4	Conduct a program of strategic, balanced and socially sensitive education to advise the local community and prospective property purchasers about the risk and effects of coastal flooding.	$20,000	$4,000	$20,000	$4,000	$4,000	$4,000	$4,000
PM5	Continue to monitor sea levels and perform periodic analyses to ascertain the rate of sea level rise relevant to Brisbane Water. Periodically communicate results to the community.	$0	$5,000	-	-	$5,000	-	-
PM7	Review and amend planning instruments and development controls across the floodplain to ensure consistency with ocean flooding. Review every five years.	$50,000	$10,000	$50,000	-	-	-	-
PM9	Develop management strategies (as part of Climate Change Adaptation Plans) to adapt to the impacts of projected sea level rise on tidal inundation.	$480,000	$72,000	$300,000	$300,000	$90,000	$90,000	$72,000
PM10	Evaluate utilities infrastructure relative to flood risk and projected sea level rise benchmarks. Partner with private utilities managers to better understand the risks to assets and formulate a plan of management over the long term for integration into Council's planning objectives.	$100,000	$7,500	$40,000	$40,000	$20,000	$7,500	$7,500

ID	Action	Indicative Costs		Stage				
		Capital	Recurrent	1	2	3	4	5
PM11	Undertake overland flow studies for key areas impacted by both overland flows and storm surge.	$100,000	$100,000	$100,000	$100,000	$100,000	$100,000	$100,000
	Property and Asset Modifications							
PM2a	Develop a voluntary house raising policy.	$10,000	$500	$10,000	$500	$500	$500	$500
PM2b	Ongoing monitoring of most at risk houses with regards to Voluntary House Raising.	-	$2,000	-	-	$2,000	-	-
PM2c	Voluntary House Raising	$80,000	$80,000	$80,000	$80,000	$80,000	$80,000	$80,000
FM3	Develop guidelines for wave run-up management.	$30,000	$500	$30,000	$500	$500	$500	$500
FM4	Install flood gates on stormwater pipe outlets as required.	$100,000	$35,000	$20,000	$26,000	$32,000	$38,000	$44,000
FM5	Develop guidelines for sea wall design and maintenance with consideration of design criteria specified in Action FM3.	$30,000	$500	$30,000	$500	$500	$500	$500
TOTAL[1]		**$1,521,000**	**$358,400**	**$1,051,000**	**$668,000**	**$401,000**	**$362,500**	**$350,500**

[1] Total annual cost would be dependent on the programing of the works, i.e. not all 'Stage 1' project would be initiated immediately after adoption of this Plan.

6.3 Strategic Context

This Plan should be regarded as a dynamic instrument requiring review and modification over time. The catalysts for change could include new flood events and experiences, legislative change, alterations in the availability of funding, reviews of Council's planning strategies and importantly, the outcome of new studies, particularly the Climate Change Adaptation Plans which have been recommended as an outcome of the floodplain risk management process.

It is recommended that the outcomes of this FRMS are incorporated into the Integrated Planning and Reporting Framework which includes Council's Delivery Program Incorporating the Operational Plan, and the Resourcing Strategy. These plans, along with the reports on the progress of each plan, outline the work Council is currently doing within the community, as well as priorities for future services and how we are working to achieve the plans. This FRMP assists in achieving the objectives of Gosford 2025 Community Strategic Plan, and is particularly relevant to Governance and Leadership objectives under the Delivery Program, which includes social planning, coastal and estuary planning, flooding and drainage planning, land use planning and climate change adaptation. Future flood risk management plans and climate change adaptation planning will need to run parallel for some aspects of the decision-making process, given the linkages between these two processes and associated linkages with infrastructure planning and asset life.

6.4 Communication of Flood Risk

A community at risk needs to understand their role in minimising the impacts of disasters, and have the relevant knowledge, skills and abilities to take appropriate action (Council of Australian Governments, 2011). Therefore, a crucial component of the floodplain risk management process is ensuring that the outcomes of the Flood Study (Cardno, 2013b), FRMS (Cardno, 2015) and FRMP are communicated to the community. This has been/will be achieved through the following:

- Public exhibition of the FRMS and FRMP draft documents and the associated community engagement programs;
- S149 Certificates will be updated in accordance with the outcomes of the FRMS and FRMP;
- Council's website provides flood information and will be updated as required based on the outcomes of the FRMS and FRMP;
- Council can provide property specific flood information upon request; and
- Flood education programs will be implemented as per relevant management actions (EM1 and PM4).

6.5 Climate Change Adaptation Plans

This Floodplain Risk Management Plan recommends that a series of *Climate Change Adaptation Plans* (CCAPs) are prepared. These CCAPs would seek to establish a framework for the management of projected climate change, subject to funding resources available to Council. Tidal inundation, in addition to storm events, would be considered as a component of the CCAPs. Recommendations set out in the CCAPs would then flow into the periodic review of the Brisbane Water FRMS and FRMP documents, Gosford City Council policy, Local Environmental Plans and Development Control Plan documents.

The Climate Change Adaptation Plans form Action PM9 of this FRMP. The 'implementation timeframe' and 'priority' for this action is outlined in **Table 6.2**. Under the floodplain risk management

process, this action resulted in a medium priority. This is a reflection of the fact that there are existing flood risks that must be managed and actions to address these existing risks were given a higher priority under this process. However, the importance of Action PM9 under other planning mechanisms in conjunction with the floodplain risk management process is acknowledged given Council's Sea Level Rise Policy. There is a need to start planning immediately for the potential impacts of sea level rise, given new developments may have an asset life of 50+ years. This is reflected in the action being assigned an "Immediate" implementation timeframe.

It is envisaged that a LGA-wide Climate Change Adaptation Plan would be prepared in the first instance as an overarching document to provide guidance for subsequent localised or issue specific plans. As an example projected sea level rise priority areas would then be identified as part of the LGA wide CCAP (based on both flood affectation and the relevance of strategies and plans) and more location-specific plans would be formulated.

The projected impacts of sea level rise on built assets, natural resources, and heritage items and places could be incorporated into the CCAPs. Council's climate change policy and predictions of sea level rise should be reviewed periodically to ensure that the most relevant and recent data is utilised in sea level rise adaptation planning.

7 Conclusions

This FRMP provides a practical framework and implementation plan for managing existing, future and continuing flood risk within the study area.

Overall it is considered that existing risks to the Brisbane Water foreshore floodplain can be managed appropriately through the implementation of development controls, emergency response measures and minor works. The effective implementation of development controls will be of key importance in reducing the damages and risk to life associated with flooding into the future through the construction of flood compatible buildings and assets.

In order to achieve the implementation of relevant management actions, a program of implementation has been developed. The actions listed in **Section 6** are recommended for implementation.

The steps in progressing the floodplain risk management process from this point onwards are:

- Council will adopt the final Plan and submit applications for funding assistance to relevant State and Commonwealth agencies, as appropriate;
- The flood management actions will be prioritised for funding through the Integrated Planning and Reporting Process; and
- As funds become available from OEH, the Commonwealth, other state government agencies and/or from Council's own resources, recommended management actions will be implemented in accordance with the established priorities.

Based on the implementation program provided in **Section 6**, this FRMP fulfils its objectives accordance with the New South Wales (NSW) Flood Prone Land Policy (NSW Government, 2001) and the principles of the Floodplain Development Manual (NSW Government, 2005).

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