Shoalhaven City Council

ST GEORGES BASIN

FLOODPLAIN RISK MANAGEMENT PLAN

Sussex Inlet - June 1991 Flood

DECEMBER 2006

NEXUS ENVIRONMENTAL PLANNING PTY LTD

WEBB, McKEOWN & ASSOCIATES PTY LTD

SHOALHAVEN CITY COUNCIL

ST GEORGES BASIN

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Webb, McKeown & Associates Pty Ltd
Level 2, 160 Clarence Street, SYDNEY 2000
Telephone: (02) 9299 2855
Facsimile: (02) 9262 6208
20034:StGeorgesFPMPlan.wpd

Prepared by: _____

Verified by: _____

ST GEORGES BASIN
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FOREWORD

The State Government's Flood Prone Land Policy is directed at providing solutions to existing flooding problems in developed areas and, to ensuring that new development is compatible with the flood hazard so that it does not create additional flooding problems in other areas.

Under the Policy, the management of flood liable land remains the responsibility of local government. The State Government subsidises flood mitigation works to alleviate existing problems and provides specialist technical advice to assist Councils in the discharge of their floodplain management responsibilities.

The Policy provides for technical and financial support by the Government through the following sequential stages:

1. *Floodplain Risk Management Committee*
   - formation of an advisory committee comprising representatives of Council, community groups and relevant government agencies.
2. *Data Collection*
   - compilation of existing data and collection of additional data.
3. *Flood Study*
   - determines the nature and extent of the existing floodplain.
4. *Floodplain Risk Management Study*
   - evaluates management options for the floodplain in respect of both existing and proposed development.
5. *Floodplain Risk Management Plan*
   - involves formal adoption by Council of a plan of management for the floodplain.
6. *Implementation of the Plan*
   - construction or implementation of floodplain risk management measures to protect existing development,
   - use of Environmental Planning Instruments (such as Local Environmental Plans and Development Control Plans) to ensure new development is compatible with the flood hazard.

The St Georges Basin Floodplain Risk Management Plan constitutes the fifth stage of the risk management process and follows on from the St Georges Basin Floodplain Risk Management Study. This plan has been prepared by Webb, McKeown & Associates for Shoalhaven City Council and provides the basis for the future management of flood prone lands within the St Georges Basin Floodplain. This plan should be reviewed every two to five years or following any significant flood. Changes to policies that have occurred since commencement of this Plan are documented in the Risk Management Study.

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SUMMARY

St Georges Basin is a coastal lagoon within the Shoalhaven City Council area. The Basin has a surface area of approximately 37 square kilometres discharging through the Sussex Inlet Channel to the Pacific Ocean at Bherwerre Beach. The total catchment area to the Pacific Ocean is approximately 327 square kilometres. The basin itself therefore represents approximately 11% of the total catchment. There are no known occurrences of the Inlet entrance to the ocean being closed.

A number of historical flood events have been reported to have occurred within the St Georges Basin floodplain. In recent times the most significant events occurred in 1959, 1971 and 1991 with several smaller events in the mid 1970's as well as 1992, 1993 and 1994. Flooding can result from a combination of mechanisms which include catchment runoff, high ocean conditions, and/or wind waves. The worst affected areas are Sanctuary Point, near Tomerong/Cockrow Creek and Sussex Inlet. Tomerong/Cockrow Creek tends to experience flash flooding whilst flooding at Sussex Inlet is of a longer duration and is influenced by the overall catchment inflows to the basin, the prevailing ocean conditions in Wreck Bay and the conditions in the channel.

In the last 30 years the land usage around the Basin has undergone significant changes, from a predominantly rural community, to a community with significant areas of urbanisation. These changes have already affected the Basin and there is the potential for further changes to occur. A number of properties surrounding the Basin and its tributaries are very low lying and flooding has caused damage in the past. In view of these factors it was necessary to define the existing flood problem and develop an appropriate action plan to carefully manage future development of the floodplain.

This Plan provides the basis for the future management of flood prone lands adjacent to the Basin, its tributaries and the Sussex Inlet Channel. The development of this Plan has been based on preceding investigations which were essential elements of the overall Floodplain Risk Management Process including:

- St Georges Basin Flood Study (September 2001) - which defined flood behaviour across the floodplain, and
- St Georges Basin Floodplain Risk Management Study - which categorised the risks and hazards for the floodplain and also considered the various issues associated with existing flood affected properties as well as potential future development of the floodplain.

Based on the findings of the St Georges Basin Floodplain Risk Management Study, this Plan sets out the actions to be adopted for the future management of the St Georges Basin floodplain. A summary of the management measures recommended for implementation is presented in Table (i) grouped under the categories of:

- Flood Modification Measures,
- Property Modification Measures,
- Response Modification Measures.

Table i): Summary of Proposed Floodplain Risk Management Measures

	MEASURE	COMMENT	ENVIRONMENTAL IMPACT	SOCIAL IMPLICATIONS	HYDRAULIC BENEFIT	ECONOMIC COST	PRIORITY
FLOOD MODIFICATION:							
F1	IMPLEMENT RECOMMENDATIONS OF STORMWATER MANAGEMENT PLAN TO DEAL WITH LOCAL FLOODING ISSUES	Local flooding problems generally do not result in houses being inundated. The Shoalhaven City Council Stormwater Management Plan identified and made recommendations for areas affected by local flooding. These recommendations should continue to be implemented to assist local flooding and drainage problems overall.	+	+	0	$2.9M over 5 years	HIGH
F2	INVESTIGATE FEASIBILITY OF FAIRVIEW CRESCENT LEVEE	Raising Fairview Crescent to form a levee will reduce the inconvenience and damage caused by frequent flood events up to the 1% AEP but will also increase evacuation time for larger events.	neg	+	0	$300,000 (not including local drainage)	MEDIUM
PROPERTY MODIFICATION:							
P1	ALLOW HOUSE RAISING FOR SUITABLE PROPERTIES	Six (6) houses have been identified as being suitable for house raising. Raising these houses will reduce flood damages but it will not change the hazard categorisation for the property.	0	neg financial + protection	0	Up to $240,000 ($40,000 per building)	MEDIUM
P2	ALLOW FLOOD PROOFING	Flood proofing should be encouraged for existing flood affected commercial properties. Generally it is not viable for residential properties but if applicable it can be considered.	0	0	0	Approx. $10,000 per building	LOW
P3	REVIEW AND UPDATE SCC INTERIM FLOOD POLICY	Formalise Council policy documentation to include findings from Floodplain Risk Management Process.	0	0	0	$50,000	HIGH
P4	ADOPT APPROPRIATE FLOOD PLANNING LEVEL	Adopt a flood planning level which is consistent for different types of development (based on risks) across the floodplain. The Flood Planning Level should incorporate the appropriate design flood level, a freeboard allowance and consideration of wind waves (where appropriate).	0	+	0	Cost to development	HIGH
P5	ADOPT A CONSISTENT FREEBOARD OF 0.5 m	A consistent freeboard of 0.5 m shall apply for all new development in flood liable areas.	0	+	0	Cost to development	HIGH
P6	MONITOR FLOOD IMPLICATIONS OF THE GREENHOUSE EFFECTS	Council to keep up to date with the latest research on climatic change pertaining to the Greenhouse effect and its impact on water levels. The increase is predicted to be relatively minor but must be closely monitored.	0	0	0	Negligible	LOW
P7	APPLY MINIMUM SET BACK FROM FORESHORE	A minimum set back shall apply for new development in areas where erosion is potentially an issue. A detailed geomorphic assessment is required to determine the setback.	+	+	+	Cost to development	HIGH
P8	MONITOR THE EXTENT OF FILLING OF FLOOD PRONE LAND	Council to monitor the cumulative extent of filling on flood prone areas with the aid of GIS. Minor filling is unlikely to have any significant impact on flood levels. Ensure local flood behaviour is not altered by affects of filling associated with individual and cumulative development.	0	0	0	Nominal	MEDIUM
P9	REVIEW AND UPDATE SECTION 149 CERTIFICATES	Updated flood information and the floor level survey need to be included on Section 149 certificates.	0	0	0	$10,000	HIGH
P10	MAINTAIN FLOOR/GROUND LEVEL DATABASE	Details of floor and ground levels for all properties within the floodplain should be updated with any new proposals or re-development.	0	0	0	Nominal	MEDIUM
P11	NOTIFY EXISTING PROPERTY OWNERS OF CURRENT S149 CERTIFICATE DETAILS	As part of a flood awareness/education program and to ensure all existing property owners are made aware of any potential flood affectation encoded as a result of this floodplain risk management process, notifications should be mailed to all flood prone property owners.	0	0	0	$5,000	MEDIUM
P12	REVIEW AND UPDATE LEP	Council are currently in the process of updating the LEP to incorporate the latest flood terminology and policies.	0	+	0	$20,000	HIGH
P13	ADOPT & IMPLEMENT UPDATED DEVELOPMENT CONTROLS FOR FLOOD PRONE LAND	Council should adopt and implement a generic Flood DCP with reference to a specific planning matrix tailored to assist with development planning of flood prone lands on the St Georges Basin floodplain.	+	+	+	Cost to development	HIGH
P14	ADOPT UPDATED DEVELOPMENT CONTROLS FOR CARAVAN PARKS	Council should adopt and implement a caravan park planning matrix with graded development controls applying to different types of developments/improvements in caravan parks on flood prone lands.	+	+	0	Cost to development	HIGH
P15	REVIEW AND ASSESS HAZARDS AND RISKS FOR ALL CARAVAN PARKS	Some 15 caravan parks exist in low lying and potentially High Hazard areas of the floodplain. Each park should be inspected in detail to accurately identify the risks and any specific needs.	0	+	0	$15,000	HIGH
P16	ENFORCE CARAVAN PARK GUIDELINES	The proposed caravan park development guidelines should be enforced for all existing and future development to ensure minimal damages are incurred.	+	neg	0	Nominal	MEDIUM
RESPONSE MODIFICATION:							
R1	IDENTIFY SUITABLE RAINFALL/WATER LEVEL GAUGE SITES, COLLECT AND ANALYSE DATA	Automatic rainfall/water level gauges should be installed at appropriate locations across the catchment to facilitate the collection of data to assist in the establishment of a flood warning system.	0	+	0	$10,000 per gauge	HIGH
R2	DEVELOP A FLOOD WARNING SYSTEM	Develop a Flood Warning System in consultation with BOM and SES. Likely to be most effective for Sussex Inlet and Basin foreshore areas.	0	+	0	$30,000	HIGH
R3	REVIEW AND UPDATE LOCAL FLOOD PLAN	The SES Local Flood Plan should be regularly reviewed and updated. This could include more detail on the particular problems at caravan parks on the Basin foreshores and in Sussex Inlet area and evacuation routes.	0	+	0	$5,000	HIGH
R4	MONITOR CHANGES TO THE FLOODPLAIN	Changes to the floodplain (such as filling, new development or re-development) occur on an ongoing basis. Such changes can alter (increase or decrease) the number of people at risk, the level of risk or evacuation needs and this information may require the Local Flood Plan to be updated.	+	0	0	Nominal	MEDIUM
R5	RAISE JACOBS DRIVE FOR 600 TO 800 METRES FROM WESTERN END	There may be some scope to raise part of Jacobs Drive to improve evacuation access times and reduce the number of properties cut off in up to a 1% AEP event by almost half.	neg	+	neg	$800,000	MEDIUM
R6	INVESTIGATE ALTERNATIVE EVACUATION ROUTE FOR SUSSEX INLET PROPERTIES	There is currently only one route leading out of Sussex Inlet and the properties on high ground north of Badgee Lagoon are easily isolated in small/frequent flood events. A second alternative route would improve trafficability early in an evacuation and ensure nearly 400 properties are not completely isolated.	neg	+	0	$30,000	MEDIUM
R7	DEVELOP AND IMPLEMENT A FLOOD EDUCATION PROGRAM	An ongoing Flood Education program will help to maintain/enhance the awareness of the community, particularly, the transient non-permanent “holiday makers”.	0	+	0	$10,000	HIGH

LEGEND:
+ = positive impact or benefit.
0 = nil impact, neutral benefit or no significant change.
neg = negative impact or disbenefit.

1. INTRODUCTION

St Georges Basin is a coastal lagoon within the Shoalhaven City Council area (Figure 1). The Basin has a surface area of approximately 37 square kilometres discharging through the Sussex Inlet Channel to the Pacific Ocean at Bherwerre Beach. The total catchment area to the Pacific Ocean is approximately 327 square kilometres. The Basin itself therefore represents approximately 11% of the total catchment.

This Floodplain Risk Management Plan covers the study area shown in Figure 1 including the Sussex Inlet Channel, the foreshore fringe area around St Georges Basin, and the lower reaches of the major tributary creeks (listed in Table 1). The study area is bound approximately by Sussex Inlet Road, the Princes Highway, The Wool Road, Jervis Bay Road and Naval College Road. A breakdown of the total catchment area is shown in Table 1.

Table 1: Catchment Area Breakdown

Tributary (1)	Catchment Area	
	(km^2)	%
Cow Creek	13.1	4.0
Tullarwalla Creek	18.3	5.6
Wandandian Creek	159.3	48.7
Pats Creek	6.4	2.0
Home Creek	4.6	1.4
Tomerong Creek (also referred to as Cockrow Creek)	42.8	13.1
Worrowing Waterway	5.9	1.8
Erowal Creek	2.6	0.8
Stony Creek	2.7	0.8
Basin and non-tributary foreshore fringe area (2)	56.5	17.3
Sussex Inlet Creek and Channel (3)	14.9	4.5
TOTAL	**327.1**	**100.0**

Notes: (1) Catchment area contributing to the Basin except where noted below.
(2) Actual Basin surface area to Sussex Inlet channel is approximately 37 km^2.
(3) Residual area below Basin.

The Sussex Inlet channel links St Georges Basin to the ocean at Bherwerre Beach. It is approximately 6 km long, with a width varying between 50 m and 300 m. The tidal range varies from approximately 1.5 m at the ocean entrance end of the channel and is then dampened to a range of only 0.2 m within the Basin. The inlet entrance is sheltered to the east and north by St Georges Head and to the south by Farnham Headland and has no record of closure.

A number of properties surrounding the Basin and its tributaries are very low lying and flooding has caused damage in the past. Historical flood level data for the more recent significant flood events of February 1971 and June 1991 were provided by many residents as part of the St Georges Basin Flood Study (September 2001 - Reference 1).

1.1 The Flood Problem

Flooding within the Study area may occur as a result of a combination of the following factors:

- an elevated Basin level due to intense rain over the total catchment. The Basin level rises when the rate of inflow to the Basin is greater than the outflow to the ocean. The Sussex Inlet channel and external ocean conditions can act as constrictions to the rate of outflow,
- elevated water levels within the individual creeks as a result of intense rain over the local tributary catchments. The levels in the creeks may also be affected by an elevated Basin level or by constrictions along their lengths,
- local runoff over a small area accumulating in low spots. Generally this occurs in areas which are relatively flat with little ground slope to facilitate drainage. The problem may be compounded by inadequate local drainage provisions and elevated Basin levels at the downstream outlet of the urban pipe or road drainage system,
- elevated ocean levels. Generally elevated ocean levels occur as a result of storm surge (from a low pressure system) in combination with increased wave activity,
- local wind conditions generating waves to setup across the fetch of the Basin.

Photograph 1: St Georges Basin Foreshore - June 1991 Flood

These factors may occur in isolation or in combination with each other. In particular, the combination of high tides, strong winds (typically onshore easterly to south-easterly but also westerly) and peak inflows to the Basin are considered to be significant. Some local residents have reported that during the 1971 flood, levels experienced at the eastern end of the Basin were 0.5 m higher than at the western end due to the effects of the wind waves which were "set up" across the fetch of the Basin.

The developed areas most at risk of inundation include the low-lying properties around the foreshores of the Basin, at Sussex Inlet and around the Park Drive area adjacent to Cockrow Creek, Sanctuary Point.

1.2 The Floodplain Risk Management Process

The floodplain risk management process provides for the investigation, analysis and management of flood prone lands. For the St Georges Basin floodplain, the process involved:

- *St Georges Basin Flood Study* (Reference 1). This included a detailed investigation of historic and design flood events, and the nature of flooding in the St Georges Basin Floodplain.
- *St Georges Basin Floodplain Risk Management Study* (Reference 2), involved an analysis of the nature of flooding and the flood hazard categorisation for the St Georges Basin Floodplain. The management study also considered potential floodplain risk management measures suitable for managing existing and future development in the floodplain.

This Floodplain Risk Management Plan sets out the implementation program for the continuing and future management of the floodplain. The flood study and the floodplain risk management study should be referred to for background information and when considering the floodplain risk management process.

1.3 Flood Study Outcomes

The St Georges Basin Flood Study determined the design flood behaviour for the 1%, 2%, 5% and 10% AEP floods and an Extreme flood event.

A summary of adopted design flood levels for selected locations (refer Flood Study for other locations) are shown in Table 2. These are referred to as still water levels in the Basin as they exclude the effect of wind wave set up in the Basin itself. The effect of wind waves in the Basin varies from 0.1 to 0.6 m above the still water level.

Table 2: Design Flood Levels

No.	Location	Creek	Level (mAHD)				
			Ext.	1%	2%	5%	10%
1	Basin	Inlet	5.1	2.35	2.09	1.78	1.54
2	The Haven	Inlet	3.1	1.96	1.86	1.75	1.74
3	200 m D/s Princes Highway	Wandandian	10.2	6.66	6.29	5.81	5.35
4	Wool Rd	Pats	5.1	4.26	4.22	4.18	4.13
5	U/s Wool Rd	Home	5.1	2.54	2.45	2.33	2.21
6	Wool Rd	Tomerong	5.1	3.44	3.26	3.01	2.75
7	Fitzpatrick St	Worrowing	5.1	2.56	2.44	2.32	2.18
8	Badgee Lagoon Jtn	Inlet	5.1	2.30	2.05	1.74	1.53
9	Jacobs Drive	Inlet	5.0	2.26	2.01	1.72	1.53
10	Cater Canal	Inlet	4.8	2.18	1.95	1.68	1.53
11	Coastal Patrol	Inlet	4.4	2.05	1.85	1.63	1.56

Note: Refer to Figure 1 for locations of flood level results.

1.4 Floodplain Risk Management Study Outcomes

1.4.1 Flood Hazard Classification

Flood hazard is a measure of the overall adverse effects of flooding. It incorporates the threat to life, difficulty in evacuating people and possessions, as well as the potential for damage, social disruption and loss of production. The hazard classification for a given area is partially a qualitative assessment based on a number of factors as listed below.

- size of flood,
- flood awareness of the community,
- depth and velocity of floodwaters,
- effective warning and evacuation time,
- rate of rise of floodwaters,
- duration of flooding,
- evacuation difficulties.

The St Georges Basin Floodplain was determined to comprise of four hazard classifications based on the above factors and the hydraulic classification. The St Georges Basin Floodplain Risk Management Study should be referred to for more detailed information but broadly speaking the classifications are:

- **High hazard floodway** - areas where a significant volume of water flows during floods with high velocities and large depths.
- **High hazard flood storage** - those parts of the floodplains that are important for temporary storage of floodwaters, floodwaters tend to rise slowly, have low velocities but large depths.
- **Low hazard flood storage** - as for high hazard flood storage except depths and velocities tend to be less.

- **Low hazard flood fringe** - those remaining areas of land affected by flooding after the floodway and flood storage areas have been defined.

Broadly speaking, Sussex Inlet Channel, the tributaries and their immediate adjoining area are classified as high hazard floodway. The Basin and the low lying developed areas of Sussex Inlet and Sanctuary Point are defined as high hazard flood storage areas. Some Basin fringe areas near Home Bay as well as land adjacent to the low lying areas of Sanctuary Point are classified as low hazard flood storage. The remaining Basin fringe and higher land adjacent to the tributaries is considered low hazard flood fringe. Figure 2 presents the flood hazard classification for the St Georges Basin Floodplain.

1.4.2 Flood Damages

The quantification of potential flood damages is an important part of the floodplain risk management process. By quantifying the cost of flood damages across the full range of event magnitudes, appropriate and cost effective management measures can be assessed for their benefits relative to the cost of implementation.

Flood damages are often defined as being “tangible” or “intangible”. Tangible damages are those for which a monetary value can be assigned, in contrast to intangible damages which cannot easily be attributed a monetary value. Intangible damages include emotional distress for humans and loss of habitat for wildlife (fast flowing floodwaters can scour out the creeks and remove vegetation and debris which once acted as shelter and a source of food for aquatic wildlife).

Based upon the surveyed floor level database obtained by Council in January/February 2001, Table 3 indicates the number of residential buildings likely to be flooded for a range of events along with the corresponding tangible flood damages. No allowance has been made for potential losses incurred through bank collapse or complete destruction of buildings. Potential damages to public utilities are also not included.

Table 3: Summary of Damages to Property

Flood	Property Affectation					Tangible Damages (2) (3) ($ millions)
	Yards	Buildings (1)				
		Sussex Inlet	Basin Foreshore	Sanctuary Point	Total	
Extreme	1434	187	890	265	1342	45.1
1% AEP	886	22	421	78	521	8.5
2% AEP	817	9	180	66	255	4.1
5% AEP	534	8	65	52	125	1.8
10% AEP	354	5	39	32	76	0.9

Notes: (1) The number of buildings identified is based on design flood levels from the Flood Study (Reference 1) and surveyed floor level information gathered by Council in Jan/Feb 2001. In order to reduce the survey time and costs, only selected properties were surveyed in relatively flat areas. The surveyed levels for the selected properties were then assumed to be representative of all properties in the nearby area. The yard is considered to be inundated if the design flood level is above the surveyed level for the property and the building is considered to be inundated if the design flood level is above the surveyed floor level for the property.

(2) Some allowance for damages incurred at caravan parks is included. Refer to Appendix A, Section A2.5.

(3) Damages will be higher if buildings experience significant structural damage.

As indicated in Table 3, the average annual tangible damages (AAD) for the St Georges Basin floodplain are estimated to be approximately $0.66 million. This figure excludes damages to public property and intangible damages. The net present value of these damages is around $9 million assuming a 50 year design life at a 7% discount rate.

In terms of the existing flood problem, the greatest concern is the number of buildings and properties shown in Table 3 to be affected by flooding. Some 76 buildings and 354 yards are potentially inundated in as little as a 10% AEP flood. Most of these properties are located around the Park Drive area adjacent to the lower reaches of Cockrow Creek (31) and in the lower areas of Sussex Inlet (29). The remaining 16 properties incorporate 10 of the Sussex Inlet Caravan Parks and 5 houses scattered around the Basin foreshore areas or along the smaller tributaries such as Worrowong Creek.

The majority of those affected in the 1% AEP event (400) are associated with the canal estates and other areas accessed by Jacobs Drive at Sussex Inlet. The flood hazard in this area has been categorised as high and there is little which can be done to mitigate the risks for the existing situation.

Photograph 2: Sussex Inlet - June 1991 Flood

Photograph 3: River Road, Sussex Inlet - June 1991 Flood

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2. DISCUSSION OF ISSUES AND RECOMMENDATIONS

2.1 Local Overland Flooding

DISCUSSION:

Local overland flooding is associated with frequent inundation of isolated areas due to the inability of the local pipe and/or channel drainage system to contain or handle the stormwater runoff generated by small storm events. This type of flooding is an important issue for residents because it tends to occur on a more frequent basis than mainstream flooding. Residents have correctly identified the lack of formalised street drainage systems (kerb and gutter with pipe and pit networks), and the filling and building on low lying land which can block overland flow paths, as the major factors contributing to local overland flooding affecting their properties.

From a floodplain management point of view, local overland flooding is invariably defined as involving shallow depths (<0.3 m) with generally little danger to personal safety. The issue therefore represents more of a nuisance than a threat but still a significant problem which warrants due recognition and consideration. However, under the terms of the State Government Funding program administered by DNR, only works or measures which address the more serious problems associated with risk/hazard to life or property are eligible for subsidised government funding as part of this Plan. Local drainage works to address nuisance problems are considered to be Council's responsibility and will be undertaken based on their priority against other works with competing objectives across the city.

RECOMMENDATIONS:

Recommended local drainage works were addressed as part of the City of Shoalhaven Urban Stormwater Management Plan (Reference 3) and these should continue to be implemented by Council as part of their ongoing capital works program. The regular maintenance of local minor drainage systems should also reduce the occurrence of localised ponding of water during rainfall events.

The cost of implementing the Stormwater Management Plan will be on going and dependent upon the severity of the local drainage issues. The City of Shoalhaven Urban Stormwater Management Plan estimated a total cost to Council of $2.9 million (across the whole LGA) for the proposed measures over a 5 year period (Reference 3).

Within the context of this Floodplain Risk Management Plan this action should have a high priority because local overland flooding occurs on a more frequent basis than mainstream flooding and is considered a major issue by the local community due to the inconvenience and nuisance caused.

ACTIONS:

F1: Implement recommendations of Stormwater Management Plan to deal with local drainage flooding issues.

2.2 Fairview Crescent - Sussex Inlet

DISCUSSION:

Fairview Crescent is located adjacent to the Sussex Inlet Channel just north of Badgee Lagoon. The roadway runs beside the Inlet Channel and the area is low lying with houses situated on the western side. A foreshore reserve with significant stands of vegetation extends between the road and the main channel on the eastern side (refer to Figure 3)

The consideration of a levee to address the existing flood problems experienced at Fairview Crescent was suggested by local residents and is considered to be warranted for several reasons:

- a levee would prevent the relatively frequent nuisance flooding currently experienced by the 16 properties affected,
- the road is inundated in small events (10% AEP or smaller) or very early in larger events which creates potential evacuation access problems,
- the local topography, features and nature of the problem lend themselves favourably to the construction of a levee,
- a levee would not create any adverse impacts for surrounding development.

Levees do however introduce some adverse consequences such as:

- possible internal drainage problems,
- the potential to create a false sense of security against all flood events (levees can be overtopped in larger events). This is particularly the case at Sussex Inlet where the access route is cut in a 10% AEP or smaller event,
- hazards are potentially increased should the levee overtop or fail,
- impact on aesthetics or amenity of the area along the foreshore.

The levee crest height should be set at 2.8 mAHD, which is the 1% AEP flood level plus 0.5 m freeboard. The length of the levee would be some 410 m with a crest width of 10 m, to account for the roadway, the batter would be at a minimum of 1 in 4 and the average height which the ground needs to be raised is 1.5 m (total width = 22 m). To improve internal drainage problems, and minimise future hazards in overtopping events, the area behind the levee could be allowed to be progressively filled with redevelopment over time. This is on the proviso that conditions are not made worse for adjoining properties.

With the crest level at 2.8 mAHD, the levee would provide protection for nine (9) dwellings likely to be inundated above floor level and all sixteen (16) yards. The Average Annual Damages (AAD) for this area under existing conditions is estimated to be around $9,600 with one (1) house and fourteen (14) yards inundated in as little as the 10% AEP event.

The total construction cost would be in the order of $300,000, including roadworks but not internal drainage requirements. With the levee constructed the AAD would be reduced to $2,500. Assuming a 50 year design life at a 7% discount rate the Net Present Value (NPV) of the Average Annual Damages would be reduced by some $97,000 (from $132,000 existing situation to around $35,000 with levee) giving a benefit cost ratio of around 0.3.

Table 4: Summary of Damages to Property in Fairview Crescent, Sussex Inlet

Flood AEP	Existing Conditions			With Levee		
	Property Affectation [1]		Tangible	Property Affectation [1]		Tangible
	Yards	Buildings	Damages [2]	Yards	Buildings	Damages [2]
Extreme	16	16	$505,000	16	16	$505,000
1%	16	9	$171,000	0	0	-
2%	16	5	$109,000	0	0	-
5%	15	3	$51,000	0	0	-
10%	14	1	$15,000	0	0	-
AVERAGE ANNUAL DAMAGES			**$9,600**			**$2,500**

Notes: (1) The number of buildings identified is based on design flood levels from the Flood Study (Reference 1) and surveyed floor level information gathered by Council in Jan/Feb 2001. The yard is considered to be inundated if the design flood level is above the surveyed ground level for the property. The building is considered to be inundated if the design flood level is above the surveyed floor level.

(2) Estimated damages are based on typical average values determined from studies of flooding in other areas. Actual values for this specific local area could vary considerably. The estimates shown are only intended to indicate the potential relative difference achieved by the measures.

RECOMMENDATIONS:

It is recommended that the feasibility of this option be investigated further by undertaking:

- detailed topographic survey of the area to establish, road levels, and facilitate development of a concept design,
- discussions with local residents to determine their acceptance and/or concerns with such an option,
- a review of environmental factors to establish the likely affects the works may have on the local environment,
- application for funding assistance subsidies from the State Government.

This measure has a medium term priority because the properties are first affected by a 10% AEP and the local community did not highlight the area as having any major problems. The levee would not only reduce flood damages for events ranging between the 10% AEP and the 1% AEP but it may provide some additional time to evacuate. However this would depend on the time at which the access routes are cut.

ACTIONS:

F2: Undertake further detailed investigation of the feasibility of a levee to protect Fairview Crescent properties.

2.3 House Raising

DISCUSSION:

House raising involves lifting an affected house of suitable construction so that the minimum habitable floor level is raised above a specified flood planning level. A review of the floor level survey data (gathered as part of the floodplain risk management study) and building types suggests that house raising could be suitable for approximately 6 properties which are inundated in the 10% AEP event. Table 5 includes details of these 6 properties.

Table 5: Properties Identified for Possible House Raising

Location	St No.	Street Name	Ground RL (mAHD)	Floor RL (mAHD)	Depth of Inundation (m)			
					10% AEP		1% AEP	
					Ground	Floor	Ground	Floor
Home Creek	9	Fisherman Rd	3.03	3.57	1.58	1.04	1.69	1.15
Sanctuary Point	41	Roulstone Cres	2.20	2.13	0.55	0.62	1.24	1.31
Erowal Bay	20	Kallaroo Rd	3.10	3.43	0.81	0.48	0.96	0.63
Sussex Inlet	5	Wunda Ave	0.92	0.97	0.61	0.56	1.38	1.33
Sussex Inlet	13	Wunda Ave	0.86	1.05	0.67	0.48	1.44	1.25
Sussex Inlet	52	Ellmoos Ave	1.24	1.08	0.29	0.45	1.02	1.18

It should be noted that house raising does not alter or reduce the flood hazard classification for a property and in fact residents will tend to remain with their house rather than be evacuated early in the event. The main benefit of house raising is the reduction in flood damages experienced by the individual property.

Assuming each of these houses was raised 3 m (one floor), the estimated reduction in Average Annual Damages would be around $69,000. The cost of the measure would be up to $240,000 (assuming $40,000 per property). The Nett Present Value of the reduction in AAD would be of the order of $955,000 giving a B/C ratio of almost 4.0.

RECOMMENDATIONS:

House raising is a viable measure of reducing flood damages for those properties satisfying the criteria. Its adoption for implementation is however dependent on individual resident acceptance and funding availability. The 6 properties which have been flagged as potentially suitable should be contacted to ascertain their position in the matter and verify the property eligibility for raising and subsidised funding. It should be remembered that while current property owners may not be interested in this option, the success of prospective or future purchases may be dependent on this option being available.

This property modification measure should be considered a high priority because it has a good benefit cost ratio, it provides a direct and immediate benefit for the affected property and can be staged or undertaken in a relatively short period of time with a potential for subsidised State Government Funding.

ACTIONS:

P1: Allow house raising for properties satisfying the criteria and add notification to Section 149 Certificate.

- Approach current property owners to advise them of the situation and ascertain their views.
- Develop a house raising program which clearly identifies the eligible houses and criteria for financial assistance.

2.4 Flood Proofing

DISCUSSION:

Flood proofing requires the sealing of doors and possibly windows (new frame, seal and door); sealing and re-routing of ventilation gaps in brickwork; sealing of all underfloor entrances and checking of brickwork to ensure that there are no gaps or weaknesses in the mortar.

This measure is rarely used in NSW for residential buildings and is more suited to commercial premises where there are only one or two entrances and maintenance and operation procedures can be better enforced. This measure is only applicable for existing developments because new buildings should have floor levels above the Flood Planning Level.

Flood proofing will not reduce the flood hazard and in fact the hazard may be increased if the measure results in occupants staying in the premises and a large flood eventually inundates the building to high depths above floor level. There are no other significant environmental or social problems. From the results of the December 2000 St Georges Basin Floodplain Risk Management Study Questionnaire this measure was acceptable to approximately 12% of the respondents and rated higher than either house raising or voluntary purchase. The implementation of this measure would be at the discretion of the owners of property for which the process is suitable.

RECOMMENDATIONS:

Owners of residential properties should be informed about the potential of this measure and allowed to undertake the works at their own convenience. It must be made clear that this measure will not completely protect the occupants or the house in large events, evacuation will still be necessary which could pose some hazard or risk.

For a house the cost is typically of the order of $10,000. This measure generally costs much less than house raising which would infer a higher B/C ratio and it is therefore worthy of further detailed consideration particularly for regularly flooded commercial properties where the potential damages are greater. Preliminary work would include detailed inspection of buildings and interviews with the property owners. This measure would be particularly applicable for the flood affected businesses located in the commercial district of Sussex Inlet.

As flood proofing is dependent on the suitability of individual buildings and is at the discretion and cost of property owners, it should have a low to medium priority for implementation under this Plan. However, information about this measure should be included in a Flood Education Program which would be given a higher priority.

ACTIONS:

P2: Inform and educate floodplain occupants about flood proofing measures.

- Promote flood proofing of existing affected commercial developments (particularly the commercial area of Sussex Inlet).

2.5 Council's Flood Planning Controls/Requirements

Currently Shoalhaven City Council have several documents which detail Council's requirements for development of flood prone land. Discussion of the various documents and the implications for flood planning control requirements is outlined below.

2.5.1 Interim Flood Policy

DISCUSSION:

The Interim Flood Policy defines Council's objectives with regard to flooding issues, the land to which the policy applies, as well as the general conditions and standards to be implemented for development affected by flooding. The Interim Policy was last revised in August 2002, and is to be superseded by a specific DCP for Flood Prone Land, which is currently being prepared by Council.

This Policy needs to include the findings from the St Georges Basin Floodplain Risk Management Study and be updated to include all types of land use categories, including Special Uses such as hospitals, police stations, Council offices, and infrastructure which may experience significant damages if flooded. Currently the Interim Policy only mentions residential, commercial and industrial developments.

RECOMMENDATIONS:

Amongst many other things, the Local Floodplain Risk Management Policy needs to set standards for controlling development within the floodplain so as to minimise damage to property whilst also ensuring minimal effect on the hydraulic behaviour of floodwaters. Council are in the process of updating the LEP to suit the current planning requirements and standards associated with floodplain risk management (as per the 2001 Floodplain Management Manual - Reference 4). As part of this process a generic DCP which deals with flood related development controls is being prepared. This DCP will effectively provide the framework of Council's Flood Policy for the overall Shoalhaven LGA. The outcomes from this study process will then be referred to provide the specific controls applicable to the local conditions prevailing in the St Georges Basin floodplain area.

This option is low cost as it can be prepared with Council's own staff resources and the benefits will apply to both existing and future development which makes it more sustainable. It will also work toward ensuring new development is consistent with the principles of the 2001 Floodplain Management Manual.

This measure is given a high priority and should begin with incorporating and implementing specific planning related aspects of the policy including those discussed below.

ACTIONS:

P3: Finalise LEP review and preparation of DCP for Floodplain Management.

- Formulate and adopt a Floodplain Risk Management Policy as part of this process.

2.5.2 Flood Planning Levels

DISCUSSION:

Since August 2002, Shoalhaven City Council has adopted the use of FPLs and specified the 1% AEP flood level plus freeboard for all new development. FPLs may be separately defined or applied for the following broad land use categories:

- community services (schools, halls),
- critical services (hospitals, police stations, Council offices),
- residential (single and multi unit),
- commercial/industrial,
- recreational facilities,
- caravan parks,
- additions/extensions to existing structures,
- public utilities (sewer, pumping stations, phone, power, gas, etc.).

For each of the above land use categories the key relevant development controls include:

- minimum floor level,
- building components,
- structural soundness,
- impact upon others,
- flood evacuation,
- flood awareness.

Different FPLs may be assigned to the different land use categories and for each type of development control within a category. For example, the habitable floor level of a residential building may be set at the 1% AEP flood level + 0.5 m freeboard, the structural soundness at the 0.5% AEP level (plus freeboard) and the evacuation level may possibly be the Extreme level. This is just one example of how the adoption and implementation of FPLs is a more flexible approach to the management of land use in the floodplain when compared to the blanket adoption of a *Standard Flood* over the entire floodplain or LGA. This is because the

FPL selected for the relevant development controls considers the hazards or risks, effective warning time, the type of development and flood duration.

RECOMMENDATIONS:

In order to maintain consistency with the interim policy FPL which has been implemented by Council for some years now, it is recommended that the 1% AEP flood level plus 0.5 m freeboard be generally adopted as the Flood Planning Level for habitable floor levels throughout the overall St Georges Basin Floodplain. This level is considered to incorporate an appropriate level or balance of risk versus cost to the community for general residential development. Variations of the FPL have been recommended for alternative types of development in accordance with the potential risks or costs involved (refer Table A1). The adoption of such a level is also in accordance with accepted standards which have been implemented in similar situations throughout NSW.

It should be noted that the Flood Study established some potential for variation in 1% AEP design flood levels around the Basin foreshore due to the effects of wind waves. Generally speaking, the implications for most foreshore areas is likely to be an increase of less than 0.1 m (as experienced at Site 1 - refer Figure 1). Such an increase would arguably be considered to be already incorporated within the normal freeboard allowance and therefore no additional increase in the FPL would be warranted. Site 3 (Figure 1) is likely to present the worst wind wave conditions but the terrain and extent of development is such that the estimated value of a 0.6 m increase in flood level is unlikely to have any impact on development in this area. The value of 0.3 m estimated for the Loralyn Avenue properties along the foreshore at St Georges Basin (Site 2 - Figure 1) is of some significance and should be incorporated as part of the design flood level when assessing development applications in this area.

However, wind wave conditions are very specific to the nature of the local topography and location of development proposed. For example, no wind wave action should be taken into account if the proposed building is more than 50 m from the foreshore. For developments less than 50 m from the foreshore a site specific assessment is required using the approach adopted in the Flood Study - Wind Wave assessment.

ACTIONS:

P4: Adopt appropriate Flood Planning Level of 1% AEP (including allowance for wind wave effects as appropriate) plus freeboard.

P5: Adopt consistent freeboard of 0.5 m.

Greenhouse Effects

DISCUSSION:
A possible consequence of the Greenhouse Effect could be a rise in sea level. This issue is complicated by other long term influences on mean sea level changes. The available literature suggests that a gradual increase in sea level is likely to occur with a rise of perhaps 0.05 m to 0.3 m within the next 50 years (Reference 5, pg 37).

The Greenhouse Effect may affect design flood levels in the St Georges Basin, however, preliminary investigations have indicated that the potential impact for this study area will be minor. The impact on the Sussex Inlet entrance and channel may be more significant but there is no definitive information available at this stage.

Of more significance will be the impact on the erosional and sedimentation regime at Sussex Inlet. The Greenhouse Effect may vary the frequency and periods for which sand bars and shallow depths occur but, at this stage, there is not enough information to allow any definite conclusions on this.

RECOMMENDATIONS:
Council should continue to monitor the available literature and reassess Greenhouse implications with respect to Council's Flood Policy as appropriate.

ACTIONS:
P6: Monitor flooding implications of climate change due to Greenhouse Effects.

2.5.3 Setback for Foreshore Development

DISCUSSION:
Currently, Shoalhaven City Council do not specify a minimum setback from the banks of water courses or the Basin foreshore. The results from the December 2000 St Georges Basin Floodplain Risk Management Study Questionnaire indicated localised erosion and collapse of waterway banks was an issue for some residents.

RECOMMENDATIONS:
A minimum setback should be applied to new development on the Basin foreshore and tributary creeks which is in line with the Water Management Act 2000 guidelines (previously Rivers and Foreshores Improvement Act 1948) which specifies the requirement of a permit for development within 40 metres of the top of bank or shoreline.

A minimum setback line should be established in a study taking into account:

- erosion potential,
- visual amenity of the area,
- environmental considerations,
- existing developments,
- wind/wave effects,
- topographic issues,
- riparian consideration.

ACTIONS:

P7: Establish and apply minimum set back requirements for foreshore developments.

2.5.4 Filling on the Floodplain

DISCUSSION:

Filling of flood prone land may be a viable method for reducing the potential damages for new development on the floodplain (i.e. filling to create a building pad). However the possible adverse hydraulic impacts for surrounding properties needs to be properly considered and addressed. Council needs to adopt a process whereby the effects of filling of flood prone land can be strategically managed to ensure that a number of small developments do not result in a major hydraulic impact overall.

Strategic management of filling could include:

- identifying lots which are filled in a theme layer of Council's GIS,
- ensuring consideration of both local drainage and mainstream flooding impacts,
- ensuring that development of subdivisions on flood prone land (if applicable) incorporate local overland flow paths in their design,
- educating the community about flooding and the need to possibly evacuate even if the house is located above the FPL,
- specifying a maximum amount of fill that will be permitted (e.g. infill development under building pad) without a detailed hydraulic assessment,
- specifying maximum allowable areas or volumes of filling and/or ensuring a balanced compensatory cut-to-fill earthworks are undertaken to maintain the overall floodplain storage volume,
- undertaking an assessment of cumulative impacts on flood behaviour due to filling.

RECOMMENDATIONS:

Council's Floodplain Risk Management Policy and/or DCP (refer Section 2.5.1) should include the specific development controls for managing the extent of filled land to achieve specified outcomes and to define how filling and excavation within the floodplain will be recorded over time.

ACTIONS:

P8: Develop GIS theme to monitor the extent of filling on the floodplain.

2.5.5 Review and Update Section 149 Certificates

DISCUSSION:

Section 149 certificates provide information on the planning controls and policies that apply to a particular parcel of land. For existing owners and prospective purchasers, the Section 149 certificate is an important source for information on whether there are flood related development controls imposed on the property.

It should be noted that the Section 149 certificate should not be the only form of acknowledgement that a property is flood prone. This is particularly relevant for rural zoned properties where S149 certificates are not mandatory as part of the conveyancing process. The community should be adequately informed about the extent of flood prone land and why the flood classification can change from one property or area to another.

RECOMMENDATIONS:

The flood affected properties identified by the St Georges Basin Floodplain Risk Management Study will require their section 149 certificates to be updated as part of the floodplain management process. At the same time, the wording or description included on the certificate should be revised to better describe in a consistent manner the flooding implications and/or planning/building restrictions which may apply. Existing property owners should be notified of the current status of the flood related information encoded to their Section 149 certificates. Details of flood level information should be continually updated as more accurate survey/flood level information becomes available.

ACTIONS:

P9: Council adopt a Flood DCP.

- Review and update Section 149 Certificates.

P10: Update and maintain database of floor and ground levels for all properties within the floodplain.

P11: Notify all existing property owners of the flood affectation relating to their property. This should include the estimated flood levels and planning/development controls or restrictions which may apply.

2.5.6 Review and Update Local Environment Plans and Development Control Plans

DISCUSSION:

Revision of the LEP is currently underway with a draft version having been prepared for discussion with Government Agencies, prior to being released for public exhibition. The development of DCP No. 106 relating to Floodplain Risk Management has also been undertaken and is effective from October 2006.

DCP No. 106 provides guidance for the preparation and assessment of development applications on the floodplain. The DCP will only address situations where a floodplain risk management plan exists and will incorporate the relevant outcomes of FRM Plans that have been prepared for specific floodplains (such as this plan).

Any other existing DCPs which incorporate or reference flooding issues will also need to be reviewed and updated to ensure consistency is maintained.

RECOMMENDATIONS:

The amended LEP is to be finalised as a matter of priority. DCP No. 106 should also be finalised with provision to reference and incorporate the main development controls identified for the St Georges Basin Floodplain as part of the Risk Management Study (refer Reference 2 or Appendix A).

The proposed development requirements discussed herein, FPLs, freeboard, setback, filing of floodplain, greenhouse and wind waves have been incorporated in a planning matrix which helps to establish development controls for different flood prone areas. The proposed planning matrix included in Appendix A demonstrates the potential interaction of development categories with applicable controls/requirements and relevant Flood Planning Levels. The different development types correspond to those outlined in DCP No. 106. It is recommended that Council adopt the planning matrix presented in Appendix A for application to the particular characteristics and issues associated with development on the St Georges Basin floodplain.

ACTIONS:

P12: Finalise review of Local Environmental Plan.

P13: Adopt and implement updated development controls for flood prone land.

2.5.7 Adopt Updated Development Controls for Caravan Parks on Flood Prone Land

DISCUSSION:

Caravan parks situated on the floodplain can represent a significant hazard to occupants and rescuers alike during a flood event. Within the St Georges Basin floodplain study area there are some 16 caravan parks with 15 located in the Sussex Inlet area. The hazard is high because a majority of the caravan parks are situated in the low lying high hazard flood risk areas along the bank of the Sussex Inlet Channel.

Shoalhaven Council has an Interim Flood Policy for Caravan Parks on Flood Prone Land (August 1995). It contains special provisions for caravan parks on the floodplain such as:

- rapid knock down annexes,
- quick release ties on the vans to prevent them floating away,
- an effective evacuation strategy documented in a Flood Action Plan,
- restrictions on the type of vans, e.g. untowable vans not permitted in certain areas, no rigid annexes,
- specific inclusion of caravan park details in the SES Local Flood Plan.

Council is responsible for implementing development controls on a park by park basis. The table presented in Appendix B summarises recommended flood related planning controls applicable for the different types of development associated with caravan parks depending on its hazard categorisation.

In principle, implementation of the provisions outlined in Appendix B should ensure minimal damage is incurred by caravan parks during a flood event. However, it is likely that the Interim Flood Policy has not been fully enforced to date and if so, many caravans will suffer damage. There is also a risk to life as residents attempt to save their property.

RECOMMENDATIONS:

Council's Interim Flood Policy - Caravan Parks, and the development controls outlined in Appendix B provide guidelines to minimise damages for caravan park developments but only if they are adopted and rigidly enforced by Council.

This issue should be further investigated by Council, and should involve a detailed field inspection to accurately assess the hazards and risks for each park. Consideration should also be given to implementing adequate safety provisions for each park (Reference 2) in order of priority based on the degree of risk involved. At a minimum, any "at risk" parks should be clearly identified in the SES Flood Plan and a site specific evacuation plan developed by the park so that the SES are made aware of any particular resourcing requirements or outstanding issues for dealing with that park.

ACTIONS:

P14: Adopt updated development controls for caravan parks as detailed in Schedule 4 of Flood DCP.

P15: Review and assess hazards and risks for all caravan parks.

P16: Develop local Approvals Policy for Caravan Parks on flood prone land and enforce development guidelines for caravan parks for both existing and future development.

2.5.8 Cost Associated with Planning Requirement Actions

The costs associated with implementing these measures will generally be reflected by the increase in the cost to new development where buildings will be required to be higher and less foreshore area will be available for development. Council will be required to inform the public of these changes and update the Flood Policy (measure P3 - refer Section 2.5.1). The total cost for further analysis and the Local Environmental Plan and DCP update process would be minimal as this can be undertaken by Council's own Strategic Planning resources. These measures should be given a high priority because of the ever increasing development pressures on land around the Basin.

2.6 Flood Warning

DISCUSSION:

Flood warning, and the implementation of evacuation procedures by the State Emergency Services (SES), are widely used throughout NSW to reduce flood damages and protect lives. A flood warning system is usually based on a series of stations or gauges which automatically record rainfall or river levels at upstream locations and telemeter the information to a central location. Alternatively this type of information can be relayed manually. The Bureau of Meteorology (BOM) is responsible for storm/rainfall predictions for St Georges Basin but there is currently no formal flood warning system in place.

Although Council monitors the situation during flood events, the statutory responsibility for issuing flood warnings rests with the BOM. Council or the SES do not issue warnings but rather help to disseminate and act on them. Council's role during floods is to assist the SES with regards to road closures and evacuations. On the nearby Shoalhaven River catchment, Council uses an ALERT system to provide information to the SES for events below the minimum level at which the BOM issues official warnings.

Council does not have a facility to forecast flood levels. If Council had its own forecasting model it would provide additional benefits such as:

- it would act as a backup system if the BOM system failed, it would also provide a "second opinion",
- it may assist in minor and local flooding situations not monitored by the BOM,

- Council may wish to take action to protect its assets based upon its own forecasting rather than waiting for the official BOM warning,
- Council should however be advised that the BOM has the statutory responsibility to issue warnings and that this role should not be confused or compromised for legal reasons.

Aside from the warning issue, the lack of any suitable rainfall/runoff data to record and later evaluate actual flood behaviour for the St Georges Basin catchment during storm events is also a significant concern. It is only through the availability and analyses of such data that confidence in the estimated design flood behaviour can be improved or verified.

RECOMMENDATIONS:

Additional gauges would primarily be of benefit to the Basin foreshore areas, Sussex Inlet and local SES preparedness. The main tributaries, Wandandian and Tomerong/Cockrow Creeks should have telemetered water level/stream gauges and rainfall gauges positioned in the middle to upper reaches of their catchment areas. There should also be a rainfall gauge in the vicinity of the Basin edge because the Basin itself makes up 10% of the total catchment. While not essential, water level gauges at the upstream and downstream ends of the Sussex Inlet channel would help estimate the receedance of floodwaters and the prevailing tide or ocean conditions originating from Wreck Bay. These gauges could be linked and the system could utilise current technology with the use of computer based models to generate real time flow estimates and (ultimately) flood levels which would allow for early warning of possible flooding for low lying areas and/or evacuation routes.

The overall cost of this measure would be in the order of $5,000 to $10,000 for each gauge established and $30,000 for the development of a model which could give some warning of high water levels for the properties at risk in the Sussex Inlet area and around the Basin foreshore.

This measure has a medium term priority because its benefits may not be realised within the short term while suitable data is gathered and analysed. The Council should begin by installing the rainfall, water level and flow gauges and monitoring these for several years. Once sufficient and reliable data has been collected, an appropriate flood warning system could be developed with the data from the flood study.

Council should also prepare a Flood Warning Manual to ensure that the existing knowledge held by current Council and SES staff is adequately documented for future reference.

ACTIONS:

R1: Install rainfall and water level recording gauges at appropriate sites within the catchment.

- Collect and analyse data.

R2: Develop a suitable flood warning system and Manual.

2.7 Evacuation Planning

DISCUSSION:

Shoalhaven City Council in cooperation with the SES produced a Local Flood Plan in October 1999 as a supporting plan to the Shoalhaven DISPLAN (Disaster Plan). The plan is divided into several key sections which serve to outline the preparation measures (Preparedness), the conduct of response operations (Response) and the co-ordination of immediate recovery measures (Recovery) for flooding within the Shoalhaven Local Government Area.

Discussions have been held with the SES and Council to review the effectiveness of the plan and to provide recommendations for further enhancement. Key areas where improvements are possible include details on:

- when and where evacuation routes are cut,
- the number and location of buildings affected at various flood heights,
- road closures and the management of them,
- the potential for bank erosion/collapse,
- incorporating information on all flood events up to and including the extreme flood event

RECOMMENDATIONS:

The Local Flood Plan should be reviewed and updated to include the surveyed floor level information and flood affectation produced as part of the St Georges Basin Floodplain Risk Management Study. A workshop should be held to update the SES, Police, fire services and other authorities to ensure that all relevant flood response authorities are fully informed of the flood hazard and extent of affectation.

It is also recommended that the Local Flood Plan be reviewed and updated on an ongoing basis as changes to the floodplain occur (i.e. works are undertaken or properties redeveloped) and as additional or better flood related information becomes available. Such updates would be particularly relevant in the aftermath of an actual flood event where direct lessons may be learnt from the implementation of the Plan to real life situations.

The cost of updating the Local Flood Plan should be borne by both Council and the State Emergency Services. Since a majority of the information required to update the Local Flood Plan has already been made available as part of this Floodplain Risk Management Process, most of the effort and cost will be associated with compiling the document, monitoring changes to the floodplain and advising/training staff about the latest information.

Updating the Local Flood Plan is considered to be a high priority because the time since the last major flood is increasing and the information and experiences gained from that event should be recorded for future reference. Additionally, changes to the floodplain are occurring on an ongoing basis. Informing the community about the new Flood Plan can be undertaken as part of the public education program discussed Section 2.9.

Of particular concern is the timing of inundation of evacuation routes. This information should be obtained from past SES flood records and updated in future events. The effect of local runoff on evacuation access should also be considered.

ACTIONS:

R3: Review and update Local Flood Plan (including evacuation routes) based on latest available information.

R4: Monitor changes to the floodplain and their potential implications for the Local Flood Plan.

2.8 Evacuation Access

DISCUSSION:

Maintaining appropriate access to or from affected areas during times of flooding is important to ensure:

- people have the chance to evacuate themselves and valuables/belongings before becoming inundated or trapped by rising floodwaters,
- emergency services (SES, ambulance, police, etc.) are not restricted or exposed to unnecessary hazards in carrying out their duties,
- areas are not isolated for extended periods of time preventing people from going about their normal routines or business or restricting access to essential services.

Within the St Georges Basin floodplain there are two main areas where access will be a problem during times of flood. These areas incorporate the settlement of Sussex Inlet and the development along The Park Drive adjoining the lower reaches of Cockrow Creek at Sanctuary Point.

At Sussex Inlet there is only one road (Sussex Inlet Road) leading in to the settlement. This joins with the main road (Jacobs Drive servicing most of the township) near the canal crossing on the fringe of the floodplain which is also the outskirts of the developed area. Jacobs Drive is relatively flat and low lying and is readily inundated in small or frequent flood events. Access for a majority of the township is therefore significantly restricted and likely to be lost early in the larger events. Alternative routes are available for the higher developed areas south of the canal estates but nearly 400 properties north of Badgee Lagoon would be isolated.

There is little opportunity to raise Jacobs Drive for its entire length because it crosses the main floodplain as well as the flow paths through to the canal estates. It therefore has the potential to dam water and change the nature of flooding in the local area. As the canal estate is situated immediately downstream of the road and ground levels are much higher, there is more potential to raise the road through this area to the same level (refer Figure 1).

Significant waterway provisions would need to be incorporated to allow floodwaters to pass through to the downstream canals and thus minimise potential impacts upstream. While this approach would not solve all the problems of the flood affected area it would increase the time available for evacuation and significantly reduce the number of properties potentially cut off by almost half. The cost of these roadworks is likely to be in the vicinity of $800,000 (assuming a unit rate of up to $1,000/m to account for waterway provisions and problems with services and property access).

While the development located on high ground north of Badgee Lagoon may actually be flood free (except for those along the foreshore in Fairview Crescent - refer Section 2.2) the only access to or from the area would be cut at the Badgee Lagoon crossing. The residents of nearly 400 properties are likely to be isolated for extended periods of time (possibly days). The only solution would be to construct a separate route heading in a westerly direction to join Sussex Inlet Road independently (refer Figure 1). There are a number of environmental, social and economic issues associated with such a proposal which would require further detailed investigation to establish its feasibility.

At Sanctuary Point, there are a number of properties along The Park Drive adjoining the lower reaches of Cockrow Creek. A number of the properties are two-storey structures and/or have been constructed on raised/filled building pads. Access to the area along Larmer Avenue and/or The Park Drive will be cut in small or frequent events and depending on the primary flooding mechanism (catchment runoff or elevated basin levels) there may be little warning time available.

There is little if any opportunity to raise these roads to improve the evacuation situation. Raising Larmer Avenue would require the provision of considerable bridging/waterway area to minimise the potential for impacts to upstream properties.

RECOMMENDATIONS:

Where possible or practical the first 600 m to 800 m of Jacobs Drive at Sussex Inlet (Figure 1) should be raised to the same level as that of the adjoining canal development immediately downstream of the road. Appropriate waterway provisions (at 3 to 4 locations corresponding with the canals overflow paths) should be incorporated to allow the passage of floodwaters and minimise upstream impacts. The feasibility of an alternative evacuation route for the development north of Badgee Lagoon (Figure 1) should be investigated in detail.

ACTIONS:

R5: Raise Jacobs Drive at Sussex Inlet where adjoining ground levels are higher.

R6: Investigate feasibility of alternative evacuation route for properties in Sussex Inlet.

2.9 Flood Awareness and Readiness

DISCUSSION:

A flood education program involves informing the community about flooding, including how it happens, where the water goes, what to do during, before and after the event and where to get help or more information. A community with high flood awareness will suffer less damage and disruption during and after a flood because people are better prepared by being aware of the potential implications or dangers of the situation and listening carefully to official warnings on the radio and television. There is often a large, local, unofficial warning network which develops over the years and residents know how to effectively respond to the warnings by raising goods, moving cars, lifting carpets, etc. Photographs and other sentimental or non-replaceable items are generally put in safe places. Some residents may have developed storage facilities or buildings, etc., which are flood compatible. The level of trauma or anxiety may be reduced as people are more aware and/or have "survived" previous floods and know what to expect and how to handle both the immediate emergency and the post flood rehabilitation phase in a calm and efficient manner.

Based on feedback from the questionnaire, public meetings and general discussions, the majority of residents of the St Georges Basin floodplain believe they are flood aware. Although the community did not appear to be aware of the potential size, extent and damage a large flood could cause, they still need to be prepared for the common or less severe floods. Since the Basin is a popular holiday destination the flood education program will also have to consider the transient population and those property owners who live outside the floodplain. The need for readiness and awareness for larger more extreme events should not be overlooked.

The SES has a medium to high level of awareness of the problem and the requirements necessary to effect evacuations. As the time since the last significant floods (1971 and 1991) increases, the experience and knowledge of the SES units will diminish. It is imperative that relevant elements of this Floodplain Risk Management Plan be integrated into the local SES flood planning.

RECOMMENDATIONS:

A suitable Flood Awareness Program should be implemented by Council using appropriate elements from Table 6. The details of the program and necessary follow up should be properly documented to establish the most effective methods of communication and to ensure that they do not lapse with time.

An estimated cost to develop and establish a flood education program would be approximately $10,000 but there would also be a continuing cost for maintaining a minimum level of awareness amongst the community.

A flood education program should be given a high priority because it is relatively inexpensive and should be included as part of Council's due diligence. Council can begin the program by informing the community of the findings of this Floodplain Risk Management Process.

ACTIONS:

R7: Develop and implement a flood education program.

Table 6: Recommended Flood Education Methods

Method	Comment
Letter/Pamphlet from Council	These may be sent (annually or bi-annually) with the rate notice or separately. A Council database of flood liable properties/addresses makes this a relatively inexpensive and effective measure. The pamphlet can inform residents of possible subsidies for private measures, changes to flood planning levels or any other relevant information. These should also be handed out as part of rental property information. Caravan parks should also have this information displayed in prominent locations for tourists to the area.
School Project or Local Historical Society	This provides an excellent means of informing the younger generation about flooding. It may involve talks from various authorities and can be combined with discussion on water quality, estuary management issues, etc.
Displays at Council Offices, Library, Schools, Local Fairs, Mobile Libraries	This is an inexpensive way of informing the community and may be combined with related displays. The displays can include photographs, newspaper articles and information on development controls and standards, flood evacuation and readiness procedures.
Historical Flood Markers or Depth Indicators on Roads	Signs or marks to indicate the level reached in previous floods can be prominently displayed in parks, on telegraph poles or such like. Depth indicators on roads advise drivers of the potential hazards. These are particularly appropriate near local waterways and low points which become flow paths during large events.
Articles in Local Newspapers	Ongoing articles in the local newspapers will ensure that the problem is not forgotten. Historical features and remembrance of the anniversary of past events (1971, 1991) make good copy.
Collection of Data from Future Floods	Collection of data assists in reinforcing to the residents that Council is aware of the problem and ensures that the design flood levels are as accurate as possible. A Post-Flood Evaluation Program documents the steps to be taken following a flood and should be included as part of the Shoalhaven City Local Flood Plan.
Notification of 149 Certificate Details	All floodplain property owners have been indirectly informed of their potential flood liability as part of the public consultation program and floor level survey. Initially, Council should formally advise all existing property owners of their potential flood liability (149 notification status). Future owners will be advised during the property searches at the time of purchase by details provided on the Section 149 certificate.
Type of Information Available	A recurring problem is that new owners consider they were not adequately advised during the purchase process that their property was flood affected on the 149 Certificate and/or what restrictions may apply. Council may wish to advise interested parties when they inquire during the property purchase process of the flood information currently available, how it can be obtained, the cost and what development controls or instruments may apply.
Establishment of a Flood Affectation Database	The database developed from the information collected in this study can provide details on which houses require evacuation, which roads will be affected (or damaged) and cannot be used for rescue vehicles, which public structures will be affected (e.g. sewer pumps to be switched off, telephone or power cuts). This database should be maintained by the relevant authorities (SES, Police, Council) and reviewed after each flood event.

Method	Comment
Flood Readiness Program	Providing information to the community regarding flooding helps to keep it informed of the problem. However, it does not necessarily prepare people to react effectively to the problem. A Flood Readiness Program would ensure that the community is adequately prepared for the event of flooding. The SES would take a lead role in this.
Foster Community Ownership of the Problem	Flood damages in future events can be minimised if the community is aware of the problem and takes appropriate actions to find solutions. For example, Council should have a maintenance program to ensure that its drainage systems are regularly maintained. Residents have a responsibility to advise Council if they see a maintenance problem such as a blocked drain. This can be linked to water quality or other water related issues including estuary management.

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3. SUMMARY OF PROPOSED MANAGEMENT ACTIONS

The floodplain risk management study (Reference 2) identified and assessed a range of risk management measures which would help mitigate flooding to reduce existing and future flood damages. The floodplain risk management measures were then assessed against the following constraints:

- legal regulations,
- environmental effects,
- economic costs,
- social acceptance,
- change in flood behaviour and levels,
- specific local issues.

With due consideration of these constraints, as well as discussions with the Floodplain Management Committee and assessment of the results from a Questionnaire Survey of floodplain occupiers (December 2000), suitable risk management measures have been selected and recommended for implementation as part of this plan. A number of the other measures were considered but deemed unsuitable for implementation due to a combination of hydraulic, environmental, economic and social issues.

Table i) presents a summary of the management measures proposed for implementation as part of the St Georges Basin Floodplain Risk Management Plan. These measures have been grouped into the following general categories:

Flood Modification Measures: Flood modification measures modify the flood's physical behaviour by undertaking structural works to change the flood behaviour (depths and velocities) in particular areas of the floodplain.

Property Modification Measures: Property modification measures modify the existing land use or building and development controls, for future development. These measures primarily involve updating policies and regulations which relate to development in the St Georges Basin floodplain.

Response Modification Measures: Response modification measures are aimed at changing and enhancing the community's response to the potential hazards of flooding. This is achieved by educating the property owners and the wider community about flooding, its behaviour and potential damages, so that they can make better informed decisions.

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4. ACKNOWLEDGMENTS

This study was carried out by Webb, McKeown & Associates Pty Ltd with Nexus Environmental Planning Pty Ltd providing input on planning matters. The study was funded by Shoalhaven City Council and the Natural Disaster Risk Management Studies Programme. The assistance of the following in providing data and guidance is gratefully acknowledged:

- Shoalhaven Natural Resources and Floodplain Management Committee,
- Shoalhaven City Council,
- Department of Natural Resources (formerly Department of Infrastructure, Planning and Natural Resources),
- State Emergency Services,
- Local residents of the St Georges Basin floodplain area.

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5. REFERENCES

1. Shoalhaven City Council
St Georges Basin Flood Study
Webb, McKeown & Associates Pty Ltd, September 2001.

2. Shoalhaven City Council
St Georges Basin Floodplain Risk Management Study
Webb, McKeown & Associates Pty Ltd, December 2006.

3. Shoalhaven City Council
City of Shoalhaven Urban Stormwater Management Plan
Willing & Partners, April 2000.

4. New South Wales Government
Floodplain Management Manual
January, 2001.

5. A Report of Working Group II of the Intergovernmental Panel on Climate Change
Technical Summary, Climate Change 2001: Impacts, Adaption and Vulnerability
February 2001.

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FIGURES

FIGURE 1

LOCALITY MAP AND STUDY AREA

WANDANDIAN

Princes Highway

The Wool Road

WANDANDIAN CREEK

TOMERONG CREEK

PATS CK.

HOME CK.

3

4

5

6

7

SITE 3

PATS BAY

BASIN VIEW

HOME BAY

PELICAN POINT

ST GEORGES BASIN

Wool Road

SITE 2

ISLAND POINT JETTY

GARDEN ISLAND

Site 1

PARADISE BEACH

SANCTUARY POINT

WORROWING CK

EROWAL CK

EROWAL BAY

Deakin St

STONEY CK

Naval College Road

Princes Highway

TULLARWALLA CREEK

COW CREEK

SWAN BAY

ST. GEORGES BASIN

Sussex Inlet Road

Alternate Evacuation Route

Fairview Crescent Levee

1

8

9

10

11

2

BADGEE LAGOON

Raise Jacobs Drive

SUSSEX INLET

SUSSEX INLET

BHERWERRE BEACH

BHERWERRE

COMMONWEALTH TERRITORY

FARNHAM

SWAN LAKE

WRECK BAY

New South Wales

Study Area

Sydney

N

LEGEND:

- Location of model gridpoint results (refer Tables)
- Wave set-up sites
- Assumed fill areas for cumulative impacts

0.5 0 0.5 1 1.5 2 2.5km

SCALE

FIGURE 2

HYDRAULIC & HAZARD CATEGORISATION ST GEORGES BASIN FLOODPLAIN

WANDANDIAN

Princes Highway

The Wool Road

TOMERONG CREEK

PATS CK

HOME CK

PATS BAY

HOME BAY

BASIN VIEW

PELICAN POINT

ST GEORGES BASIN

Wool Road

WORROWING CK

EROWAL CK

EROWAL BAY

WANDANDIAN CREEK

Princes Highway

ISLAND POINT JETTY

GARDEN ISLAND

PARADISE BEACH

SANCTUARY POINT

Deakin St

Naval College Road

STONEY CK

TULLARWALLA CREEK

SWAN BAY

COW CREEK

ST. GEORGES BASIN

Sussex Inlet Road

BHERWERRE

BADGEE LAGOON

COMMONWEALTH TERRITORY

SUSSEX INLET

SUSSEX INLET

FARNHAM

BEACH

BHERWERRE

SWAN LAKE

N

LEGEND:

- Limit of Study Area
- Approx. Extreme Flood extent defining limit of Flood Prone lands
- High Hazard Floodway
- High Hazard Flood Storage
- Low Hazard Flood Storage
- Low Hazard Flood Fringe

Note:
Mapping based on available topographic contour information. Hydraulic and Hazard Categorisations could vary depending on actual surveyed ground levels (particularly around fringe areas).
Categorisations and mapping extent based on Flood Planning Level (1% AEP flood + 0.5m freeboard)

0.5 0 0.5 1 1.5 2 2.5km

SCALE

Note: Refer to Section 3 of the Floodplain Risk Management Study for definiton of hydraulic and hazard categories

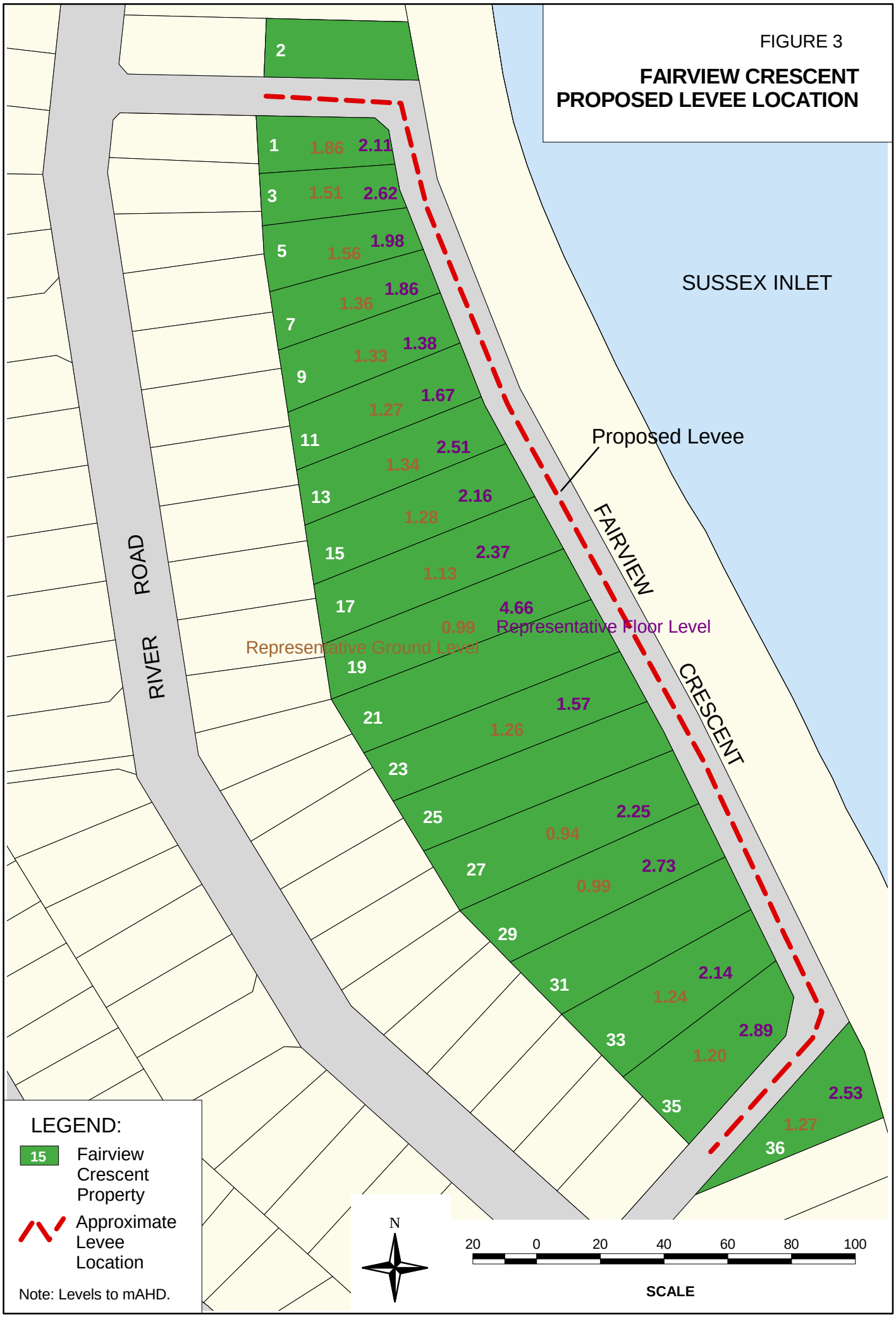
FIGURE 3
FAIRVIEW CRESCENT
PROPOSED LEVEE LOCATION
SUSSEX INLET
Proposed Levee
FAIRVIEW CRESCENT
RIVER ROAD
Representative Ground Level
Representative Floor Level
2
1 1.86 2.11
3 1.51 2.62
5 1.56 1.98
7 1.36 1.86
9 1.33 1.38
11 1.27 1.67
13 1.34 2.51
15 1.28 2.16
17 1.13 2.37
19 0.99 4.66
21 1.26 1.57
23
25 0.94 2.25
27 0.99 2.73
29
31 1.24 2.14
33 1.20 2.89
35
36 1.27 2.53
LEGEND:
15 Fairview Crescent Property
Approximate Levee Location
Note: Levels to mAHD.
N
20 0 20 40 60 80 100
SCALE

Table A1: Flood Related Development Controls - General Development

HAZARD CATEGORY	OUTSIDE FLOOD PLANNING AREA (Above the Flood Planning Level but below the PMF)									WITHIN FLOOD PLANNING AREA (Below the Flood Planning Level)																											
										HIGH HAZARD																				LOW HAZARD							
										FLOODWAY										FLOOD STORAGE OR FLOOD FRINGE										FLOODWAY, FLOOD STORAGE OR FLOOD FRINGE									
LAND USE CATEGORY	CRITICAL UTILITIES	SPECIAL USES	RESIDENTIAL DEVELOPMENT	COMMERCIAL / INDUSTRIAL DEVELOPMENT	SUBDIVISION	OPEN SPACE / NON URBAN	EARTHWORKS	MINOR DEVELOPMENT	EXEMPT DEVELOPMENT	CRITICAL UTILITIES	SPECIAL USES	RESIDENTIAL DEVELOPMENT (existing use rights only)	DUAL OCCUPANCY OR STRATA	COMMERCIAL / INDUSTRIAL DEVELOPMENT (existing use rights only)	SUBDIVISION	OPEN SPACE / NON URBAN	EARTHWORKS	MINOR DEVELOPMENT	EXEMPT DEVELOPMENT	CRITICAL UTILITIES	SPECIAL USES	RESIDENTIAL DEVELOPMENT	DUAL OCCUPANCY OR STRATA	COMMERCIAL / INDUSTRIAL DEVELOPMENT	SUBDIVISION	OPEN SPACE / NON URBAN	EARTHWORKS	MINOR DEVELOPMENT	EXEMPT DEVELOPMENT	CRITICAL UTILITIES	SPECIAL USES	RESIDENTIAL DEVELOPMENT	DUAL OCCUPANCY OR STRATA	COMMERCIAL / INDUSTRIAL DEVELOPMENT	SUBDIVISION	OPEN SPACE / NON URBAN	EARTHWORKS	MINOR DEVELOPMENT	EXEMPT DEVELOPMENT
FLOOR LEVEL	2	2	1	1								1		1				1 or 4				1	1	1				4				1	1	1				4	
BUILDING COMPONENTS	2	1	1	1								1		1		1		1	1			1	1	1		1		1	1			1	1	1		1		1	1
STRUCTURAL SOUNDNESS	1	1										2		2		3		3	3			3	3	3		3		3	3									
FLOOD AFFECTATION	1	1										1		1		1			1			1	1	1		1	2		1									
EVACUATION/ ACCESS	1	1										1,2		1,2				2				1,2	1,2	1,2				2				1,2	1,2	1,2	1,2			2	
FLOOD EVACUATION PLAN	1	1										1		1				1				1	1	1				1											
MANAGEMENT & DESIGN	1	1										1,2		1		1,2			1			1,2	1,2	1		1,2			1							1,2			1

NOT SUITABLE FOR DEVELOPMENT

NOT REQUIRED

NOTE: FOR DEFINITIONS OF THE LAND USE CATEGORY REFER TO THE RELEVANT COUNCIL DOCUMENTATION.

FPL = MINIMUM FLOOR LEVEL REQUIREMENT:	
1	1% AEP FLOOD LEVEL + 0.5 m FREEBOARD
2	PROBABLE MAXIMUM FLOOD (PMF) LEVEL
3	5% AEP FLOOD LEVEL + 0.5 m FREEBOARD
4	EXISTING HABITABLE FLOOR LEVEL OR HIGHER AS PRACTICAL
5	1% AEP FLOOD LEVEL
BUILDING COMPONENTS:	
1	ANY PORTION OF THE BUILDING OR STRUCTURE BELOW THE FPL TO BE BUILT FROM FLOOD COMPATIBLE MATERIALS
2	ANY PORTION OF THE BUILDING OR STRUCTURE BELOW THE PMF TO BE BUILT FROM FLOOD COMPATIBLE MATERIALS
STRUCTURAL SOUNDNESS:	
1	APPROPRIATE CONSULTING ENGINEER'S REPORT - THE BUILDING CAN WITHSTAND FORCES OF FLOODWATERS INCLUDING DEBRIS AND BUOYANCY FORCES UP TO THE PMF SCENARIO
2	APPROPRIATE CONSULTING ENGINEER'S REPORT - THE BUILDING CAN WITHSTAND FORCES OF FLOODWATERS INCLUDING DEBRIS AND BUOYANCY FORCES UP TO A 0.2% AEP FLOODING SCENARIO
3	APPROPRIATE CONSULTING ENGINEER'S REPORT - THE STRUCTURE WILL NOT BECOME FLOATING DEBRIS DURING A 1% AEP FLOODING SCENARIO
FLOOD AFFECTATION:	
1	APPROPRIATE CONSULTING ENGINEER'S REPORT FOR BUILDING FOOTPRINT AREA OVER 250 SQ. METRES - THE DEVELOPMENT WILL NOT INCREASE FLOOD HAZARD OR FLOOD DAMAGE TO OTHER PROPERTIES OR ADVERSELY AFFECT FLOOD BEHAVIOUR FOR A 5% AEP UP TO THE PMF SCENARIO
2	APPROPRIATE CONSULTING ENGINEER'S REPORT FOR EARTHWORKS VOLUME EXCEEDING 250 CUBIC METRES - THE EARTHWORKS WILL NOT INCREASE FLOOD HAZARD OR FLOOD DAMAGE TO OTHER PROPERTIES OR ADVERSELY AFFECT FLOOD BEHAVIOUR FOR A 5% AEP UP TO THE PMF SCENARIO
EVACUATION/ACCESS:	
1	RELIABLE EMERGENCY VEHICLE ACCESS IS REQUIRED FOR AMBULANCE, SES, FIRE BRIGADE, POLICE AND OTHER EMERGENCY SERVICES
2	RELIABLE ACCESS FOR PEDESTRIANS IS REQUIRED
FLOOD EVACUATION PLAN:	
1	APPROPRIATE ENGINEER'S REPORT DEMONSTRATING THAT PERMANENT, FAIL-SAFE, MAINTENANCE-FREE MEASURES ARE INCORPORATED IN THE DEVELOPMENT TO ENSURE THAT THE TIMELY, ORDERLY AND SAFE EVACUATION OF PEOPLE IS POSSIBLE FROM THE AREA AND THAT IT WILL NOT ADD SIGNIFICANT COST AND DISRUPTION TO THE COMMUNITY OR THE SES
MANAGEMENT AND DESIGN:	
1	APPLICANT TO DEMONSTRATE THAT THERE IS AN AREA WHERE HAZARDOUS AND VALUABLE GOODS CAN BE STORED ABOVE THE FLOOD PLANNING LEVEL
2	APPLICANT TO DEMONSTRATE THAT THERE IS AN AREA WHERE ANIMALS CAN FIND REFUGE ABOVE THE FLOOD PLANNING LEVEL

APPENDIX B: GRADED DEVELOPMENT CONTROLS FOR CARAVAN PARKS IN FLOOD PRONE AREAS

Table B1: Graded Development Controls for Caravan Parks in Flood Prone Areas

	OUTSIDE FLOOD PLANNING AREA (FPL to PMF)			WITHIN FLOOD PLANNING AREA (below the Flood Planning Level)								
	ALL HAZARD CATEGORIES			HIGH HAZARD						LOW HAZARD		
				FLOODWAY			FLOOD STORAGE OR FLOOD FRINGE			FLOODWAY, FLOOD STORAGE OR FLOOD FRINGE		
	New Park	Renewal or Extension within Existing Park		New Park	Renewal or Extension within Existing Park		New Park	Renewal or Extension within Existing Park		New Park	Renewal or Extension within Existing Park	
DEVELOPMENT CONTROL CONSIDERATION		MANUFACTURED HOME (UNTOWABLE) OR RIGID ANNEXE	MOVEABLE DWELLING - includes caravan or relocatable home with or without Flexible Annexe		MANUFACTURED HOME (UNTOWABLE) OR RIGID ANNEXE	MOVEABLE DWELLING - includes caravan or relocatable home with or without Flexible Annexe		MANUFACTURED HOME (UNTOWABLE) OR RIGID ANNEXE	MOVEABLE DWELLING - includes caravan or relocatable home with or without Flexible Annexe		MANUFACTURED HOME (UNTOWABLE) OR RIGID ANNEXE	MOVEABLE DWELLING - includes caravan or relocatable home with or without Flexible Annexe
FLOOR LEVEL									1		2	1
BUILDING COMPONENTS									1		1	1
STRUCTURAL SOUNDNESS									1		2	2
FLOOD AFFECTATION	1											
FLOOD AWARENESS	1	1	1						1		1	1
RAPID KNOCK DOWN									1			1

NOT SUITABLE FOR DEVELOPMENT

NOT REQUIRED

FLOOR LEVEL:	
1	EXISTING HABITABLE FLOOR LEVEL OR HIGHER AS PRACTICAL
2	HABITABLE FLOOR LEVEL TO BE EQUAL TO OR GREATER THAN THE 1% AEP FLOOD LEVEL + 0.5 m FREEBOARD
BUILDING COMPONENTS:	
1	ANY PORTION OF THE DWELLING OR STRUCTURE BELOW THE FPL SHOULD BE BUILT FROM FLOOD COMPATIBLE MATERIALS
STRUCTURAL SOUNDNESS:	
1	CONSULTING ENGINEERS REPORT TO PROVE THE STRUCTURE SUBJECT TO A FLOOD UP TO A 1% AEP FLOOD EVENT CAN WITHSTAND THE FORCE OF FLOWING FLOODWATER INCLUDING DEBRIS AND BUOYANCY FORCES
FLOOD AFFECTATION:	
1	APPROPRIATE CONSULTING ENGINEERS REPORT TO PROVE THAT THE DEVELOPMENT WILL NOT INCREASE THE FLOOD HAZARD OR FLOOD DAMAGE FOR OTHER PROPERTIES OR ADVERSELY AFFECT FLOOD BEHAVIOUR FOR EVENTS UP TO PMF SCENARIO
FLOOD AWARENESS:	
1	SITE SPECIFIC FLOOD EVACUATION AND MANAGEMENT PLAN (Please note: Before any moveable dwellings are approved, the flood evacuation plan has to be amended to show that sufficient resources will be available at all times to evacuate and move in sufficient time all moveable dwellings within the park - both existing and new to a location above the PMF level)
RAPID KNOCK DOWN:	
1	SUBJECT TO SATISFYING RAPID KNOCK DOWN CONDITION IN LESS THAN 24 HOURS