LOWER SHOALHAVEN RIVER FLOODPLAIN RISK MANAGEMENT PLAN

MAY 2008

NEXUS ENVIRONMENTAL PLANNING PTY LTD

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SHOALHAVEN CITY COUNCIL

LOWER SHOALHAVEN RIVER

FLOODPLAIN RISK MANAGEMENT PLAN

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LOWER SHOALHAVEN RIVER
FLOODPLAIN RISK MANAGEMENT PLAN

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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 four 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 Lower Shoalhaven River Floodplain Risk Management Plan constitutes the fifth stage of the risk management process and follows on from the Lower Shoalhaven River 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 Lower Shoalhaven River floodplain.

This plan should be reviewed every two years or following any significant flood. Changes to policies that have occurred since commencement of this Plan are documented in the Risk Management Study.

SUMMARY

The Shoalhaven River catchment covers an area of some 7000 square kilometres with approximately 120 square kilometres of floodplain downstream of Nowra. Terara was the original settlement on the south bank, however, the devastating floods of 1860 and 1870 caused most of the population to move to the higher ground at Nowra with the subsequent decline of Terara. Nowra is now the main centre of population but there are a number of smaller developed centres which exist on the floodplain downstream of Nowra. The majority of the Lower Shoalhaven River floodplain is used for agricultural purposes and contains numerous rural homesteads.

Historical flood records are available since 1860 and the largest floods were 1870, 1873, 1925, 1860, 1916, 1891 and 1978 (in order of magnitude). The flood of April 1870 was probably greater than a 1% Annual Exceedance Probability (AEP) event. It inundated the Terara township by over a metre and swept away approximately one third of the village. Five lives were lost in rural areas along the Shoalhaven River. According to some accounts, the earlier 1860 flood was even more devastating and carried away over 50 buildings. Several lives were lost as well as some 79 acres (32 hectares) of land. More recent significant floods occurred in August 1974, June 1975, October 1976 and March 1978.

Two hundred years ago the main entrance and the natural mouth of the river was at Shoalhaven Heads. This entrance is now intermittent following the construction in 1822 of the Berry's Canal link between the Shoalhaven River and the Crookhaven River, to the south. Shoalhaven Heads is opened by the occurrence of floods and subject to closure by natural onshore oceanic processes. Normal flows presently reach the ocean at Crookhaven Heads, via the man-made channel "Berry's Canal", which has a more protected and permanent entrance due to the headland.

This Plan provides the basis for the future management of flood prone lands adjacent to the Lower Shoalhaven and Crookhaven Rivers. The development of this Plan has been based on preceding investigations which were essential elements of the overall Floodplain Risk Management Process including:

- Lower Shoalhaven River Flood Study (April 1990) - which defined flood behaviour across the floodplain, and
- Lower Shoalhaven River 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 Lower Shoalhaven River Floodplain Risk Management Study, this Plan sets out the actions to be adopted for the future management of the Lower Shoalhaven River 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 (year 2000 costs)	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 GREENWELL POINT LEVEES	Levees are a potential means of reducing the flood hazard and damages for existing development. At Greenwell Point some 137 buildings are inundated in as little as a 10% AEP flood event. While there are a number of issues which may limit the feasibility or viability of levee protection for these properties, further detailed investigation of the possible levee solutions is warranted.	neg	+	0	$80,000 (study only)	MEDIUM
F3	FINALISE, IMPLEMENT AND UNDERTAKE REGULAR REVIEW OF COUNCIL'S SHOALHAVEN RIVER ENTRANCE MANAGEMENT PLAN FOR FLOOD MITIGATION	This Plan will ensure that the optimal flood mitigation benefit is achieved through management of the Shoalhaven Heads Entrance in an ecologically sustainable manner.	0	+	+	$10,000 per annum	HIGH
PROPERTY MODIFICATION:							
P1	ALLOW HOUSE RAISING FOR SUITABLE PROPERTIES	Sixteen (16) 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	0	Up to $640,000 ($40,000 per building)	MEDIUM
P2	ALLOW FLOOD PROOFING	Flood proofing should be encouraged for existing flood affected commercial properties.	0	0	0	Approx. $10,000 per building	LOW
P3	REVIEW AND UPDATE FLOOD POLICY	Formalise Council's Flood Policy documentation to include findings from Floodplain Risk Management Process.	0	0	0	$20,000	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 based on the Shoalhaven Heads entrance closed condition and a freeboard allowance.	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 planning areas.	0	+	0	Cost to development	HIGH
P6	MONITOR FLOOD IMPLICATIONS OF CLIMATE CHANGE	Council to keep up to date with the latest research on climatic change and its impact on water levels. The potential impact on flooding 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.	+	+	+	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.	neg	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	neg	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 FRMP process, notifications should be mailed to all flood prone property owners.	0	neg	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. This LEP must resolve all previous deferred zonings. A restricted development zoning due to flooding is recommended for Hay Avenue (presently a deferred zoning).	0	+	0	$20,000	HIGH
P13	ADOPT & IMPLEMENT UPDATED DEVELOPMENT CONTROLS FOR FLOOD PRONE LAND	Council should adopt and implement the generic Flood DCP No. 106 with reference to a specific planning matrix tailored to assist with development planning of flood prone lands on the Lower Shoalhaven River 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 14 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	INSTALL ADDITIONAL TELEMETERED WATER LEVEL GAUGES, COLLECT AND ANALYSE DATA	Additional automatic water level gauges should be installed at appropriate locations to assist with the collection of flood warning/evacuation information. Sites include Shoalhaven Heads, Greenwell Point and the various floodgate structures across the broader floodplain.	0	0	0	$10,000 per gauge	HIGH
R2	IMPROVE PUBLIC ACCESS TO FLOOD WARNING INFORMATION	Develop a Warning Information System in consultation with BOM and SES. Likely to be most effective for lower areas of Greenwell Point, Shoalhaven Heads and isolated rural properties.	0	+	0	$10,000	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 in the Shoalhaven Heads area.	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	INVESTIGATE RAISING OF GREENWELL POINT ROAD	There may be some scope to raise part of Greenwell Point Road to improve evacuation access times and reduce the number of properties isolated in as little as a 10% AEP event.	neg	+	neg	$50,000 (study ONLY)	HIGH
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

The Shoalhaven River catchment covers an area of some 7000 square kilometres with approximately 120 square kilometres of floodplain downstream of Nowra (Figure 1). The river rises approximately 50km inland of Moruya and follows a northerly direction for 170km before turning east for a further 90km to reach the Pacific Ocean at Crookhaven Heads. The Shoalhaven River has a length of around 332 kilometres from its headwaters to the mouth. Terara was the original settlement on the south bank, however, the devastating floods of 1860 and 1870 caused most of the population to move to the higher ground at Nowra with the subsequent decline of Terara. Nowra is now the main centre of population but there are a number of smaller developed centres which exist on the floodplain downstream of Nowra. The majority of the Lower Shoalhaven River floodplain is used for agricultural purposes and contains numerous rural homesteads. This study is primarily concerned with the floodplain areas downstream of the township of Nowra, generally termed the floodplain of the Lower Shoalhaven River.

1.1 The Flood Problem

Historical flood records are available since 1860 and Table 1 lists floods for which some information is available. The largest floods were 1870, 1873, 1925, 1860, 1916, 1891 and 1978 (in order of magnitude). There is still debate about the exact magnitude of these events but according to some sources the 1870 flood was 1.2 m higher than the March 1978 event.

Table 1: Historical Flood Events

Month	Year	Month	Year
February	1860	April	1945
June	1864	May	1948
April	1867	June	1949
June	1867	June	1951
March	1870	May	1955
April	1870	February	1956
May	1871	July	1956
February	1873	October	1959
June	1891	March	1961
February	1898	November	1961
July	1899	June	1964
July	1900	September	1967
July	1904	August	1974
January	1911	June	1975
October	1916	October	1976
December	1920	March	1978
July	1922	April	1988
11 May	1925	August	1990
27 May	1925	June	1991
April	1927	8 August	1998
January	1934	19 August	1998
February	1934	October	1999
September	1938	November	2000

Note: Data prior to 1980 were obtained from the *Lower Shoalhaven River Flood History at Nowra Bridge 1860-1980*.

The local newspaper, the "Shoalhaven News", was produced in Terara (the main settlement at the time) in the period 1860-1873 and a good description is available of the eight major floods which occurred in that time. The flood of April 1870 was probably greater than a 1% AEP event. It inundated the Terara township by over a metre and swept away approximately one third of the village. Five lives were lost in rural areas along the Shoalhaven River.

> *".....The spot where once stood the post office, the telegraph office, the steam company's store and wharf, where all was life, business and activity, is now one vast vacant blanket and forms part of the Shoalhaven River. The streets turned into innumerable fullies, sand banks and creeks, fences were washed away and the whole formation of the town completely destroyed....."* Quotation taken from Shoalhaven - History of the Shire of Shoalhaven by W A Bailey.

According to some accounts, the earlier 1860 flood was even more devastating and carried away over 50 buildings. Several lives were lost as well as some 79 acres (32 hectares) of land.

A major feature of both these floods was erosion of the river bank. Historical plans indicate the bank may have migrated south by up to 400 m. None of the floods since 1870 have matched these two events for destruction of property or loss of land.

More recent significant floods occurred in August 1974, June 1975, October 1976 and March 1978.

Flood levels have been recorded at Nowra Bridge since approximately 1960, however, despite a rigorous investigation of all available data, the peak level of many historical events are not precisely known. A series of nine automatic water level recorders have now been installed along the river and all future events should be accurately recorded.

Table 2 lists the known or estimated heights of the major historical events and compares them with the design flood levels derived in the April 1990 Flood Study (Reference 1).

1.1.1 The Floodplain Risk Management Process

The floodplain risk management process provides for the investigation, analysis and management of flood prone lands. For the Lower Shoalhaven River, the process involved:

- *Lower Shoalhaven River Flood Study* (Reference 1). This included a detailed investigation of historic and design flood events, and the nature of flooding in the Lower Shoalhaven River floodplain.
- *Lower Shoalhaven River Floodplain Risk Management Study* (Reference 2), involved an analysis of the nature of flooding and the flood hazard categorisation for the Lower Shoalhaven River 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 plan 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.

1.2 Design Flood Events

The Lower Shoalhaven River Flood Study determined the design flood behaviour for the 1%, 2% and 5% AEP floods and an Extreme flood event. The Floodplain Risk Management Study then established, using the same models and procedures, the peak design levels for the 0.2%, 0.5% and 10% AEP design floods.

A summary of adopted design flood levels for selected locations are shown in Table 2.

Table 2: Peak Levels of Major Floods (mAHD)

	Historical Events				Design Events				
	1860	**1870**	**1974**	**1978**	**5%**	**2%**	**1%**	**0.5%**	**Extreme**
Nowra Bridge	5.5	6.55	4.9*	5.3*	5.3	5.8	6.3	6.8	8.9
Shoalhaven River at Terara	4.8	5.7	4.4*	4.7*	4.8	5.1	5.5	5.8	7.4
Numbaa	U	U	U	3.7#	3.3	3.6	4.1	4.4	6
Shoalhaven Heads (Wharf Rd)	U	U	U	U	2.7	2.9	3.3	3.6	4.2
Greenwell Point	U	U	1.65#	U	2.4	2.9	3.4	3.7	5.2
Orient Point	U	U	U	U	2.2	2.6	3	3.3	4.7
Estimated AEP at Nowra Bridge	3%	0.7%	8%	5%					
Estimated Average Recurrence Interval (ARI) at Nowra Bridge	30 years	150 years	12 years	20 years					

NOTES:
- * Recorded level taken from the Lower Shoalhaven River Flood History at Nowra Bridge 1860-1980.
- E The levels for the 1860 and 1870 floods at Nowra Bridge and in the Shoalhaven River at Terara are estimated as no actual levels were recorded. The levels shown are based on other historical flood data taken from the Lower Shoalhaven River Flood History at Nowra Bridge 1860-1980.
- U Unknown
- # Recorded level in Shoalhaven River Flood Study Compendium of Data

It should be noted that the design flows were determined using a rainfall-runoff routing approach, as opposed to a statistical frequency analysis of historical flood records. Therefore, any change in the estimates of the 1860 and 1870 flood levels at Nowra Bridge, or elsewhere, will not alter the design flood results.

The best means of improving the accuracy of the adopted design flood data is by collecting better flood data from future flood events. For this reason a post flood evaluation and review program should be undertaken following each flood and a possible program has been developed and included in Reference 2.

1.3 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 Lower Shoalhaven River floodplain was determined to comprise of five hazard classifications based on the above factors and the hydraulic classification. The Lower Shoalhaven Floodplain River 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.
- **High hazard flood fringe** - these areas comprise the beach and back dune areas. During a large flood it is possible that floodwaters will overtop these areas and the area becomes a Floodway. These areas can also be affected by wave runup action from the ocean.
- **Low hazard flood storage** - as for high hazard flood storage except depths and velocities tend to be less.
- **Low hazard flood fringe** - **High hazard flood fringe** - these areas comprise the beach and back dune areas. During a large flood it is possible that floodwaters will overtop these areas and the area may become a Floodway. These areas can also be affected by wave runup action from the ocean.

Broadly speaking the high hazard floodway areas of the floodplain include the main Shoalhaven River channel from Nowra to the entrance, the Crookhaven River from Culburra Road to the entrance, Berry's Canal and the land to the east including the low areas of Comerong Island and the residential area of Greenwell Point from Greens Road in the west and South Street in the north through to the waterway. Hay Avenue, Shoalhaven Heads, is also classified as high hazard floodway because it is very low lying and adjacent to the river. The remaining portions of the floodplain, which include the Broughton Creek catchment, and the swampy catchment of Crookhaven River are classified high hazard flood storage, with the outer edges being low

hazard fringe. Figure 2 presents the flood hazard classification for the overall Lower Shoalhaven River floodplain.

1.4 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 shown in Table 4. 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: Buildings Inundated

Area	Flood Events				
	Extreme	**1% AEP**	**2% AEP**	**5% AEP**	**10% AEP**
Nowra	104	34	12	5	3
Riverview Road area	117	7	2	nil	nil
Terara Village	55	44	13	1	nil
Bomaderry	77	33	27	24	11
Shoalhaven Heads	199	134	92	60	39
Greenwell Point	382	350	275	211	137
Orient Point/Crookhaven	207	132	90	64	27
TOTAL	**1141**	**734**	**511**	**365**	**217**

Note: The above assessment is based on the assumed modelling scenario (Flood Study design conditions) where the entrance at Shoalhaven Heads is closed at the start of the flood event and allowed to scour out progressively with the passage of floodwaters and surveyed floor level information gathered by Council in Jan/Feb 2001. The building is considered to be inundated if the design flood level is above the surveyed floor level for the property. At least one level is included at each caravan park.

The average annual tangible damages (AAD) for the Lower Shoalhaven River floodplain are estimated to be of the order of $1.8 million (year 2000 costs). This figure excludes the Riverview Road and Terara Village areas, damages to public property, much of the rural areas and intangible damages. The net present value of these damages (year 2000 costs) is around $25.4 million ($26.6 million including Riverview Road and Terara Village) assuming a 50 year design life at 7% discount rate.

Table 4: Estimated Flood Damages

Design Flood Frequency	Damages ($ million) (year 2000 costs)	
	Entrance Condition at Start of Flood	
	Closed	Open
Extreme	47.7 (63.0)	47.1
0.2%	41.8 (54.1)	37.5
0.5%	35.8 (41.1)	30.5
1% AEP	28.2 (30.1)	25.9
2% AEP	21.8 (22.4)	17.5
5% AEP	7.2 (7.3)	3.1
10% AEP	2.6 (2.7)	1.0
Average Annual	**1.8 (1.9)**	**1.2**

Note: ( ) bracketed values include damages for the Riverview Road and Terara Village areas which were considered in separate floodplain risk management studies.

In terms of the existing flood problem, the greatest concern is the number of buildings shown in Table 3 to be inundated above floor level. Some 137 buildings in Greenwell Point are potentially inundated in as little as a 10% AEP flood.

Photo 1: Nowra Bridge and Civic Centre Site - March 1978 Flood

Photo 2: Hay Avenue, Shoalhaven Heads - March 1978 Flood

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 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, any recommended works would have little impact on "main stream" flood behaviour. For this reason, under the terms of the State Government Funding program administered by the Department of Natural Resources, only works or measures which address problems associated with the broader mainstream flooding problems are eligible for subsidised funding as part of this Plan. Local drainage works are Council's responsibility.

RECOMMENDATIONS

Recommended drainage works were raised 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 Urban Stormwater Management Plan estimated a total cost to Council of $2.9 million for the proposed measures. This money would be spent over the 5 year period of implementation (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 caused.

ACTIONS

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

2.2 Levees

DISCUSSION

The benefits of levees in floodplain management have long been recognised for the protection of large areas of existing flood liable development. However, in recent years a number of disbenefits have also become clear.

They are expensive (the Riverview Road levee cost approximately $600/m length in 1986), and can be intrusive (aesthetically displeasing) for riverside residents. There is also the concern that they may exacerbate river bank erosion or collapse. It is also important to ensure that adequate internal drainage can be provided so that the protected area is not flooded by the ponding of local (internal) runoff.

Unless a levee is built to prevent inundation in the largest possible event (termed the Probable Maximum Flood or PMF), which would generally be unacceptable economically and socially, it will eventually be overtopped in a very large event. When this happens, initial velocities will be high and substantial damage will occur. Failure of the levee may also occur during a flood event, prior to overtopping. The situation will probably be exacerbated by the fact that the levee has engendered a false sense of security in the local population and substantially lowered flood awareness. This was the case at Nyngan in 1990.

Construction of a levee may also lead to a push to alter Council's Flood Policy and allow further development of low lying flood liable areas. Previous reports on flooding at Riverview Road considered that levees should only be used to protect existing dwellings and should not be promoted to facilitate further development on the floodplain.

The inundation of floodplains by floodwaters is a naturally occurring phenomenon and limiting this feature may result in a reduction in the environmental quality of the area. For this reason major levees along the banks of the Shoalhaven River are not supported.

However, small local levees to protect isolated communities have been considered. The two main areas are at Shoalhaven Heads and at Greenwell Point. The main problem with these local levees are:

- relatively high cost to fully protect the number of properties affected,
- the size of the levees (length, height and width) would need to be considerable and could be difficult to accommodate in many locations due to existing physical constraints,
- they are visually obtrusive and not supported by many residents, particularly those who "see" the levee but are afforded no real benefit (such as a new house at a high level or a two storey house without habitable areas at ground level),
- levees can and do fail during a flood. They can also be overtopped in floods larger than the design event,

- local drainage behind the levee can be a major issue. This can be addressed through the use of flap gated culverts but will generally always have some residual problems,
- vehicle access across the levee can present practical major problems.

At Shoalhaven Heads, the properties most at risk are located at Hay Avenue and within the backwater area of the unnamed creek (sometimes referred to as Zealands Creek) along Jerry Bailey Road. Protection of the Hay Avenue and Jerry Bailey Road properties would involve construction of two levees through private property, one along the main river bank and the other at the rear of the Jerry Bailey Road properties. This would present a number of social, aesthetic and practical problems and is not considered a viable solution for these properties.

The protection of most flood affected properties at Greenwell Point would require the construction of nearly 4.5 km of levees (refer Figure 3). Some 2.5 km of this would need to be positioned along the foreshore areas through a combination of reserves and private property. Construction costs alone (excluding design, property acquisition, internal drainage, etc.) are likely to well exceed $3 million and probably closer to $4 or $5 million. The net present worth of the reduction in flood damages (assuming 1% AEP protection and 50 year design life at 7% discount rate) could be of the order of $8 million which would infer a B/C ratio of around 2.6. Providing a smaller levee, affording protection in a 10% AEP event, could still achieve a $4 to $5 million NPW reduction in damages with a B/C closer to 1.0. Thus from a purely economic perspective, some form of levee protection would be considered a viable measure for Greenwell Point.

However, there are a number of significant other issues which are likely to influence the ultimate decision of whether this measure could be implemented. In particular, the levee alignment is dependent on obtaining suitable space and/or access rights around the foreshore (through reserves and private property). Geotechnical ground conditions, environmental, social and aesthetic issues are also of concern as the structure would significantly alter the amenity of the foreshore outlook and access to both properties and the surrounding waterways would be adversely affected. The levee would also create internal drainage issues and hydraulic impacts for the floodplain areas immediately upstream.

Further detailed investigation of this measure may develop or identify alternative options (refer Figure 3 for alternative alignment possibilities) to overcome some of these concerns while still achieving sufficient benefits. This may also however create other issues such as the isolation of some properties which then cannot be protected (particularly those along the foreshore areas).

RECOMMENDATIONS

Levees are a potential means of reducing the flood hazard for existing development and have been considered at Shoalhaven Heads and at Greenwell Point. In both situations there are a number of issues which limit their feasibility or viability as a practical means for addressing the nature of the flood problems experienced in these areas. Some form of possible levee protection at Shoalhaven Heads is not considered to be viable or practical. However, further investigation of the possible levee solutions available for Greenwell Point is warranted.

Levees are also considered to be economically, socially and environmentally unacceptable as a means of protecting future development from the risks of flooding.

ACTIONS

F2: Investigate feasibility of Greenwell Point levees.

2.3 Management of the Shoalhaven Heads Entrance

DISCUSSION

The opening of the Shoalhaven River entrance during floods is a major issue for all floodplain residents and in particular those at Shoalhaven Heads. Council has developed a Shoalhaven River Entrance Management Plan for Flood Mitigation (EMPFM) which has subsequently been reviewed as part of the Floodplain Risk Management Study.

The EMPFM provides a balance between environmental and flooding concerns and is intended to provide an ecologically sustainable solution to a problem that has developed from Alexander Berry's original channel works in 1822.

RECOMMENDATIONS

Council's EMPFM must be finalised, implemented and accurately monitored to ensure that it is working successfully. The Plan must be reviewed every two years or after every opening. It is essential that this work be done immediately after each opening to ensure that all available data are collected and analysed.

ACTIONS

F3: Finalise and implement Council's Shoalhaven River Entrance Management Plan for Flood Mitigation. The Plan must be reviewed every two years or immediately after every opening.

2.4 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 16 properties (Table 5) which are inundated in the 10% AEP event.

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
Greenwell Point	42	Adelaide Street	1.58	1.04	0.44	0.98	1.54	2.08
Bomaderry	22	Bolong Road	3.60	3.64	1.00	0.96	2.38	2.34
Orient Point	41#	Prince Edward Ave	3.47	1.03	-1.53	0.91	-0.27	2.17
Greenwell Point	11	Adelaide Street	1.19	1.63	0.83	0.39	1.93	1.49
Greenwell Point	7	Adelaide Street	1.30	1.64	0.72	0.38	1.82	1.48
Greenwell Point	59	Adelaide Street	1.46	1.64	0.56	0.38	1.66	1.48
Greenwell Point	59	Haiser Road	1.39	1.58	0.55	0.36	1.81	1.62
Greenwell Point	2	Keith Avenue	1.49	1.59	0.45	0.35	1.71	1.61
Bomaderry	64	Bolong Road	3.48	4.27	1.13	0.34	2.61	1.82
Greenwell Point	1	Church Street	1.68	1.73	0.34	0.29	1.44	1.39
Greenwell Point	76	Greens Road	1.36	1.66	0.58	0.28	1.84	1.54
Orient Point	3	Raglan Street	1.64	1.66	0.30	0.28	1.56	1.54
Greenwell Point	3	Adelaide Street	1.25	1.74	0.77	0.28	1.87	1.38
Greenwell Point	70	Greens Road	1.37	1.67	0.57	0.27	1.83	1.53
Greenwell Point	68	Greens Road	1.44	1.68	0.50	0.26	1.76	1.52
Greenwell Point	9	Adelaide Street	1.19	1.76	0.83	0.26	1.93	1.36

Note: # House located downhill from land where ground level measured.

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 (AAD) would be around $1.25 million (year 2000 costs). The cost of the measure would be up to $640,000 (assuming $40,000 per building). The Nett Present Value of the reduction in AAD would be of the order of $955,000 giving a B/C ratio in the order of 2.0.

RECOMMENDATIONS

House raising is a viable means 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 16 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.

2.5 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 (such as may be found at Bomaderry) 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 Lower Shoalhaven River Floodplain Risk Management Study questionnaire this measure was acceptable to approximately 9% 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 may still be necessary which could pose some hazard or risk.

For a house the cost is typically of the order of $10,000 (year 2000 costs). 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 Bomaderry.

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 affected commercial developments.

2.6 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.

2.6.1 Council's Flood Policy

DISCUSSION

Previously the Interim Flood Policy defined Council's objectives with regard to flooding issues, the land to which the policy applied, 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 was subsequently superseded in 2006 by a specific DCP for Floodplain Management (DCP No. 106). DCP No. 106 only applies to areas for which a Floodplain Risk Management Plan has been prepared. For all other areas Council's Flood Policy applies.

This Policy needs to include the findings from the Lower Shoalhaven River 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. The previous Interim Policy only mentioned residential, commercial and industrial developments.

RECOMMENDATIONS

Amongst many other things, the local Flood Policy needs to set standards for controlling development within the floodplain so as to minimise damage to property whilst also ensuring minimal affect 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 FMM 2001 - Reference 4. This version has been superceded by the April 2005 Floodplain Development Manual). As part of this process DCP No. 106 which deals with flood related development controls will be refined. 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.

The cost of this option is likely to be in the order of $20,000 (year 2008 costs) but the benefits will apply to both existing and future development which makes it more sustainable.

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: Review and update Council's Flood Policy

2.6.2 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. In the Lower Shoalhaven River Flood Study two design entrance conditions (open or closed) at Shoalhaven Heads were evaluated. The closed condition was adopted for design and should be used for setting all FPLs throughout the Lower Shoalhaven River floodplain. This is consistent with the approach adopted in Council's Entrance Management Plan for Flood Mitigation (2006). 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 the overall Lower Shoalhaven River 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. The adoption of such a level is also in accordance with accepted standards which have been implemented in similar situations throughout NSW.

ACTIONS

P4: Adopt appropriate Flood Planning Level of 1% AEP plus freeboard assuming the entrance closed condition consistent with Council's Entrance Management Plan.

P5: Adopt consistent freeboard of 0.5 m.

Climate Change

DISCUSSION

A possible consequence of Climate Change 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 global sea level is likely to occur with a rise of perhaps between 0.18 m to 0.79 m over the next 80 years (Reference 5). Along the NSW coast, taking into account ice flow melt, the rise may be up to 0.91 m.

Climate Change may affect design flood levels in the Lower Shoalhaven River, however, preliminary investigations have indicated that the potential impact for this study area will be minor.

Of more significance will be the impact on the erosional and sedimentation regime at Shoalhaven Heads. Climate Change may vary the frequency and periods of entrance openings 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 Climate Change implications with respect to Council's Flood Policy as appropriate.

ACTIONS

P6: Monitor potential flooding implications of climate change.

2.6.3 Setback for Foreshore Development

DISCUSSION

Currently, Shoalhaven City Council do not specify a minimum setback from the banks of watercourses. The results from the December 2000 Lower Shoalhaven River Floodplain Risk Management Study questionnaire indicated localised erosion and collapse of waterway banks was an issue for some residents, specifically around Greenwell Point.

RECOMMENDATIONS

A minimum setback should be applied to new development on the foreshore and tributary creeks of the Shoalhaven and Crookhaven Rivers 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.

ACTIONS

P7: Apply minimum set back requirements for foreshore developments.

2.6.4 Filling on the Floodplain

DISCUSSION

Filling of flood prone land is generally 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 an appropriate hydraulic investigation includes both local and mainstream impacts,
- ensuring future subdivisions of flood prone land 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 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.

RECOMMENDATIONS

Council's flood policy should include development controls for limiting the extent of filled land 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.

2.6.5 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 purchases, 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. 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 Lower Shoalhaven Floodplain River 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: Review and update Section 149 Certificates.

P10: 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 estimated flood level and planning/development controls or restrictions which may apply.

2.6.6 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 also 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.

The revised LEP must resolve those areas presently under a deferred zoning. Most notably this would include the Hay Avenue area where there has been several applications for further development.

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 Lower Shoalhaven River floodplain as part of the Risk Management Study.

The proposed development requirements discussed herein, FPLs, freeboard, setback, filing of floodplain and greenhouse effects 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 Lower Shoalhaven River floodplain.

The presently deferred zoning at Hay Avenue suggests that some 20 additional lots could be developed. If approved this would increase the density of development in a high hazard floodway and would appear to be contrary to the objectives of the NSW Government's flood prone lands policy. It is recommended that a restricted development zoning be applied which would prevent further subdivision and ensure development is compatible with Council's DCP No. 106.

ACTIONS

P12: Review and update Local Environmental Plan

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

2.6.7 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 Lower Shoalhaven River floodplain study area there are some 14 caravan parks. The hazard varies for each caravan park because they are scattered throughout the floodplain. The most vulnerable parks for the 10% AEP flood event and their hazard classification are shown in Table 6.

Table 6: Hazard Classification of Worst Affected Caravan Parks

Caravan Park	Hazard
Shoalhaven Heads Tourist Park	High Hazard flood fringe
Anglers Rest	High Hazard flood storage
Coral Tree Lodge	High Hazard floodway
Jans Caravan Park	Low Hazard flood fringe
Pine Van Park	High Hazard flood storage
Shoalhaven Ski Park	not applicable
Tall Timbers Caravan Park	Low Hazard flood fringe
Mountain View Village	Low Hazard flood fringe
Camelia Caravan Park	Low Hazard flood fringe

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 are responsible for implementing development controls on a park by park basis. The table presented in Appendix B summarises the 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 and the development controls outlined in Appendix B provide suitable guidelines to minimise damages for caravan park developments but only if they are rigidly enforced.

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,

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

P16: Enforce development guidelines for caravan parks for both existing and future development.

2.6.8 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.) The total cost for consulting fees, further analysis and the Local Environmental Plan and DCP update process is likely to be in the order of $100,000. These measures should be given a high priority because of the ever increasing development pressures on land on the foreshore, specifically at Shoalhaven Heads and Greenwell Point.

2.7 Flood Warning

DISCUSSION

An ALERT system (Automated Local Evaluation in Real Time) has been operated in the catchment by Shoalhaven City Council and the BOM since 1989. It cost $120 000 at the time to install which was shared between the two authorities. It consists of fifteen (15) rainfall and eight (8) stream sensor stations and a number of repeater stations. The system has not been tested in a large flood but has performed successfully in smaller events which occurred in the 1990's. Some operational problems (radio interference, battery life, software problems) have occurred but these have now been addressed.

Although Council monitors the situation during flood events, the responsibility for issuing flood warnings rests with the BOM and at a local level the SES. Council does not issue warnings. Council's role during floods is to assist the SES with regards to road closures and evacuations. Council uses the 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 but is currently investigating this matter. If Council had its own forecasting model it would provide additional benefits such as:

- it would act as a fall back 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 interim actions to protect its assets based upon its own forecasting rather than waiting for the official BOM warning,
- decisions regarding the conditions at the Shoalhaven Heads entrance and whether to assist with its opening can be made.

The main improvement that could be made to the existing system is the use of computer based models to generate real time flow estimates and (ultimately) flood levels. Access to better flood event information over the internet will increase the community's awareness during and after the event. The availability of better flood warning information rated the second highest preferred floodplain management measure in the responses to the December 2000 questionnaire.

Gauging stations at the Shoalhaven and Crookhaven River entrances to monitor prevailing ocean conditions, wind direction and water levels would assist in managing the Shoalhaven River entrance issue during flood events. Additionally, upgrading of the existing flood level recorders (located at the various floodgate structures controlling the swamp drains) to more modern telemetered gauges would provide much needed additional information on water levels across the broader floodplain areas. This would also give the SES a better idea on the status of certain evacuation routes servicing the rural properties situated in the broader floodplain. The cost of this measure would be in the order of $5,000 to $10,000 (year 2000 costs) for each

gauge established and say $10,000 to $20,000 to develop a system which provides better access to flood event information for the general community.

RECOMMENDATIONS

The ALERT system is a suitable approach for providing flood warning advice for the Shoalhaven River. The system should be continually monitored and upgraded as required. More sophisticated computer modelling, installation of gauges and rectification of the minor existing system problems are the main limitations of the present system. Additional telemetered gauges are recommended for installation at the Shoalhaven and Crookhaven River entrances as well as the existing floodgate structures located across the floodplain. 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 and implementation.

ACTIONS

R1: Install additional telemetered water level gauges. Collect and analyse data.

R2: Improve public access to flood warning information.

2.8 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). Subsequently this was updated in February 2004. 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 Council 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 Lower Shoalhaven River Floodplain Risk Management Study. A workshop should be held to update the SES, Police, banks, buildings societies and other authorities to ensure that all appropriate 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 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 in Section 2.10.

ACTIONS

R3: Review and update Local Flood Plan based on latest available information.

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

2.9 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 Lower Shoalhaven River floodplain there are two main areas where access will be a problem during times of flood. One area incorporates the settlement of Greenwell Point and the other is Hay Avenue, Shoalhaven Heads.

Discussions with the SES indicate that there are no obvious roads that require immediate attention. There are a number of issues to be considered in raising roads including:

- the relatively high cost,
- the level they should be raised to. How much benefit is provided?
- whether the raising of the road causes an unacceptable hydraulic impact,
- the entire evacuation route needs to be raised to a minimum serviceability level for properties upstream from the affected area to high ground. If there are remaining "low spots" the work is of little benefit and may lead people into trying to evacuate themselves and putting their lives at risk.

Within the Lower Shoalhaven River floodplain there are several situations where access may present a significant problem during times of flood. These areas incorporate the settlement of Greenwell Point, Comerong, Pig and Numbaa Islands and to a lesser extent Shoalhaven Heads, Orient Point and Culburra.

Recent survey of Greenwell Point Road indicates the road is cut by floodwaters in events less than a 10% AEP event. The stage hydrograph for the 10% AEP flood event (included in Appendix H as Figure H4 of Reference 2) shows that at the point Greenwell Point Road is cut (approximately RL 1.5 mAHD - Brundee) properties in Greenwell Point are also becoming inundated.

At Greenwell Point there is only one road (Greenwell Point Road) leading in to the settlement. The road is relatively flat and low lying with approximately 5.7km below RL 2.0 mAHD and is readily inundated in small or frequent flood events. Access for the entire township is therefore significantly restricted and likely to be lost early in the larger events.

There is little opportunity to raise Greenwell Point Road for its entire length (some 8.5 km) because it crosses the main floodplain and therefore has the potential to dam water and change the nature of flooding in the local area. Significant waterway provisions would need to be incorporated to allow floodwaters to pass through to the downstream areas and thus minimise potential impacts for upstream properties. While this approach would not solve all the problems for the flood affected township it would increase the time available for evacuation. The cost of raising the full length of road is likely to be well in excess of $8.5 million (assuming a unit rate of up to $1,000/m (year 2000 costs) to account for waterway provisions and problems with services and property access) and would therefore not be cost effective.

Instead, it may be more feasible to address any localised weak spots ("low points") in the route to ensure a consistent minimum level of serviceability/trafficability is attained. As a significant number of the Greenwell Point properties are flood affected in as little as the 10% AEP event, the benefits of providing any greater level of serviceability would quickly diminish (almost negligible) as opposed to the increase in costs. A road centreline survey indicated that if the low points along the road were raised to RL 1.9 mAHD, and additional waterway crossings installed then the depth of inundation during a 10% AEP flood event would be of the order of 200 mm or less. Since velocities in the area are generally low or close to zero the hydraulic hazard would also be very low and conventional velocities should still be able to drive to higher ground. It is estimated approximately 4.1km needs to be raised by up to 400 mm to achieve a minimum level of RL 1.9 mAHD (refer to Figure 4). The potential to create adverse hydraulic impacts is reduced as the extent and level of roadworks is also minimised. Further detailed investigation of this issue is required to fully identify the optimum level of serviceability along with the associated extent and cost of works.

With regard to the evacuation access for the different "Island" settlements (Comerong, Numbaa and Pig) the critical issue is the loss of ferry services with rising water levels early in an event. The increase in river currents (velocities) also presents a problem which can make boat evacuation quite dangerous. From a physical works point of view, there is little which can be done to improve this situation due to the various constraints which exist. The simplest solution would be to ensure people are evacuated before access is lost but as this would need to occur at relatively low river levels it would often result in needless (false alarm) evacuations.

Hay Avenue is a high hazard floodway area because it is low lying and because of its proximity to the Shoalhaven River. There is potential to raise the roadway in an effort to increase evacuation time for residents. However, the costs for raising the road far outweigh the benefits since the road raising will not protect property and there is considerable lead time before evacuation of the area is required.

RECOMMENDATIONS

Further investigations should be undertaken to determine the benefits and costs of raising 4.1km of Greenwell Point Road. Appropriate waterway provisions (at locations corresponding to existing waterways) should be incorporated to allow the passage of floodwaters and minimise upstream impacts.

ACTIONS

R5: Investigate raising of Greenwell Point Road.

2.10 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 Lower Shoalhaven River 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 worst affected areas of Shoalhaven Heads and Greenwell Point are popular holiday destinations the flood education program will also have to consider the transient population and those property owners who live outside the floodplain.

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 flood (1978) 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 7. 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

R6: Develop and implement a flood education program.

Table 7: 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 event (1978) 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.
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.
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.

Method	Comment
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.

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) in the Summary presents an outline of the management measures proposed for implementation as part of the Lower Shoalhaven River 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 Lower Shoalhaven River 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 Lower Shoalhaven River floodplain.

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5. REFERENCES

1. Public Works Department
Lower Shoalhaven River Flood Study
Webb, McKeown & Associates Pty Ltd, April 1990.

2. Shoalhaven City Council
Lower Shoalhaven River Floodplain Risk Management Study
Webb, McKeown & Associates Pty. Ltd., May 2008.

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 1 to the 4th Assessment Report of the Intergovernmental Panel on Climate Change
Climate Change 2007: The Physical Science Basis. Summary of Policy Makers.
February 2007.

6. **NSW State Flood Plan**
April 2001.

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FIGURES

FIGURE 1

LOWER SHOALHAVEN RIVER FLOODPLAIN
LOCALITY MAP AND STUDY AREA

PRINCES HIGHWAY
BROUGHTON CREEK
COOLANGATTA RD
GERROA RD
ZEALANDS CREEK
Bomaderry
Shoalhaven Heads
BOLONG RD
SHOALHAVEN
PIG ISLAND
NUMBAA ISLAND
COMERONG ISLAND ROAD
BEVAN ISLAND
RIVERVIEW RD
Terara
RIVER
OLD MAN ISLAND
NOWRA CREEK
Nowra
CROOKHAVEN CREEK
COMERONG ISLAND
Worrigee Swamp
GREENWELL POINT ROAD
YALWAL RD
BERRYS
CANAL
ALBATROSS RD
GREENWELL POINT ROAD
Greenwell Point
Orient
Point
CURLEYS
BAY
CROOKHAVEN RIVER
CURRAWONG RD
Culburra

LEGEND:

0.5 0 0.5 1 1.5 2 2.5 km

SCALE

N

FIGURE 2

HYDRAULIC & HAZARD CATEGORISATION
LOWER SHOALHAVEN RIVER FLOODPLAIN

PRINCES HIGHWAY
BROUGHTON CREEK
COOLANGATTA RD
Bomaderry
Note: Insufficient data available to properly define localised High Hazard Floodway areas which exist in the overbank areas.
Shoalhaven Heads
SHOALHAVEN
NUMBAA ISLAND
PIG ISLAND
COMERONG ISLAND ROAD
Terara
RIVER
Nowra
CROOKHAVEN CREEK
Worrigee Swamp
COMERONG ISLAND
GREENWELL POINT ROAD
YALWAL RD
BERRYS
CANAL
Note: Insufficient data available to properly define localised High Hazard Floodway areas which exist in the overbank areas.
Orient Point
Greenwell Point
CURLEYS BAY
ALBATROSS RD
PRINCES HIGHWAY
CROOKHAVEN RIVER
CURRAMONG RD
PENGUIN HEAD
Culburra
CULBURRA ROAD

N

LEGEND:

- High Hazard Floodway
- High Hazard Flood Storage
- High Hazard Flood Fringe
- Low Hazard Flood Storage
- Low Hazard Flood Fringe
- Refer Riverview Road Area Floodplain Management Plan
- Refer Terara Village Floodplain Management Plan
- Approx. Extreme Flood Extent defining limit of flood prone lands
- Detailed Survey Not Available

Note: Refer to Section 1.3 for definition of hydraulic and hazard categories.

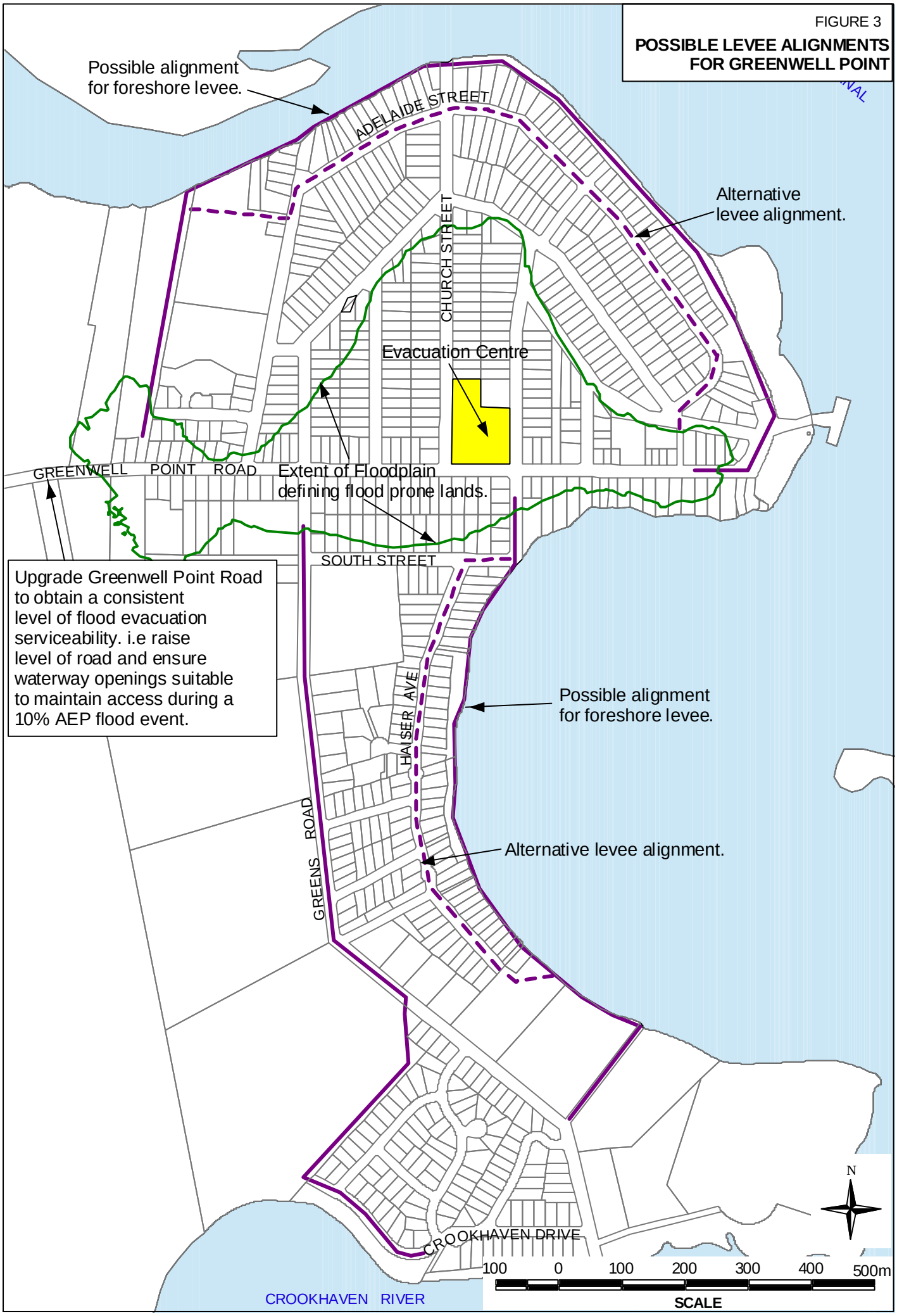
Note: Mapping based on available topographic contour information. Hydraulic and Hazard Categorisations could vary depending on actual surveyed ground levels (particularly around fringe areas).
Categorisations and mapping extent based on Flood Planning Level (1% AEP flood + 0.5m freeboard)

0.5 0 0.5 1 1.5 2 2.5 km

SCALE

FIGURE 3

POSSIBLE LEVEE ALIGNMENTS FOR GREENWELL POINT



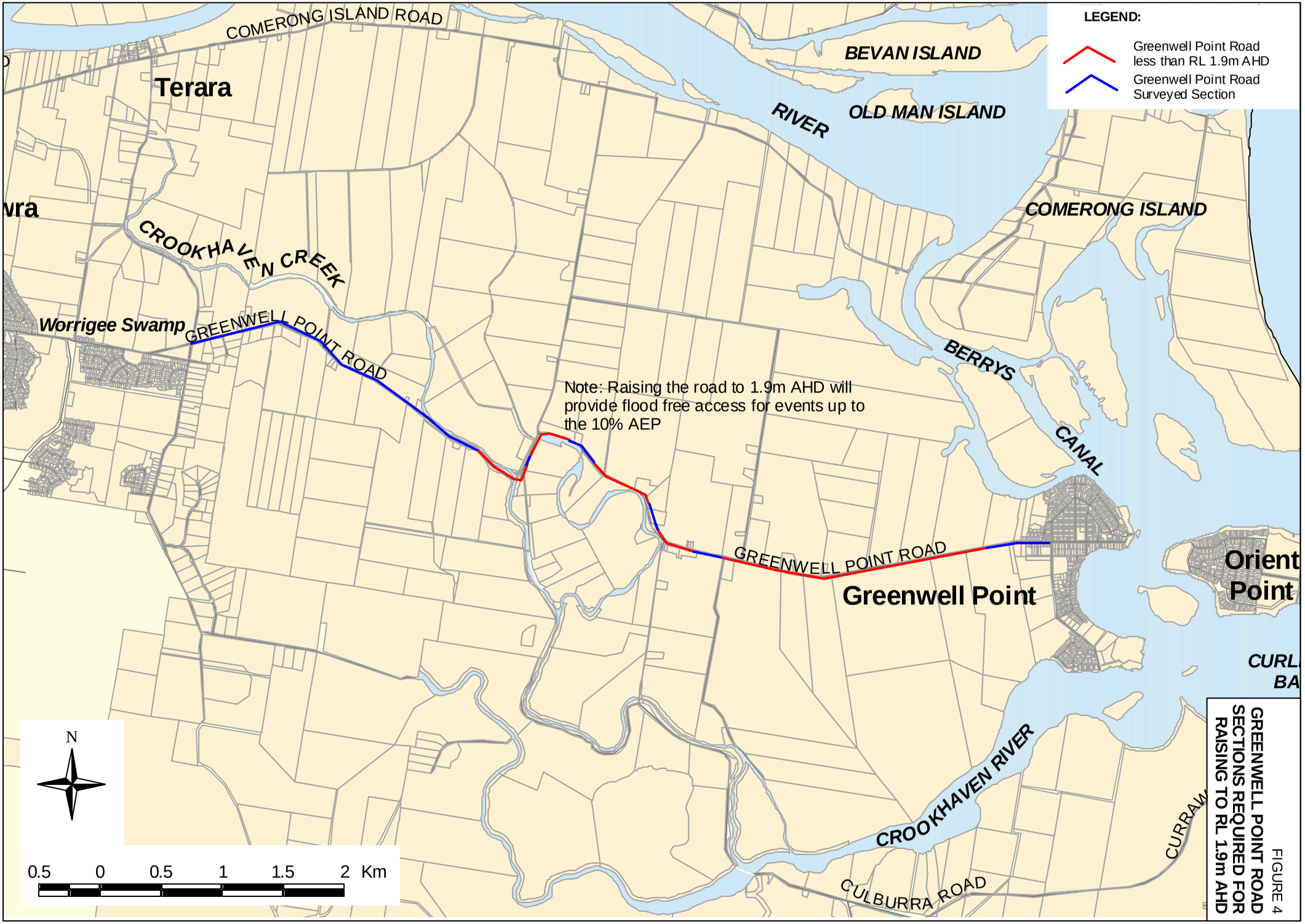


FIGURE 4
GREENWELL POINT ROAD SECTIONS REQUIRED FOR RAISING TO RL 1.9m AHD

APPENDIX A: FLOOD RELATED DEVELOPMENT CONTROLS - GENERAL DEVELOPMENT

Table A1: Graded Development Controls for Flood Prone Areas - 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

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