Shoalhaven City Council

ST GEORGES BASIN

FLOODPLAIN RISK MANAGEMENT STUDY

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NEXUS ENVIRONMENTAL PLANNING PTY LTD

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SHOALHAVEN CITY COUNCIL

ST GEORGES BASIN
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ST GEORGES BASIN
FLOODPLAIN RISK MANAGEMENT STUDY

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FOREWORD

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

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

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

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

The St Georges Basin Floodplain Risk Management Study constitutes the fourth stage of the risk management process. This study has been prepared by Webb, McKeown & Associates for Shoalhaven City Council and provides the basis for the future management of flood prone lands within the St Georges Basin Floodplain. This study was commenced in 2000. Subsequently there has been a number of changes to policies. A summary of the key changes are provided in Appendix H.

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SUMMARY

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

This Floodplain Risk Management Study examines flooding issues relating to the floodplain area associated with the St Georges Basin (Figure 1).

The study was initiated by Shoalhaven City Council to address the management of the flood problem of the St Georges Basin floodplain area. The primary objectives of the Study were to define the nature and extent of the hazard; to identify, assess and optimise measures aimed at reducing the impact of flooding on both existing and future development; and to make recommendations for the future management of the study area.

This Floodplain Risk Management Study builds on the St Georges Basin Flood Study (completed in September 2001), which defines design flood levels within the floodplain. Once the Management Study is completed and a preferred scheme adopted, an overall Floodplain Risk Management Plan can be prepared.

THE EXISTING FLOOD PROBLEM

A number of historical flood events have been reported to have occurred within the St Georges Basin floodplain. In recent times the most significant events occurred in 1959, 1971 and 1991 with several smaller events in the mid 1970's and 1992, 1993 and 1994. Flooding can result from a combination of mechanisms which include catchment runoff, high ocean conditions, and/or wind waves.

A detailed survey of ground and floor levels for properties situated within the floodplain was obtained by Council for the purposes of this study. The availability of this property information in conjunction with the design flood information established by the Flood Study (Reference 1) has enabled the potential flood liability of each property to be determined and an estimate of likely flood damages experienced by the floodplain to be quantified. A summary of the property affectation and estimated damages for the St Georges Basin Floodplain is presented in Table (i).

Table i): Summary of Damages to Property

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

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

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

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

The average annual damages are estimated to be $660,000. The net present value of these damages is around $9 million assuming a 50 year design life at 7% discount rate.

STUDY AREA ISSUES

A range of issues relating to the St Georges Basin Floodplain have been raised at Council/committee meetings, by the community as part of the consultation process, or were outlined in the original study brief. These issues include:

- lack of appropriate flood warning,
- review Council's Interim Flood Policy,
- review Local SES Flood Plan,
- urban expansion areas - affect on downstream areas,
- impact of infill developments,
- assessment of development of Sussex Inlet,
- impact of wave set-up on foreshore areas,
- siltation of St Georges Basin and the Sussex Inlet channel,
- overgrown and silted tributary creeks,
- local overland flooding,
- lack of kerb and guttering in some areas,
- blocked drains,
- Sussex Inlet Channel,
- the Wool Road bypass,
- evacuation access and planning.

FLOODPLAIN RISK MANAGEMENT MEASURES

This floodplain risk management study process has 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 have been assessed against the following constraints:

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

Consideration of these constraints, together with discussions with the Floodplain Management Committee and assessment of the results from a Questionnaire Survey of floodplain occupiers (December 2000), have resulted in a selection of recommended risk management measures for implementation as part of the St Georges Basin Floodplain Risk Management Plan.

Table (ii) presents a summary of these management measures which have been grouped into the general categories of:

- **Flood Modification Measures:** measures which modify the flood's physical behaviour by undertaking structural works.
- **Property Modification Measures:** measures which modify the existing land use or building and development controls, for future development.
- **Response Modification Measures:** measures which are aimed at changing and enhancing the community's response to the potential hazards of flooding.

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Table ii): Summary of Proposed Floodplain Risk Management Measures

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

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

GLOSSARY

Taken from the 2001 Floodplain Management Manual

acid sulfate soils — Are sediments which contain sulfide mineral pyrite. These sediments may become extremely acid following disturbance or drainage as sulfur compounds react when exposed to oxygen to form sulfuric acid. More detailed explanation and definition can be found in the NSW Government Acid Sulfate Soil Manual prepared by the Acid Sulfate Soil Management Advisory Committee (ASSMAC).

Annual Exceedance Probability (AEP) — The chance of a flood of a given or larger size occurring in any one year, usually expressed as a percentage. For example, if a peak flood discharge of 500 m^3/s has an AEP of 5%, it means that there is a 5% chance (that is one-in-20 chance) of a peak flood discharge of 500 m^3/s or larger occurring in any one year (see average recurrence interval).

Australian Height Datum (AHD) — A common national surface level datum approximately corresponding to mean sea level.

Average Annual Damage (AAD) — Depending on its size (or severity), each flood will cause a different amount of flood damage to a flood prone area. AAD is the average damage per year that would occur in a nominated development situation from flooding over a very long period of time.

Average Recurrence Interval (ARI) — The long term average number of years between the occurrence of a flood as big as, or larger than, the selected event. For example, floods with a discharge as great as, or greater than, the 20 year ARI flood event will occur on average once every 20 years. ARI is another way of expressing the likelihood of occurrence of a flood event.

caravan and moveable home parks — Caravans and moveable dwellings are being increasingly used for long-term and permanent accommodation purposes. Standards relating to their siting, design, construction and management can be found in the Regulations under the Local Government Act, 1993.

catchment — The land area draining through the main stream, as well as tributary streams, to a particular site. It always relates to an area above a specific location.

consent authority — The council, government agency or person having the function to determine a development application for land use under the Environmental Planning and Assessment Act (EP&A Act). The consent authority is most often the council, however there are instances where legislation or an environmental planning instrument (EPI) specifies a Minister or public authority (other than a council), or the Director General of Planning NSW, as having the function to determine an application.

development — Is defined in Part 4 of the Environmental Planning and Assessment Act (EP&A Act).

infill development: refers to the development of vacant blocks of land that are generally surrounded by developed properties and is permissible under the current zoning of the land. Conditions such as minimum floor levels may be imposed on infill development.

new development: refers to development of a completely different nature to that associated with the former land use. For example, the urban subdivision of an area previously used for rural purposes. New developments involve rezoning and typically require major extensions of existing urban services, such as roads, water supply, sewerage and electric power.

redevelopment: refers to rebuilding in an area. For example, as urban areas age, it may become necessary to demolish and reconstruct buildings on a relatively large scale. Redevelopment generally does not require either rezoning or major extensions to urban services.

disaster plan (DISPLAN)	A step by step sequence of previously agreed roles, responsibilities, functions, actions and management arrangements for the conduct of a single or series of connected emergency operations, with the object of ensuring the coordinated response by all agencies having responsibilities and functions in emergencies.
discharge	The rate of flow of water measured in terms of volume per unit time, for example, cubic metres per second (m^3/s). Discharge is different from the speed or velocity of flow, which is a measure of how fast the water is moving for example, metres per second (m/s).
ecologically sustainable development (ESD)	Using, conserving and enhancing natural resources so that ecological processes, on which life depends, are maintained, and the total quality of life, now and in the future, can be maintained or increased. A more detailed definition is included in the Local Government Act 1993. The use of sustainability and sustainable in this manual are related to ESD.
effective warning time	The time available after receiving advice of an impending flood and before the floodwaters prevent appropriate flood response actions being undertaken. The effective warning time is typically used to move farm equipment, move stock, raise furniture, evacuate people and transport their possessions.
emergency management	A range of measures to manage risks to communities and the environment. In the flood context it may include measures to prevent, prepare for, respond to and recover from flooding.
flash flooding	Flooding which is sudden and unexpected. It is often caused by sudden local or nearby heavy rainfall. Often defined as flooding which peaks within six hours of the causative rain.
flood	Relatively high stream flow which overtops the natural or artificial banks in any part of a stream, river, estuary, lake or dam, and/or local overland flooding associated with major drainage before entering a watercourse, and/or coastal inundation resulting from super-elevated sea levels and/or waves overtopping coastline defences excluding tsunami.
flood education, awareness and readiness	**flood education** seeks to provide information to raise awareness of the flood problem so as to enable individuals to understand how to manage themselves an their property in response to flood warnings and in a flood event. It invokes a state of flood readiness. **flood awareness** is an appreciation of the likely effects of flooding and a knowledge of the relevant flood warning, response and evacuation procedures. **flood readiness** is an ability to react within the effective warning time.
flood fringe areas	The remaining area of flood prone land after floodway and flood storage areas have been defined.
flood liable land	Is synonymous with flood prone land (i.e. land susceptible to flooding by the probable maximum flood (PMF) event). Note that the term flood liable land now covers the whole of the floodplain, not just that part below the flood planning level, as indicated in the 1986 Floodplain Development Manual (see flood planning area).
flood mitigation standard	The average recurrence interval of the flood, selected as part of the floodplain risk management process that forms the basis for physical works to modify the impacts of flooding.
floodplain	Area of land which is subject to inundation by floods up to and including the probable maximum flood event, that is, flood prone land.
floodplain risk management options	The measures that might be feasible for the management of a particular area of the floodplain. Preparation of a floodplain risk management plan requires a detailed evaluation of floodplain risk management options.

floodplain risk management plan	A management plan developed in accordance with the principles and guidelines in this manual. Usually includes both written and diagrammetic information describing how particular areas of flood prone land are to be used and managed to achieve defined objectives.
flood plan (local)	A sub-plan of a disaster plan that deals specifically with flooding. They can exist at State, Division and local levels. Local flood plans are prepared under the leadership of the State Emergency Service.
flood planning area	The area of land below the flood planning level and thus subject to flood related development controls. The concept of flood planning area generally supersedes the "flood liable land" concept in the 1986 Floodplain Development Manual.
Flood Planning Levels (FPLs)	The combination of flood levels and freeboards selected for planning purposes, as determined in floodplain risk management studies and incorporated in floodplain risk management plans. The concept of flood planning levels supersedes the "standard flood event" of the first edition of this manual.
flood proofing	A combination of measures incorporated in the design, construction and alteration of individual buildings or structures subject to flooding, to reduce or eliminate flood damages.
flood prone land	Is land susceptible to flooding by the Probable Maximum Flood (PMF) event. Flood prone land is synonymous with flood liable land.
flood risk	Potential danger to personal safety and potential damage to property resulting from flooding. The degree of risk varies with circumstances across the full range of floods. Flood risk in this manual is divided into 3 types, existing, future and continuing risks. They are described below. **existing flood risk:** the risk a community is exposed to as a result of its location on the floodplain. **future flood risk:** the risk a community may be exposed to as a result of new development on the floodplain. **continuing flood risk:** the risk a community is exposed to after floodplain risk management measures have been implemented. For a town protected by levees, the continuing flood risk is the consequences of the levees being overtopped. For an area without any floodplain risk management measures, the continuing flood risk is simply the existence of its flood exposure.
flood storage areas	Those parts of the floodplain that are important for the temporary storage of floodwaters during the passage of a flood. The extent and behaviour of flood storage areas may change with flood severity, and loss of flood storage can increase the severity of flood impacts by reducing natural flood attenuation. Hence, it is necessary to investigate a range of flood sizes before defining flood storage areas.
floodway areas	Those areas of the floodplain where a significant discharge of water occurs during floods. They are often aligned with naturally defined channels. Floodways are areas that, even if only partially blocked, would cause a significant redistribution of flood flows, or a significant increase in flood levels.
freeboard	A factor of safety typically used in relation to the setting of floor levels, levee crest levels, etc. It is usually expressed as the difference in height between the adopted flood planning level and the flood used to determine the flood planning level. Freeboard provides a factor of safety to compensate for uncertainties in the estimation of flood levels across the floodplain, such as wave action, localised hydraulic behaviour and impacts that are specific event related, such as levee and embankment settlement, and other effects such as "greenhouse" and climate change. Freeboard is included in the flood planning level.

habitable room	**in a residential situation:** a living or working area, such as a lounge room, dining room, rumpus room, kitchen, bedroom or workroom. **in an industrial or commercial situation:** an area used for offices or to store valuable possessions susceptible to flood damage in the event of a flood.
hazard	A source of potential harm or a situation with a potential to cause loss. In relation to this manual the hazard is flooding which has the potential to cause damage to the community. Definitions of high and low hazard categories are provided in the Floodplain Management Manual.
hydraulics	Term given to the study of water flow in waterways; in particular, the evaluation of flow parameters such as water level and velocity.
hydrograph	A graph which shows how the discharge or stage/flood level at any particular location varies with time during a flood.
hydrology	Term given to the study of the rainfall and runoff process; in particular, the evaluation of peak flows, flow volumes and the derivation of hydrographs for a range of floods.
local overland flooding	Inundation by local runoff rather than overbank discharge from a stream, river, estuary, lake or dam.
local drainage	Are smaller scale problems in urban areas. They are outside the definition of major drainage in this glossary.
mainstream flooding	Inundation of normally dry land occurring when water overflows the natural or artificial banks of a stream, river, estuary, lake or dam.
major drainage	Councils have discretion in determining whether urban drainage problems are associated with major or local drainage. For the purpose of this manual major drainage involves: • the floodplains of original watercourses (which may now be piped, channelised or diverted), or sloping areas where overland flows develop along alternative paths once system capacity is exceeded; and/or • water depths generally in excess of 0.3 m (in the major system design storm as defined in the current version of Australian Rainfall and Runoff). These conditions may result in danger to personal safety and property damage to both premises and vehicles; and/or • major overland flow paths through developed areas outside of defined drainage reserves; and/or • the potential to affect a number of buildings along the major flow path.
mathematical/computer models	The mathematical representation of the physical processes involved in runoff generation and stream flow. These models are often run on computers due to the complexity of the mathematical relationships between runoff, stream flow and the distribution of flows across the floodplain.
merit approach	The merit approach weighs social, economic, ecological and cultural impacts of land use options for different flood prone areas together with flood damage, hazard and behaviour implications, and environmental protection and well being of the State's rivers and floodplains. The merit approach operates at two levels. At the strategic level it allows for the consideration of social, economic, ecological, cultural and flooding issues to determine strategies for the management of future flood risk which are formulated into Council plans, policy and EPIs. At a site specific level, it involves consideration of the best way of conditioning development allowable under the floodplain risk management plan, local floodplain risk management policy and EPIs.

minor, moderate and major flooding	Both the State Emergency Service and the Bureau of Meteorology use the following definitions in flood warnings to give a general indication of the types of problems expected with a flood: **minor flooding:** causes inconvenience such as closing of minor roads and the submergence of low level bridges. The lower limit of this class of flooding on the reference gauge is the initial flood level at which landholders and townspeople begin to be flooded. **moderate flooding:** low-lying areas are inundated requiring removal of stock and/or evacuation of some houses. Main traffic routes may be covered. **major flooding:** appreciable urban areas are flooded and/or extensive rural areas are flooded. Properties, villages and towns can be isolated.
modification measures	Measures that modify either the flood, the property or the response to flooding. Examples are indicated in Table 2.1 and further discussion is given in Appendix J of the Floodplain Management Manual.
peak discharge	The maximum discharge occurring during a flood event.
Probable Maximum Flood (PMF)	The largest flood that could conceivably occur at a particular location, usually estimated from probable maximum precipitation. Generally, it is not physically or economically possible to provide complete protection against this event. The PMF defines the extent of flood prone land, that is, the floodplain. The extent, nature and potential consequences of flooding associated with the PMF event should be addressed in a Floodplain Risk Management study.
Probable Maximum Precipitation (PMP)	The greatest depth of precipitation for a given duration meteorologically possible over a given size storm area at a particular location at a particular time of the year, with no allowance made for long-term climatic trends (World Meteorological Organisation, 1986). It is the primary input to the estimation of the probable maximum flood.
probability	A statistical measure of the expected change of flooding (see annual exceedance probability).
risk	Chance of something happening that will have an impact. It is measured in terms of consequences and likelihood. In the context of the manual it is the likelihood of consequences arising from the interaction of floods, communities and the environment.
runoff	The amount of rainfall which actually ends up as streamflow, also known as rainfall excess.
stage	Equivalent to “water level”. Both are measured with reference to a specified datum.
stage hydrograph	A graph that shows how the water level at a particular location changes with time during a flood. It must be referenced to a particular datum.
survey plan	A plan prepared by a registered surveyor.
water surface profile	A graph showing the flood stage at any given location along a watercourse at a particular time.
wind fetch	The horizontal distance in the direction of wind over which wind waves are generated.

1. INTRODUCTION

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

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

In the last 30 years the land usage around the Basin has undergone significant changes, from a predominantly rural community, to a community with significant areas of urbanisation. The town of Sussex Inlet in particular has undergone massive changes, mainly due to the development of the canal estates which commenced in 1971. There has been a significant increase in population and a heightened awareness of environmental issues. These changes have already affected the Basin and there is the potential for further changes to occur. In view of these factors it is necessary to define the existing flood problem and carefully manage future development on the floodplain.

1.1 The Flood Problem

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

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

Photograph 1: St Georges Basin Foreshore - June 1991 Flood

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

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

1.2 Historical Flood Data

Records for the water level recorder at the Island Point Jetty indicate that since it was installed in July 1991, the only significant rises in water level within the Basin occurred in February 1992 (1.18 mAHD) and April 1994 (0.57 mAHD). During a significant flood event for Tomerong (Cockrow) Creek in September 1993, the Basin level only reached 0.23 mAHD which is nominally just above the high tide level.

Based on examination of daily rainfall, records dating from 1952 for Sussex Inlet were examined, and it was determined that significant storm events occurred in:

- March 1959,
- October 1959,
- February 1971,
- June 1991.

Corresponding basin water levels for the above events are not included due to lack of information.

Minor storm events have also been experienced in:

- May 1953,
- February 1958,
- March 1961,
- March 1975,
- March 1976,
- October 1976,
- February 1992,
- September 1993,
- April 1994.

One or more flood levels are available for the following events:

- 6 February 1971,
- 11 June 1991,
- 11 February 1992,
- 18 September 1993,
- 14 April 1994.

In some cases the flood peak may have actually occurred a day either side of the date shown.

1.3 Floodplain Risk Management Process

Shoalhaven City Council has commissioned the following studies in accordance with the guidelines of the Floodplain Management Manual (Reference 2):

Stage 1: Flood Study - completed in September 2001 (Reference 1),
Stage 2: Floodplain Risk Management Study - initiated August 2000,
Stage 3: Floodplain Risk Management Plan - initiated August 2000.

The Flood Study (Stage 1 of the process - Reference 1) established the design flood levels for the study area with selected values presented in Table 3 of Section 3.2. The “1% AEP” or “1 in 100" flood has a 1 in 100 chance of being equalled or exceeded in any year. On a LONG TERM average it is likely to happen once every 100 years, but it is wrong to think it can only happen once in a century. Because floods are random events there is still a 1 in 100 chance of the flood occurring next year no matter what may happen this year.

This Floodplain Risk Management Study (Stage 2) seeks to fully identify the flood problem in terms of risks to the floodplain occupants and their assets, and to then canvass various measures to mitigate the effects of flooding. The end product is the Floodplain Risk Management Plan (Stage 3) which will describe how flood liable lands are to be managed in the future. This process requires community interaction to ensure that the proposals are fully supported. Ultimately Council will complete the process through implementation of the actions identified in the Plan (depending upon financial and other constraints).

2. BACKGROUND

2.1 Catchment Description

St Georges Basin is a 37 km^2 coastal lagoon within the Shoalhaven City Council area (Figure 1) which discharges through the Sussex Inlet Channel to the Pacific Ocean at Bherwerre Beach. The Basin itself therefore represents approximately 11% of the total catchment area of 327 km^2.

The study area for this investigation incorporates the Sussex Inlet Channel, the fringe area around St Georges Basin, and the lower reaches of the major tributary creeks (listed in Table 1). The tributaries are bound approximately by Sussex Inlet Road, the Princes Highway, The Wool Road and Jervis Bay Road. A breakdown of the total catchment area is shown in Table 1.

Table 1: Catchment Area Breakdown

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

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

A significant part of the upper catchment is rural land which has been largely cleared of natural vegetation. It is mainly used for hobby farm activities. The lower slopes in the vicinity of the Basin contain a number of centres of urban development, including Sussex Inlet, Wandandian, Bewong, Basin View, St Georges Basin, Sanctuary Point, Old Erowal Bay, Erowal Bay and Wrights Beach. Urbanisation along Sussex Inlet is concentrated on the western side with the eastern foreshores remaining as an attractive visual amenity. The dominant visual impact of St Georges Basin and Sussex Inlet, when viewed from the developed areas is of natural, unspoiled areas particularly the foreshore areas in the east, south and west. Most of the lake's foreshore remains naturally timbered and relatively unimpacted.

The Sussex Inlet channel links St Georges Basin to the ocean at Bherwerre Beach. It is approximately 6 km long, and ranges between 50 m and 300 m wide. The tidal range varies by approximately 1.8 m at the ocean entrance end of the channel and is then dampened or reduced to only 0.2 m at the Basin. The inlet entrance is sheltered to the east and north by St Georges Head and to the south by Farnham Headland and has no record of closure.

In the last 30 years the land usage around the Basin has undergone significant changes, from a predominantly rural community, to a community with significant areas of urbanisation. The town of Sussex Inlet in particular has grown considerably, mainly due to the development of canal estates which commenced in 1971. There has been a significant increase in population and a heightened awareness of environmental issues. These changes have already affected the Basin and there is the potential for further changes.

2.2 Description of Study Area

2.2.1 Climate

The study area of St Georges Basin is relatively low in elevation and is situated close to the coast, which results in temperatures being generally mild with average temperatures for nearby Jervis Bay being 14 °C and 24 °C for June and January respectively. Both mean monthly temperatures and pan evaporation are highest in the summer months. Rainfall is more pronounced during the summer/autumn months, with the least rainfall occurring in July, August and September. The average annual rainfall for Nowra (north of the study area) and Milton (south of the study area) are 1110 mm and 1270 mm respectively.

2.2.2 Geology and Soils

The catchment of St Georges Basin has been developed in sandstones and siltstones of Permian age with the Wandrawandian Siltstone forming the northern shoreline of the Basin. The Snapper Point sandstone formation forms the north eastern shoreline. Extensive alluvium is located in the west of the Basin with marine sand barrier deposits blocking the former bay to the south and forming the southern shoreline. There are seven soil associations listed for the St Georges Basin catchment area with the largest association being the Cumberland - Parma, consisting of predominantly podsolic soils of low relief and low erosion hazard. The Birrilee-Hammondville and Illaroo-Woronora groups include yellow earths and peat soils and have high erosion hazard associated with either high relief or proximity to watercourses (Reference 3).

Bed Sediments

The foreshore and adjacent shallows are comprised of clean or muddy sand. This grades to sandy muds and muds in the deeper sections where local waves have no effect on circulation.

Sedimentation

St Georges Basin is permanently open to the sea via the Sussex Inlet channel and is considered to be in the early stages of infilling with catchment sediments. The present rate of infill by sediments brought down by the streams is not enough to cause a noticeable reduction in lake volume but may be observable in shallow areas adjacent to the shoreline and near the entrance of the tributary streams.

Natural sedimentation prior to European settlement would not have been rapid. Although land use changes within the catchment will have increased this slow rate, the degree of change has not been determined. Increased rates of sedimentation will, over geological time, reduce the lake depth and volume. However, because of its present size and the relatively small sediment input compared to total volume, its function as a coastal fishery resource and recreational amenity will continue over the foreseeable future. Indirect effects of sedimentation, including increased turbidity associated with rainfall events have the potential to decrease water quality and affect the ecological function within the lake environment.

Potential Acid Sulphate Soils (PASS)

Acid sulfate soils contain pyrite (iron sulfide) which when exposed to the atmosphere (usually by site excavation or drainage of land) oxidises to form sulfuric acid. Potential acid sulfate soils are poorly drained and rich in pyrite but are nearly neutral or only slightly acidic in the field. They become acid sulfate soils only when exposed to the air.

The occurrence of coastal acid sulfate soils is related to past rising sea levels when marine derived clays, containing sulfur and iron, were deposited in mangroves and estuaries. They are now likely to be found in low lying coastal areas with saline or brackish water such as deltas, coastal flats and backswamps and in seasonal or permanent freshwater swamps which were previously brackish. An indication of high and low potential Acid Sulphate Soil areas, provided by Shoalhaven City Council, is included on Figure 2.

Clause 27 of the Shoalhaven Local Environment Plan (Reference 4) requires Council consent for any development on acid sulphate soils.

2.2.3 Land Uses

Land uses for the study area are shown on Figure 3. Most of the St Georges Basin catchment is zoned for rural land use. More than 80% of the catchment remains forested. The land clearing along Wandandian and Tomerong/Cockrow Creeks has been primarily for grazing purposes, and for residential uses around the northern Basin foreshores and the western shore of Sussex Inlet.

The forest areas have been managed for the supply of timber products (sawlogs, poles, girders, mining timber, charcoal) and non-timber products (seed, eucalypt oil, honey etc.). A system of forest zoning identifies the most appropriate utilisation for specific areas of forest.

Grazing is the main agricultural use in the catchment. There are no known intensive agricultural practices. Some of the land on the southern foreshore of the basin and the eastern side of Sussex Inlet remain uncleared and part of Commonwealth Territory.

Residential and tourist areas which make up 5.4% of the catchment are centred on Sussex Inlet, Erowal Bay, Sanctuary Point, Pelican Point and Basin View. Population growth between 1996 and 2001 was 4.7% p.a. for the areas on the northern side of the Basin and 2.7% p.a. for Susses Inlet. Recent development pressure has proposed extension into areas presently zoned rural near Sussex Inlet and also in the north west of the Basin (Reference 3). There is also a small area of land around Badgee Lagoon which is currently zoned Village.

Sussex Inlet contains the main industrial estate within the St Georges Basin catchment with some smaller zoned areas centred around the northern developments, at Basin View, St Georges Basin and Sanctuary Point.

Other land uses as a percentage area of catchment include:

- State Forests (47%),
- National Parks (6%),
- Environmentally sensitive areas (4%),
- Wetlands (including SEPP 14 Wetlands) (1%),
- Public Infrastructure (Sewage Treatment Plant, Roads, etc.). (The extent of this land use activity cannot be accurately established but is estimated to be less than 5%.)

2.2.4 Ecology

The Shoalhaven LGA has a diverse fauna and flora range and a large number of endemic species. There are 67 fauna and 25 flora species that occur within the Shoalhaven LGA and are listed under the threatened Species Conservation Act 1995. A further 47 plant species are listed as Rare or Threatened Australian Plant species.

Environmental studies undertaken in the St Georges Basin/Jervis Bay area have identified concentrations of endangered fauna and flora which are well above expected levels. Figure 2 indicates the distribution of threatened fauna and other flora sites identified around the study area.

Considerable concern has been expressed regarding the encroaching urban development around St Georges Basin. Runoff, inadequate sediment controls and other aspects related to development, have been reported to be increasing sedimentation and structural damage to waterbodies. In addition, erosion hazards are increasing with the construction of roads, power and other infrastructure associated with subdivision development and increased density.

Flora

The plants of St Georges Basin were identified and grouped into 16 major community types made up from 27 floristically distinct groups. The periphery vegetation groups can then be divided into three broad groups:

- halophyte (salt tolerant) communities along the shores of Sussex Inlet,
- mixed wetland communities along the shore of the central Basin,
- riparian (river bank) vegetation along Wandandian Creek.

Fauna

The fragmentation and isolation of bushland reserves resulting from European settlement and urbanisation, has seen natural areas too small in size and too distant from larger areas to support many indigenous fauna species. The introduction of non-native fauna (e.g cats, foxes and rabbits) which have subsequently turned feral, as well as high rates of companion animal (cat and dog) ownership have resulted in higher levels of predation and increased competition for resources. Although, coast dunes, swamp communities and areas dominated by rainforest are small in actual area they contribute a large amount to faunal diversity.

Aquatic Environment

The aquatic environment is an important ecosystem because many organisms live in or from it and they rely on the numerous habitats that exist beneath and around the water. Aquatic animals often need more than one type of habitat and if one is damaged or destroyed the impact on this animal can be life threatening. Some of the important habitats found in local waterways include:

- seagrasses - often found in shallow, sheltered inshore areas
- intertidal sand and mud flats - foreshores or intertidal areas provide an important habitat for fish and invertebrates, both as a nursery and for adult species.
- mangroves and other bank vegetation - these are generally specially adapted plants. The plant, their roots and fallen branches can provide habitat for fish, birds, molluscs, worms, crustacea, butterflies and other insects,
- the water itself.

Wetlands

There are some sixteen SEPP 14 wetland areas associated with the Basin and Sussex Inlet as shown on Figure 2. A number of additional non SEPP 14 wetlands have also been identified in the area. Wetland types range from the essentially estuarine (tidal) wetlands (mangroves and saltmarsh), mainly concentrated along the edge of Sussex Inlet, to freshwater wetlands occurring along the western and northern shores of the Basin and along the creeks running into the western and northern edges of the Basin. There are almost 30 ha of saltwater wetlands (3.6 ha of saltmarsh and 25.2 ha of mangroves) in the estuary. Saltwater wetlands are mainly confined to the tidal inlet (Sussex Inlet) and to the muddy deltas of Wandandian and Cockcrow Creeks.

Since a majority of wetlands occur in low lying areas near watercourses it is reasonable to assume that during large flood events the wetlands may become inundated and act as part of the flood storage. Wetlands can therefore be an important part of both the floodplain and the local ecosystem.

Fishing

St Georges Basin has been used extensively for both commercial and recreational fishing. This has lead to commercial fishing being one of the major industries for the catchment and hence its preservation is important for the community. Fishery values for the Basin include:

- a diverse and abundant fish and invertebrate fauna,
- a variety of estuarine habitats,
- a permanently open entrance,
- a productive commercial fishery, the most productive on the south coast, supporting the largest number of boats and crew,
- a popular recreational fishery year round.

Since 1990, the total fisheries production for the Basin has declined by around 50%, falling from 200t to 100t. Over the last few years the catch rates for particular species has remained fairly stable. Meshing and prawning are the most commonly employed fishing methods in the Basin.

Muddy sand substrate is the main fish habitat in the Inlet and the Basin while seagrass is the dominant vegetation type in the Basin.

As of 1st May 2002, commercial fishing has been banned from St Georges Basin with only recreational fishing permitted. The change has resulted from new initiatives to improve the conservation and management of the aquatic resources in NSW.

2.2.5 Waterways

The main waterways feeding into St Georges Basin (refer Figure 1) include Cow Creek, Tullarwalla Creek, Wandandian Creek, Pats Creek, Home Creek, Tomerong/Cockrow Creek, Worrowing Waterway, Home Creek, Erowal Creek and Stony Creek. Recreational fishing, boating and swimming are the most popular activities in the Basin and Inlet. Public access to the foreshores is difficult because of private ownership and lack of vehicle access but this allows for the preservation of these areas and encourages overutilisation of the accessible areas. Swimming tends to be concentrated near the entrance and the northern Basin beaches, where access is facilitated. There are a number of established sailing courses covering the main Basin area and water skiing is popular along the sheltered straighter reaches of Wandandian Creek.

Wandandian and Tomerong/Cockrow Creek catchment areas have a big influence on the rise in the basin level during significant flood events.

Wreck Bay is a popular fishing location for boats based in Sussex Inlet. However, access to the Bay is limited by the condition of the entrance channel, particularly the depth of the channel as well as external wave activity. As a result vessels drawing more than about 0.5 m often need to work the tide or risk damage/grounding when negotiating the entrance. This creates a potentially dangerous situation when storms blow up and tides trap unwary boaters in the Bay. Boating access is improved following flood events when the higher outflow velocities produce a wider, deeper and straighter channel. Flushing of the Basin is also marginally improved. However, such improvements are limited in time due to infilling by beach and marine sediments.

Erosion along Sussex Inlet is causing a loss of foreshore vegetation and contributing to shoaling. There has been some minor loss of seagrass beds over the last 40 years but the channels have remained fairly stable. Continuing uncontrolled erosion could lead to increased areas of bank destabilisation and denuded vegetation. The collapse of banks in the canal estate is spoiling the residential amenity and increasing sedimentation.

A recent investigation by the Healthy Rivers Commission, Coastal Lakes, Independent Public Inquiry into Coastal Lakes: Final Report 2002, classified St Georges Basin as a coastal lake with healthy modified conditions. This classification was termed provisional because a more detailed assessment is necessary.

The basis for the classification of the basin is included in the Table 2, but also includes other significant factors, such as existing patterns of settlement, natural resource use, key government or court decisions and the potential for restoration or rehabilitation.

Table 2: St Georges Basin - Coastal Lake Classification Data Summary

Natural Sensitivity Risk	High
Existing Catchment Condition	Modified
Existing Lake Condition	Slightly Affected
Recognised Conservation Value	High

* Refer to Reference 5 (HRC, 2002) for more information.

2.2.6 Water Quality

Water quality in estuaries varies depending on the amount and source of freshwater, exchange with oceanic water, catchment activities, depth and morphology of the estuary and the condition of the entrance. The available water quality data indicates that levels of measured parameters are within the acceptable ANZECC ranges for maintaining aquatic ecosystems over most of the estuary. Tributary creeks have experienced elevated nutrient levels as well as relatively high faecal coliform readings under some fluvial conditions. These are not of a major concern because of the high dilution rates and do not directly affect conditions over the bulk of the Basin. To date, no algal blooms have been recorded within the Basin (Reference 3).

2.2.7 Social Characteristics

Population Demographics

The permanent residential population of the area is approximately 13400 (2001 Census) with most people living in close proximity to the basin. The growth rate during the 1996-2001 intercensal period was high at 4.7% for the northern region and 2.7% for Sussex Inlet.

Community Profile

The permanent population mainly live in the larger urban areas of St Georges Basin, Sanctuary Point and Sussex Inlet. There is also a large number of caravans and “coastal village” holiday homes which make up a significant percentage of the residential dwellings for the area. As a consequence, the population can increase by up to four times during peak holiday periods.

For the Shoalhaven City Local Government Area the population age spread according to the 2001 Census is 22% for 0-14 year olds, 47% for 15-54 year olds, 12% for 55-64 year olds and 19% for 65 years and over. More specifically, at Sussex Inlet 49% of people are over 55 years of age.

The relatively high percentage of older residents and the potential for a significant temporary increase in population can both create issues for evacuation planning. On the one hand, additional external resources may be required (or placed at risk) to provide assistance for the increased population and/or those less mobile. Additionally, a large proportion of any temporary

transient population (tourist/holiday makers) would most likely have a very low flood awareness which would require additional resources to manage and could place some at direct risk.

Aboriginal Heritage

Aboriginal occupation in the area of St Georges Basin would have been linked to the drowning of the landscape by the rise in sea level since the last glaciation and consequently data from at least 6000 years BC would have been submerged. Occupancy in some form would pre-date this time but would not be associated with a coastal setting.

The area surrounding St Georges Basin was occupied before early European settlement by the Wandandian people. Early historical reports indicate the extensive use of the waterways by aboriginal canoes and the local feast of fish, seafood and marsupials was dependent on the coastal location. The National Parks and Wildlife Service maintain a register of all known archaeological sites in the St Georges Basin area.

European Heritage

The first official exploration of the area around Jervis Bay was conducted in 1819 by the government surveyors, James Meehan and John Oxley, and early use of the area was concentrated around Huskisson. The building of Wool Road in 1841, connecting Braidwood with Huskisson, allowed further settlement and the villages of Wandandian and Tomerong/Cockrow were settled in 1850 by purchase at auction. They served as small service centres for the surrounding rural area.

1898 saw the growth of tourism at Sussex Inlet and Huskisson, but it was not until the widespread use of the motor car in the 1920s that more constant use was evident. The state forests were established in the catchment in 1941. During the 1950s tourism expanded and the construction of the “weekender” became a feature of development near the coast.

The distribution of heritage sites across the floodplain is indicated on Figure 2.

2.3 Flood Study Review

The St Georges Basin Flood Study (September 2001 - Reference 1) details the hydrologic and hydraulic investigations carried out by Webb, McKeown & Associates on behalf of Shoalhaven City Council to determine the design flood levels. The approach adopted for the hydrologic and hydraulic modelling of the catchment was influenced by the quality and quantity of data available.

The estimation of catchment runoff was undertaken using the WBNM hydrologic model and the RUBICON hydraulic model was used to define flood behaviour. The hydraulic model incorporated the main waterways within the designated study area, which encompasses the Sussex Inlet Channel, the Basin and its fringe area as well as the lower reaches of the major tributary creeks.

The results and findings from the flood study have been referred to and relied upon as part of this Floodplain Risk Management Study as detailed in Section 3 of this report.

2.4 Review of Existing Policies and Strategies

2.4.1 Council's Interim Flood Policy

Council adopted an interim flood policy in September 1987 and last revised it in August 2002. The main points include:

- the Flood Planning Level is defined as the 1% AEP flood plus freeboard,
- the freeboard for the floor levels of habitable rooms of commercial and residential developments is typically 0.5 m in a floodway and 0.3 m elsewhere. Local rules may otherwise apply such as 0.0 m for the commercial area of Sussex Inlet,
- where the proposed development could be damaged by flooding, the structure is to be suitably designed to meet the applicable guidelines,
- materials used in construction below the minimum floor level are to be compatible with immersion in floodwaters,
- where it is impractical to raise the floor level for proposed dwelling extensions, application of the minimum floor level requirement will be considered on its merits,
- creation of new residential lots by subdivision will not be permitted in floodway areas.

The Interim Flood Policy was originally developed following the release of the first NSW Government Floodplain Development Manual in 1986. The latest revision was then initiated as a result of the new Floodplain Management Manual (Reference 2) which was released in January 2001. The amendments to the Policy were mainly of a nominal nature to update terminology references. The general content of the document and its interrelationship with Council's various other planning instruments is therefore becoming dated compared to current trends in Best Practice.

As a result of preliminary findings from this floodplain risk management study process, Council have initiated a number of concurrent actions to update and formalise this interim policy in accordance with the latest Floodplain Management Manual (Reference 2). These actions include the preparation of a specific flood related Development Control Plan (DCP) and a revision of the Local Environmental Plan (LEP).

Further detailed discussion on Council's flood policy is provided in Sections 5.2.8 and 6.6.1 with an initial planning review included in Appendix F.

2.4.2 Council's Existing Planning Instruments and Related Documents

Over the years, Council has developed and implemented a wide range of planning instruments, policies/strategies and related documents to deal with new development, some of which is on flood prone lands. As this process has been of a gradual nature and often driven by changing regulations or development needs, the resulting documents are becoming increasingly out of date, disjointed and often conflicting. The various documents as they pertain to floodplain management were critically reviewed from a planning perspective in the initial stages of this study and the outcomes of these findings are summarised by the discussion paper included in Appendix F. It should be noted that these findings were an early input to the study process which identified a number of problems or issues to be addressed. As this is an iterative process, these findings are largely outdated or superseded by the subsequent steps and measures initiated by Council to address the problems identified. Further discussion of this issue is presented in Section 6.6.

This Floodplain Management Study will provide recommendations to ensure that Council's planning instruments and local policies for development on flood prone land is consistent with contemporary Best Management Practice and the principles outlined in the NSW Government's Floodplain Management Manual (Reference 2).

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3. EXISTING FLOOD PROBLEM

3.1 Flooding Mechanism

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

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

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

3.2 Hydraulic Classification

The Floodplain Management Manual (Reference 2) defines three hydraulic categories which can be applied to different areas of the floodplain. These categories are to be used for assessing the suitability of future types of land use and areas of possible development on a broad scale rather than the assessment of individual or isolated development proposals. The definitions for hydraulic categories of flood prone land include:

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

> *"Flood storage* areas are those parts of the floodplain that are important for the temporary storage of floodwaters during the passage of a flood. The extent and behaviour of flood storage areas may change with flood severity, and loss of flood storage can increase the severity of flood impacts by reducing natural flood attenuation. Hence, it is necessary to investigate a range of flood sizes before defining flood storage areas."
>
> *"Flood fringe* areas are the remaining area of flood prone land after floodway and flood storage areas have been defined."

The hydraulic classification of the St Georges Basin floodplain primarily varies depending upon the distance from the Basin and its tributary creeks. This is because the flood depths and velocities generally decrease with increasing distance from the basin or tributary streams as ground levels rise. The above hydraulic classifications have been applied to the St Georges Basin floodplain based on a detailed assessment of flood behaviour, the available topographic information and interpretation of model results from the Flood Study (Reference 1). An overview of the hydraulic classification for the overall floodplain study area is indicated on Figure 4 and shown in greater detail for specific areas on Figures 4a to 4d. These maps have been prepared on a broad scale and are of a qualitative nature which incorporates consideration of a number of factors as outlined above. Therefore, they should only be relied on for a general indication of the classification. The classifications are based on the existing topographic information and technology, available at the time of the study, in order to indicate the main flow paths and areas which have surface levels below the Flood Planning Level (1% AEP flood level plus 0.5 m freeboard). There can be some variation in the hydraulic classification depending upon the size of the flood. As such, it is quite possible that a more detailed site specific investigation may suggest a different classification is applicable. Under such circumstances it is recommended that the situation be reviewed in light of any more detailed information and considered on its merits.

There is no clear cut division between each category but generally the basin and the main channel area of the inlet and tributaries are classified as floodway, the adjacent areas are classified as flood storage and the remainder becomes flood fringe. An indication of the range for design flood levels in key areas is presented in Table 3.

Table 3: Design Flood Level Ranges

Flood Event	Flood Level (mAHD)		
	Basin (upstream of Sussex Inlet)	**Cockrow Creek at Sanctuary Point Road**	**Sussex Inlet Channel at Jacobs Drive**
5% AEP Event	1.8	1.8 to 2.0	1.7 to 1.8
2% AEP Event	2.1	2.1 to 2.2	2.0 to 2.1
1% AEP Event	2.4	2.4 to 2.5	2.2 to 2.3
Extreme Event	5.1	5.0 to 5.5	4.5 to 5.0

Note: Levels rounded to 1 decimal place.

3.3 Flood Hazard Classification

Flood hazard is a measure of the overall adverse effects of flooding. It incorporates threat to life, difficulty in evacuating people and possessions, as well as the potential for damage, social disruption and loss of production. Land is typically classified as either *low* or *high* hazard for a range of flood events.

The hazard classification for a given area is partially a qualitative assessment based on a number of factors as discussed below. The accompanying Figure 4 and Figures 4a to 4d define low and high hazard classifications for the St Georges Basin floodplain resulting from such an assessment. The following four hazard categories have been identified:

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

Size of Flood

The severity of the flood hazard is largely related to the relative size of the event. Relatively low flood hazard is generally associated with frequent, minor floods while rare major floods are more likely to present high hazard situations. A flood hazard is usually assigned based on a specific flood event such as the Flood Planning Level or other event of note. The 1% AEP flood event is most commonly used as a base for planning and FPM purposes.

For the St Georges Basin floodplain, the 10%, 5% and 2% AEP flood events would only produce low to medium hazard conditions for the majority of affected areas. The 1% AEP flood would generally present greater hazard classifications and was therefore adopted as the basis for the overall mapping presented on Figure 4. Greater detail of key floodplain areas is shown on Figures 4a to 4d.

For the purposes of this mapping exercise and to assist delineation of the extent of floodplain area incorporated within the Flood Planning Area, the extent of hydraulic and hazard mapping actually portrays the outer limit of the proposed main Flood Planning Level (1% AEP flood level plus 0.5 m freeboard). An indication of the relative extent of the Extreme flood is also shown to complete the picture and provide some guidance on the maximum extent of land susceptible to flooding (Flood Prone Land).

As with the hydraulic classification, these figures provide a broad indication of potential hazard only. A more detailed assessment of a specific localised area may reveal some differences. In events larger than the 1% AEP some areas of low hazard will become high hazard. It is also possible that some areas not flooded in the 1% AEP event will become high hazard areas in the Extreme or PMF event. These will only occur at the limits of the high hazard area and accurate identification of these areas would require additional survey data. In events smaller than the 1% AEP there may be a decrease in the area of high hazard. Again, additional survey is required to more accurately define these areas.

Flood Awareness of the Community

A flood aware community will be wise to the dangers of flooding and also possibly be well prepared with measures and plans in place to deal with the recurrence of flood events. Based on the responses to the questionnaire (Diagram 1 of Section 4.2), the potentially worst affected communities of Sussex Inlet and Sanctuary Point consider themselves to be well aware of the flooding issues in their area because these areas are low lying and have previously experienced flood events considered as minor. Since a large (say 1% AEP or greater) flood has not occurred during the recording period, the community may not be fully aware of the potential implications (depths and velocities) or possible extent of flooding. Large flood events will affect more people and more areas in a variety of ways and it is unlikely that any of the local residents have a true appreciation or feel for what to expect or how to respond in a major flood. General Community Awareness also tends to decrease as the time between flood events increases.

Additionally, as discussed in Section 2.2.7 the area is also a popular tourist/holiday destination with the potential for a significant temporary increase in population. Many of these “visitors” are very unlikely to have been exposed to previous flood events in the area or aware of any local evacuation/response measures and procedures.

The average level of awareness for the overall St Georges Basin floodplain community is expected to be mediocre at best and the hazard categorisation presented in Figure 4 has taken this into consideration, particularly for Sussex Inlet.

Depth and Velocity of Floodwaters

The flood hazard classification is often determined on the basis of the predicted flood depth and velocity. A high flood depth will generally cause a hazardous situation while a low flood depth may only cause a minor inconvenience but these are dependent on the corresponding velocity being experienced.

For the St Georges Basin floodplain the flood depth is generally the more dominant factor as velocities are mostly not that high. The hazard (and hydraulic) classifications are therefore primarily dependent on the existing ground level and distance from the waterway, which varies for the townships and foreshore areas around the Basin. The high hazard areas are Sussex Inlet, Sanctuary Point (adjacent to Tomerong/Cockrow Creek), and areas adjacent to Pats and Home Creek. Some of these areas are inundated up to 1 metre above ground level, with velocities up to 1m/s. The resulting hazard classifications are shown on Figure 4 and Figures 4a to 4d for more detail in key areas.

A comparison of historical and design flood level and velocity results obtained from the model established for the St Georges Basin Flood Study (Reference 1) are presented in Tables 4 and 5 respectively.

Table 4: Comparison of Modelled Historical and Design Flood Levels

Ref. No.	Location	Creek	Level (mAHD)						
			1971	1991	1992	Extreme	1% AEP	2% AEP	5% AEP
1	Basin	Inlet	2.23	1.49	1.07	5.1	2.35	2.09	1.78
2	The Haven	Inlet	1.13	1.01	0.66	3.1	1.96	1.86	1.75
3	200 m D/s Princes Highway	Wandandian	6.98	4.56	4.72	10.2	6.66	6.29	5.81
4	Wool Rd	Pats	4.33	4	4.04	5.1	4.26	4.22	4.18
5	U/s Wool Rd	Home	2.56	1.81	1.87	5.1	2.54	2.45	2.33
6	Wool Rd	Tomerong	3.62	2.11	2.47	5.1	3.44	3.26	3.01
7	Fitzpatrick St	Worrowing	2.56	1.71	1.86	5.1	2.56	2.44	2.32

Note: Refer to Figure 1 for location of model gridpoints.

Table 5: Comparison of Modelled Historical and Design Flood Velocities

Ref. No.	Location	Creek	Velocity (m/s)						
			1971	1991	1992	Ext.	1%	2%	5%
1	Basin	Inlet	0.4	0.3	0.3	0.3	0.4	0.4	0.3
2	The Haven	Inlet	1.2	1	0.9	2.2	1	0.9	0.8
3	200 m D/s Princes Highway	Wandandian	2.4	2.2	2.3	2.7	2.4	2.4	2.4
4	Wool Rd	Pats	0.9	0.4	0.5	1.2	0.8	0.7	0.7
5	U/S Wool Rd	Home	1.7	1	1	0.7	1.7	1.6	1.5
6	Wool Rd	Tomerong	0.8	0.7	0.7	1	0.7	0.7	0.7
7	Fitzpatrick St	Worrowing	1.5	1	1.1	2.1	1.5	1.5	1.4

Note: Refer to Figure 1 for location of model gridpoints.

Effective Warning and Evacuation Times

The effective flood warning time is dependent on the rate at which flood waters rise, the efficiency of the flood warning system, and the awareness and promptness of the community to act. In small catchments floodwaters tend to rise and peak not long after the peak rainfall burst and will then subside relatively quickly. Larger catchments respond to rainfalls more gradually with the flood peaks occurring more slowly with the accumulation of larger volumes of runoff.

The flood levels experienced on the Basin tributaries tend to rise and fall more quickly than the water level in the Basin itself (refer Figures 5 to 8). The fall in the Basin water level is influenced by the Sussex Inlet channel and the ocean level in Wreck Bay. During significant events the main tributary catchments of Wandandian and Tomerong/Cockrow Creeks have a big influence on the volumes of runoff contributing to the rise in the Basin level.

An indication of catchment response or available warning times is presented in Table 6 for the 1% AEP 9 hour design event (refer Figure 6) as well as the historical 1971 (refer Figure 8) and 1991 events. It should be noted that the design events are based on theoretical peak storm bursts and as such are more likely to be conservative estimates (quicker response times) compared to conditions associated with actual or historical flood events.

Table 6: Comparison of Catchment Response/Waiting Times

Ref. No. [1]	Location	Contributing Catchment		Time to Peak Water Level [5]		
		Tributary	Critical Storm Duration (h)	1% AEP 9h Design Event [2]	1971 Flood [3]	1991 Flood [4]
1	Basin	Sussex Inlet	48	22h10m	49h10m	53h
3	200 m d/s Princes Highway	Wandandian Ck	9	7h	40h30m	46h30m
4	The Wool Road	Pats Creek	4.5	5h45m	39h25m	45h35m
5	U/S The Wool Road	Home Creek	2	5h20m	39h10m	33h15m
6	The Wool Road	Tomerong/Cockrow Creek	9	6h35m	40h5m	46h15m
7	Fitzpatrick Street	Worrowing Creek	4.5	5h35m	39h5m	45h10m

Notes:
(1) Refer Figure 1 for location of model gridpoints.
(2) Time to peak rainfall burst 1% AEP 9h Duration - 4.5 hours
(3) Time to peak rainfall burst 1971 Flood Event - 38.5 hours
(4) Time to peak rainfall burst 1991 Flood Event - 33 hours
(5) All times taken from assumed commencement of storm rainfall.

There is currently no flood warning system operational for the St Georges Basin floodplain. However, the SES has emergency evacuation procedures in place. Warning systems are more effective for areas where the rate of rise of the floodwaters is slow enough to allow sufficient time for the evacuation plan to be implemented. A flood warning system may therefore be beneficial in reducing damages in the Sussex Inlet and foreshore areas but would not be as effective, to the Sanctuary Point areas affected by Tomerong/Cockrow Creek as this is mostly subject to a faster rate of rise of floodwaters. Accordingly, the hazard anticipated at Sanctuary Point (along Park Drive) is greater than what might be expected at Sussex Inlet.

Rate of Rise of Floodwaters

The rate of rise of floodwaters is related to the catchment size, but it is also influenced by the catchment slope, soil types and land use. The rise in level on the tributaries occurs relatively quickly. Whereas for the Sussex Inlet area, the rise experienced in the channel level is delayed, taking a relatively long time, because it is downstream of the basin which slowly fills and rises from the tributary inflows. An indication of the rate of rise at several key locations within the study area is shown by the comparison of 1% AEP design stage hydrographs on Figures 5 to 7.

The rate of rise of floodwaters on the main tributaries tends to also be dependent on catchment size and the corresponding critical storm duration (refer Figure 5) which produces 'peaky' rainfall bursts and runoff. For instance, the smaller catchments of Pats, Home, Worrowing and Erowal Creeks have relatively fast rates of rise while the larger Cow, Tullarwalla, Wandandian and Tomerong/Cockrow Creeks rise at a slower rate but not as slow as the Basin which is more volume dependant (refer Figure 7 for critical 48 hour duration event). The hazard classification for these different areas has been adjusted as appropriate.

Duration of Flooding

The greater the duration of flood inundation the greater the disruption to the community and the potential impacts on damages (particularly where agricultural damages are involved). The duration of inundation is closely related to the duration and size of the storm event over the catchment.

For the Basin itself, the critical 1% AEP flood event was estimated to be caused by the 48 hour storm (Figure 7) which is due to the overall volume of runoff produced from the catchment rather than the peak flows associated with short sharp rainfall bursts. Due to the considerable volume of temporary floodplain storage available these short rainfall bursts do not cause a significant increase in water level. These longer duration storm events would typically result in the duration of flooding being of the order of some 3 days depending on prevailing ocean conditions.

In contrast, the tributaries of St Georges Basin tend to be influenced by shorter duration storms with higher rainfall intensities which produce higher peak flows but shorter durations of flooding (Figures 5 and 6). Table 7 summarises the 1% AEP critical storm duration for the major tributaries of the Basin.

Table 7: Critical Storm Durations for St Georges Basin and Tributaries

Tributary	Catchment Area (km^2)	Critical Storm Duration (hours)
Cow Creek	13.1	9
Tullarwalla Creek	18.3	9
Wandandian Creek	159.3	9
Pats Creek	6.4	4.5
Home Creek	4.6	2
Tomerong Creek (also referred to as Cockrow Creek)	42.8	9
Worrowing Waterway	5.9	4.5
Erowal Creek	2.6	4.5
Sussex Inlet/Basin outflow	327.1	48

The comparison of stage hydrographs presented as Figures 5 to 7 provides an indication of the durations for which flooding may be experienced at different levels. For example, for the Basin and foreshore areas, water levels are expected to be at or above RL2.0 mAHD for up to 25 hours in the 1% AEP 48 hour design event (Figure 7). In the historical 1971 event the corresponding duration of inundation was 27 hours (refer Figure 8). The basin water level does not exceed RL2.0 mAHD in the 1% AEP 9 hour design event (peak level of 1.6 mAHD).

Evacuation Access

Access and evacuation difficulties arise from:

- high depths and velocities of floodwaters over access routes,
- difficulties associated with wading (uneven ground, obstructions such as fences),
- the distance to higher, flood free ground,
- number of people and vehicular capacity of evacuation routes,
- inability to contact or communicate with evacuation and emergency services,
- availability of suitable equipment (rescue boats, heavy trucks, etc.),
- poor community awareness of evacuation procedures, and/or unwillingness to leave properties in sufficient time,
- poorly planned development areas.

Within the St Georges Basin floodplain there are four main situations which are likely to require evacuation:

- flood prone properties around the fringes of the Basin itself or the tributaries,
- the existing houses adjoining the lower reaches of Tomerong/Cockrow Creek in the vicinity of The Park Drive,
- the properties situated within the floodplain around the main township of Sussex Inlet,
- the flood free properties located on the high ground immediately north of Badgee Lagoon.

Generally speaking there is sufficient warning time and opportunity for properties around the fringe of the Basin and floodplain to evacuate to higher ground. Additionally, these areas are only exposed to a nominal risk in the larger events.

At Sanctuary Point, there are some 180 properties adjoining the lower reaches of Cockrow Creek. A number of the properties are two-storey structures and/or have been constructed on raised/filled building pads. Access to the area along Larmer Avenue and/or The Park Drive will be cut in small or frequent events and depending on the primary flooding mechanism (catchment runoff or elevated basin levels) there can be little warning time available. Evacuation of this area should therefore be initiated as early as possible and have a high priority. There is little if any opportunity to raise the key roads to improve the evacuation situation. Raising Larmer Avenue would require the provision of considerable bridging/waterway area to minimise the potential for impacts to upstream properties. The Wool Road bypass (as discussed in Section 6.3.1) has recently provided a flood free crossing of the creek to improve the through flow of traffic in times of flood.

The township of Sussex Inlet experiences access and evacuation difficulties in as little as 10% AEP (1 in 10 ARI) design event and greater. River Road near Cater Canal (Photograph 2) and Jacobs Drive near Badgee Creek appear to be the first affected major roads for the area. Road closures tend to isolate sub-sections of the community and the whole town (developed area) will be isolated from the Princes Highway in larger events such as the 1% AEP (1 in 100 ARI) event.

There is only one road (Sussex Inlet Road) leading in to the settlement and this joins with the main road of Jacobs Drive. Jacobs Drive and also River Road are relatively flat and low lying and readily inundated in small or frequent flood events. Access for a majority of the township (including the canal estate) is therefore significantly restricted in as little as a 10% AEP (1 in 10) event and likely to be lost early in the larger events. As a consequence, the hazard classification for this area has been increased even though depths and velocities are not always high and some warning may be available. The older areas to the south of the canal estate are situated on higher ground with alternative access around the floodplain.

Photograph 2: River Road, Sussex Inlet - June 1991 Flood

While the development located on high ground north of Badgee Lagoon may also be flood free (except for those along the foreshore in Fairview Crescent - refer Section 6.3.4) the only access to or from the area would be cut from the Badgee Lagoon crossing. The residents of nearly 400 properties are likely to be isolated for extended periods of time (possibly days). Such a situation would not directly endanger the residents but could leave them without power, water or sewer, as well as access to food or medical supplies without the need for third party

intervention. Evacuation of these properties is not as critical as those directly flood affected but measures need to be enacted early in the event to facilitate evacuation from the area or those electing to stay must have sufficient supplies available. The only alternative solution would be to construct a separate route heading in a westerly direction to join Sussex Inlet Road independently (refer Section 6 and Figure 1).

3.4 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.

The extent of disruption to the community and overall cost of flood damage can depend upon many factors which include:

- the magnitude (depth, velocity and duration) of the flood,
- land usage and susceptibility to damage,
- awareness of the community to flooding,
- effective warning time,
- the availability of an evacuation plan or damage minimisation program,
- physical factors such as erosion of the river bank, flood borne debris, sedimentation.

The estimation of flood damages tends to focus on the physical damage to the human environment in the floodplain but there is also a need to consider the ecological costs to the natural environment, and benefits to flooding in the floodplain. 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). Further discussion on the various types of damage with details of how the costs were calculated for this study are included in Appendix A.

Based upon the surveyed floor level database obtained by Council in Jan/Feb 2001 (Refer Table D1 of Appendix D), Table 8 indicates the number of residential buildings likely to be flooded for a range of events and shows the corresponding tangible damages. No allowance has been made for potential losses incurred through bank collapse (refer Appendix C) or complete destruction of buildings. Likely damages to public utilities are discussed in Appendix A.

Table 8: Summary of Damages to Property

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

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

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

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

The total likely damages figure shown in Table 8 for a given flood is useful to get a “feel” for the relative magnitude of the flood problem but is of only limited value for precise economic evaluation. When considering the economic effectiveness of a proposed mitigation option, the key question is the total damages prevented over the life of the option. This is a function not only of the high value damages which occur in the larger less frequent floods but also of the lesser but more frequent damages which occur in small floods.

The standard way of expressing flood damages is in terms of the Average Annual Damages (AAD). These are calculated by multiplying the damages that can occur in a given flood by the probability of the flood occurring in a given year and then summing across the range of floods. By this means the smaller floods, which occur more frequently, are given a greater weighting than the rare catastrophic floods.

As indicated in Table 8, the average annual tangible damages (AAD) for the St Georges Basin floodplain are estimated to be approximately $0.66 million This figure excludes damages to public property and intangible damages and damages to some public utilities/property (refer Appendix A.2.4). The net present value of these damages is around $9 million assuming a 50 year design life at 7% discount rate.

4. COMMUNITY CONSULTATION

4.1 Components

A rigorous public consultation program (Appendix B) was carried out as part of this study and included:

- an introductory newsletter,
- a questionnaire for the first phase of the process,
- floodplain management committee meetings and workshops which included interested representatives of the public,
- newsletters,
- public meetings,
- open shop days and public exhibition of material.

The direction of the study and emphasis placed upon the issues and various management measures was influenced by feedback from this public consultation program. A summary of the community response to the different stages of the program is provided below.

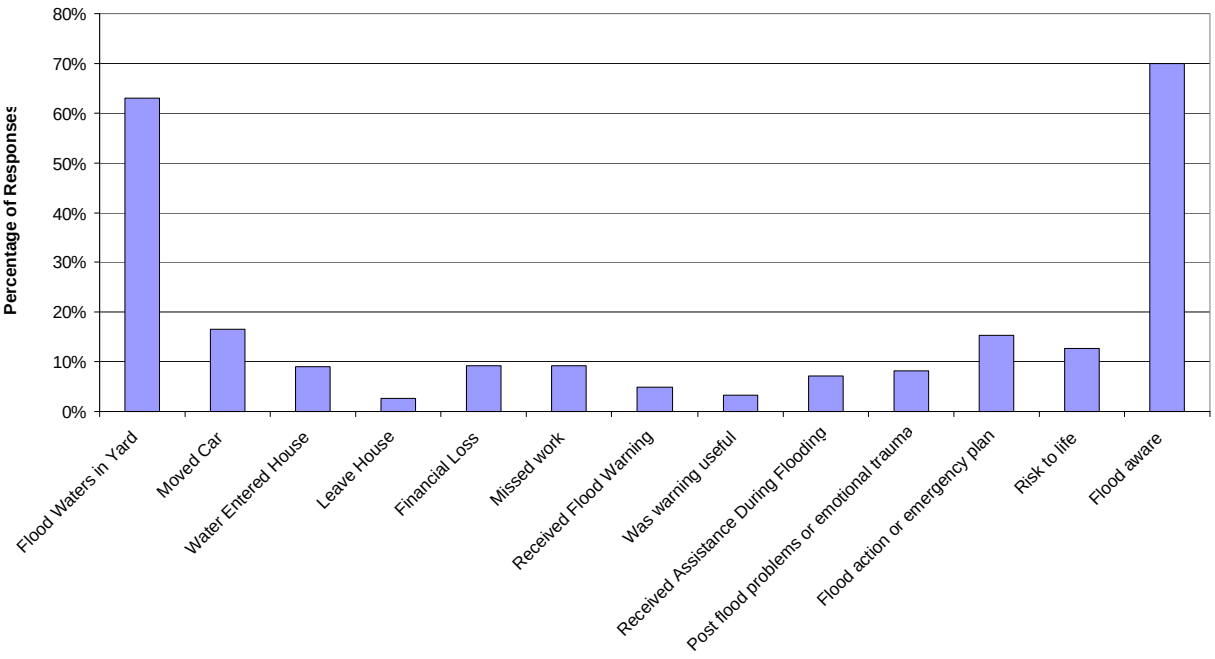
4.2 Questionnaire - December 2000

An indication of public awareness and the means by which the flooding problem should be addressed were obtained from responses to the questionnaire distributed. The questionnaire (refer Appendix B) was sent out to all owners of properties which were thought to lie within the floodplain, together with an accompanying newsletter. It was considered that the remaining residents within the overall study area, would have little experience of flooding.

The questionnaire was distributed to some 2066 property owners within the St Georges Basin floodplain and 404 (approximately 20%) were completed and returned. Of those responding, approximately 95% were related to residential houses with 67% concerned about flooding and 60% requested to be kept informed by joining the contact group. The average time for people residing at the property was 13 years.

There was a varying response to the experiences residents had encountered in relation to flooding, and these are summarised below in Diagram 1. Some 20% of respondents felt they could provide useful information regarding flooding which included photographs, letters or just comments about the information available.

Diagram 1: Flood Experiences



When asked to what extent people thought they might be affected by different size flood events the results were varied as indicated in Table 9. In general, a majority thought their yard would be inundated during a small flood event while 39% felt their house would be affected by the extreme event.

Table 9: Respondents Perception of Potential Flood Affectation

Size of Flood Event	Potential Affectation (1)		
	Evacuation Access (%)	Yard Inundation (%)	Building Inundation (%)
Small to medium flood which is more likely to occur	10	27	9
In a large flood which is less likely to occur	8	42	23
In the largest possible flood event	8	56	39

(1) Results indicate the % of respondents who thought that they might be affected under the given flood magnitude.

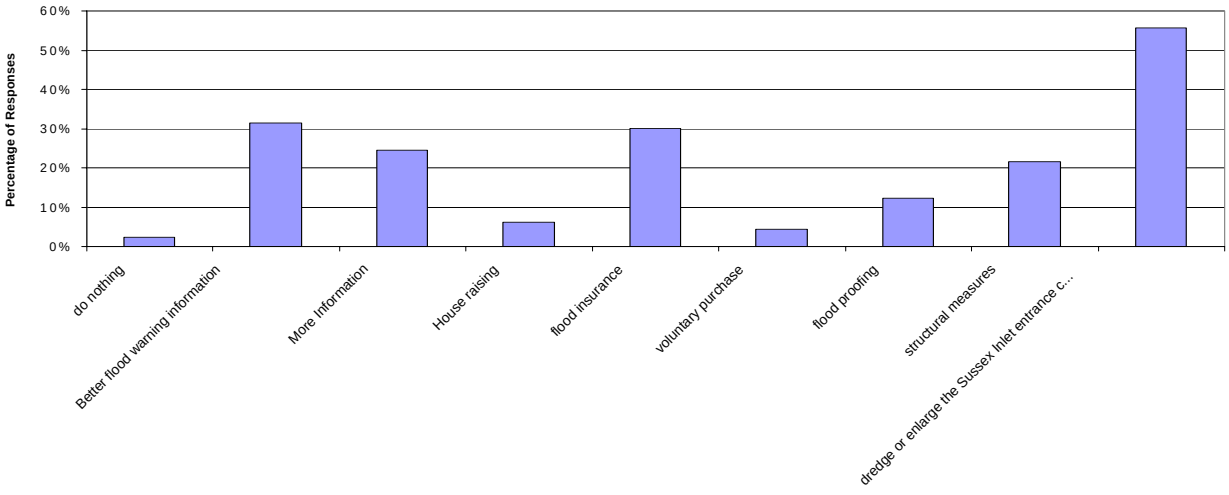
In terms of resident's knowledge of available flood warning time, nearly 26% of respondents had "no idea" about how much time they would have to undertake emergency measures if a major flood were to occur. The range of estimated time responses is detailed below and it should be remembered that the actual times would be dependent on the location of the property within the catchment study area.

Estimated flood warning time available:	No idea	=	26%
	1 day	=	17%
	12 hours	=	16%
	6 hours	=	9%
	Less than 6 hours	=	15%
			83%

Note: 17% did not answer the question.

As a means of gauging community ideas and thoughts on what mitigation measures might be worthy of further consideration, nine options were listed as potential means of addressing the flood problem. A summary of responses to the options is shown in Diagram 2. It is evident that the dredging of the Sussex Inlet channel (56%) was seen as the most popular solution with better flood warning information (31%) and flood insurance (30%) also considered important. Around 21% thought that some form of structural measure might work. The individual property solutions such as house raising and voluntary purchase were least favoured with less than 7% support.

Diagram 2: Possible Flood Mitigation Options



A detailed summary of the questionnaire results is included in Appendix B.

4.3 Stakeholder Options Workshop

A workshop was held on 16 May 2001 to discuss management options for the St Georges Basin Floodplain. The workshop was held at Council Offices and was attended by members of the Shoalhaven Floodplain Management Advisory Committee, Councillors and staff representatives of relevant Council departments.

The consultants provided background information of flooding issues within the St Georges Basin Floodplain and some preliminary ideas on potential risk management options to initiate the discussion process.

The workshop attendants were split into two groups to discuss the potential management options and any new suggestions brought forward. The ideas, recommendations and most beneficial areas for application of the management options were discussed and are summarised in Appendix G.

The resulting list of potential options was then included in a second Community Information Sheet (Included in Appendix B) which was sent to all residents within the floodplain in order to obtain feedback on the community's preferred risk management options. The community were also invited to participate in the open shop days and public meetings to allow them to ask questions, relay their concerns or make comments on the study.

4.4 Open Shop Days

An Open Shop Day consisting of two separate sessions was held on 27th June 2001. The details are tabulated below. Residents were advised of the date of the meeting in a hand delivered newsletter (approximately 2066 delivered to all residents in the floodplain) and by advertisements in the local media (radio, newspapers). All members of the Floodplain Management Committee were invited by letter.

	Venue	Date	Attendees (approx.)
1	St Georges Basin Community Centre	27 June 2001 - 9:00am to 12 noon	15
2	Sussex Inlet Community Centre	27 June 2001 - 2:00pm to 5:00 pm	10

At each of the open shops, the findings of the study to date were made available and an opportunity provided for residents to discuss their concerns and provide verbal or written feedback (questionnaire). The outcomes are included in Appendix F and are summarised below.

St Georges Basin Open Shop

Approximately 15 people attended the Open Shop Day at St Georges Basin Community Centre. Those in attendance had been informed either through the community information sheet, the local newspapers and/or the local radio station. Their reason for attending the Open Shop varied. Some residents were primarily curious as to what the Open Shop was about while others were concerned about their property and if they would be affected. Others wanted to express which flood issues they felt were the most important.

Those who attended were generally grateful to have their concerns and ideas listened to. Comments sheets were provided and attendees were encouraged to submit their concerns in writing. Two comment sheets requesting more information regarding flood affectation of their property were completed. These requests were forwarded to Council for follow-up.

Sussex Inlet Open Shop

Approximately 10 people attended the Open Shop Day at the Sussex Inlet Community Centre. The reason for attendance varied from general curiosity to concern for their flood prone property and the area overall. Of those in attendance, four comment sheets were submitted, raising issues or queries regarding:

- siltation of Jacobs Drive bridge,
- stormwater drainage problems,
- the results of the floor level survey for their property,
- a suggestion to form a harbour in Wreck Bay which would reduce the effect of the ocean conditions on the Inlet,
- a property owner in Fairview Crescent at Sussex Inlet felt a levee with one-way flap gates for drainage would protect up to 20 low lying properties in Fairview Crescent. The build up of debris on overbank vegetation (causing re-distribution of floodwaters) and siltation of the Inlet were also seen to be an issue.

One couple who attended the Open Shop owned a caravan park at Sussex Inlet. They discussed how they have developed and implemented their own evacuation procedures for flood events and how they informed their customers about the flood history of the area.

4.5 Public Meetings

As a follow on from the community information sheet, two public meetings were held to present the information and study findings in a more formal setting which allowed for open discussion at the completion of the presentation. The first public meeting was held on 27th June 2001 after the open shop day in Sussex Inlet, and the second was held in St Georges Basin on 16th August 2001.

St Georges Basin FPMS Public Meeting, 27 June 2001, 7:00pm to 9:00pm

The Public Meeting at Sussex Inlet Community Centre was attended by over 20 people including Councillors, Council staff and interested members of the community. The general discussion which followed on from the presentation raised several issues as described below.

- Sussex Inlet Channel and Entrance,
- property affectation,
- evacuation of the floodplain,
- warning time,
- stormwater issues.

St Georges Basin FPMS Public Meeting, 16 August 2001, 7:00pm to 9:00pm

A second Public Meeting was held for the northern area residents at St Georges Basin Community Centre on 16th August 2001 because many property owners indicated they were not afforded sufficient notice to enable them to attend the June 2001 meeting. This was primarily a result of problems experienced with the mail distribution contractors. This issue was very disappointing to both Council and the Consultants working on the project. Hence, it was considered that there was a strong need for a subsequent Public Meeting to allow the community to participate in the study as originally intended.

The August Public Meeting followed the same format and presented the same information as the June Public Meeting and the following issues were discussed:

- siltation of the basin and the Sussex Inlet Channel,
- debris and siltation of the local creeks,
- local overland flooding,
- construction and maintenance of stormwater drains,
- zoning of land.

A detailed summary of the Public Meetings can be found in Appendix B.

5. STUDY AREA ISSUES

5.1 General Issues for the Whole Study Area

A range of issues relating to the St Georges Basin Floodplain have been raised at Council/committee meetings, by the community as part of the consultation process by the Consultant, or were outlined in the original study brief. These issues include:

- lack of appropriate flood warning,
- flood awareness of the community,
- evacuation access and planning,
- review Council's Interim Flood Policy,
- review Local SES Flood Plan,
- urban expansion areas - effect on downstream areas,
- impact of infill developments,
- cumulative impacts,
- assessment of development of Sussex Inlet,
- impact of wave set-up on foreshore areas,
- siltation of St Georges Basin and the Sussex Inlet channel,
- overgrown and silted tributary creeks,
- local overland flooding,
- lack of kerb and guttering in some areas,
- blocked drains,
- Sussex Inlet channel,
- The Wool Road by-pass.

Some of these issues are also addressed more specifically below or in Section 6 under Floodplain Risk Management Measures.

5.2 Discussion of Specific Issues

5.2.1 St Georges Basin By-Pass (The Wool Road)

Council is planning to construct a bypass road around St Georges Basin, which involves linking Island Point Road and The Wool Road (St Georges Basin) to avoid the built up area of Sanctuary Point. The Sanctuary Point Floodplain Management Study, October 1993 (Reference 6) suggested that an appropriate option to provide flood protection to houses in the vicinity of The Wool Road would be to raise the bypass road to act as a levee. The area of The Wool Road near Salinas Street and Vost Drive experiences flooding from both the local catchment and from Tomerong Creek, and hence the bypass road may alleviate flooding in this area.

The issue is the need to protect the properties in The Wool Road area without adversely raising flood levels and affecting upstream or surrounding properties. Detailed hydraulic modelling has been undertaken to address this issue which is discussed further in Section 6.3.1.

5.2.2 Sussex Inlet Channel

Sedimentation of the Sussex Inlet channel and entrance bar are considered by members of the community to be major issues with regards to flooding. It is perceived, that this sedimentation has significantly restricted the available waterway area which prevents floodwaters from dissipating quickly and thus causes backwater effects during flood events.

The buildup of sediments within the channel and basin typically occurs because the tidal flow characteristics at the entrance make the inflowing tide faster than the outflowing tide. During a flood event where the volume and velocity of the outflowing floodwaters is much greater, the buildup is reduced to make the main channel area wider and deeper in the short to medium term. As this clearing of the restriction typically occurs with the rising limb of the flood hydrograph the increased channel capacity is already available and effective to help reduce flood levels at the peak of the event.

Detailed discussion of this issue is included in Section 6.3.3.

5.2.3 Jervis Bay Settlement Strategy

The Jervis Bay Settlement Strategy, Draft for Discussion, was prepared by the Planning Services Division of Shoalhaven City Council in July 2001 (Reference 7). The purpose of the strategy was to identify the capacity of the area for future development while providing for sustainable growth of selected settlements. Specifically for Sanctuary Point, the ultimate expansion of urban zoned area is to be limited to the St Georges Basin Bypass road (The Wool Road).

The impacts on flood levels if all land up to The Wool Road was developed would be minimal. As discussed in Section 6.3.1, the raising of The Wool Road to form a levee has little if any impact on flood levels downstream of The Wool Road. Development of this land would result in changes to local flow paths and hence may have implications for more frequent flooding events.

5.2.4 Nebraska Estate

The Nebraska Estate is an old "paper subdivision" (refer Figure 1, Gridpoint Location No.5) located around Home Creek, a tributary on the northern side of St Georges Basin. The Estate incorporates part of the St Georges Basin floodplain which is low lying and of "swampy" nature, it also contains dense stands of casuarina trees, commonly found around the Basin. The Estate currently comprises 120 lots now distributed between 40 to 50 owners. Consequently, there is increasing pressures for development within the area. Due to the potential flood affectation as well as other local environmental issues, Council therefore needs to closely consider the most appropriate land use zones for the area.

At present only a few lots have been developed with the remainder being vacant. Of the eight (8) lots which have been developed and surveyed, only one (1) property would be inundated in the 10% to 1% AEP range and a further five (5) inundated in the extreme event.

Approximately one third of the lots are zoned rural 1D, another third residential, and the reminder is zoned rural 1G flood liable. The rural 1G zone roughly corresponds to the extreme flood extent established by the flood study. Where there are differences and the extreme flood extent line is outside the rural 1G line, then the extreme flood line should be adopted for the rural 1G limit.

Evacuation access during a flood event should not be an issue for a majority of the lots within the estate. Some of the lots at the eastern end of Pelican and Fisherman Roads may however have difficulty accessing higher ground by road.

It is recommended that:

- no further residential development should occur within the Extreme flood extent line (typically the rural 1G limit) on both flooding and environmental grounds,
- development on the lots at the eastern end of Pelican and Fisherman Creeks should be restricted to ensure there is minimal increase in potential damages due to flooding and to minimise the number of people requiring evacuation assistance during a flood.

5.2.5 Flood Warning System

There is currently no formal flood warning system in place for the St Georges Basin Catchment. At Sanctuary Point there is little time between the rainfall and the occurrence of flooding, so a flash flood warning system would not be warranted for the benefit of only a few properties mainly located on The Wool Road. An "ALERT" radio telemetry flood warning network has been installed on the nearby Shoalhaven River Catchment which is operated by Council and the BOM. It was recommended in the Sanctuary Point FPM Plan (Reference 8), that additional rain recorders could be installed in the St Georges Basin Catchment and used in conjunction

with the Shoalhaven River system to facilitate more timely warnings for the residents of the St Georges Basin Catchment.

Flood height records are available for 2 gauges within the study area. The "Wandandian" gauge situated just upstream of the Princes Highway and the "St Georges Basin" gauge which is located on the western side of the Island Point Jetty on the northern edge of the Basin (refer Figure 1). The latter gauge was installed by NSW Public Works in July 1991 and is now operated by Manly Hydraulics Laboratory. The gauge datum is 0 mAHD (which approximates mean sea level) and the data shows that the average Basin water level is approximately 0.1 mAHD with tidal range variations of up to 0.2 m in a day reasonably common. Further variations can be caused by rainfall events. An assessment of this issue is included in Section 6.5.1.

5.2.6 Filling of Land

The community of St Georges Basin was concerned about the filling of the floodplain and what affect it might have on flood levels in the area. The impact of the filling was perceived to be most evident for the smaller more frequent events where surface flows are minor but filling associated with infill development in existing areas has altered the local flow path. Several residentially zoned areas have been filled for development and these include the area in and around the canals at Sussex Inlet, and some areas of Sanctuary Point near Tomerong Creek.

Filling of low lying land is sometimes undertaken to provide a level building pad area to assist with raising the floor level above the design flood level. Where the filling of the land is situated within the floodplain it can result in:

- the loss of temporary floodplain storage which could cause an increase in peak flow and flood levels downstream (unlikely to be an issue for the St Georges Basin foreshore floodplain unless a significant quantity of fill or loss of floodplain storage is to be undertaken,
- the loss of available flow paths which could result in an increase in flood levels upstream,
- redirection of local runoff onto adjoining properties.

While small or individual instances of filling may be shown to have minimal impact in isolation, the cumulative effects of filling can have a greater overall impact and this needs to be managed by pre-determined considerations and controls established for the Plan. Further discussion of this issue is included in Section 6.6.6.

5.2.7 Local Flood Plan

Shoalhaven City Local Flood Plan, October 1999

Shoalhaven City Council produced a local flood plan in October 1999 as a supporting plan to the Shoalhaven DISPLAN (Disaster Plan). The plan is divided into several key sections which serve to outline the preparation measures (Preparedness), the conduct of response operations (Response) and the co-ordination of immediate recovery measures (Recovery) for flooding within the Shoalhaven Council Area. The following summarises the content of this plan with respect to the abovementioned sections.

The Introduction includes the purpose of the plan, the Authority under which the plan is issued (State Emergency & Rescue Management Act, 1989 and the State Emergency Services Act, 1989), the area covered by the plan and the people and organisations who have specific responsibilities with respect to implementation of the plan. The general responsibilities of emergency service organisations and supporting services are detailed in the Shoalhaven Local Disaster Plan. The areas with specific flood risk are included in detail in an annexure.

The Preparedness section outlines the measures which need to be in place in preparation for the occurrence of flood events in the plan area. This includes public education to ensure that the residents of the Council area are aware of the flood threat in their area and how to protect themselves against it. The steps the Shoalhaven State Emergency Service Local Controller (SES Controller) will undertake to activate the plan. Sources of flood information and intelligence, and the various types of warnings which indicate potential flooding problems are imminent.

The Response section outlines how the plan will be implemented and managed during and after a flood event. This includes:

- Control - the type of operation,
- Operations Centre - where they are located and who is responsible for their operation,
- Liaison - co-ordination between organisations with specific responsibilities,
- Communications - devices and methods for communication,
- Information - how information will be disseminated to the public in relation to river heights, flood behaviour, road conditions and closures, advice on temporary mitigation and the confirmation of warnings,
- Road Control - who is responsible for closing and opening flood affected roads,
- Flood Rescue - procedures for conducting flood rescues,
- Evacuations - defines responsibility for undertaking of evacuations, how they will be conducted and the location of evacuation centres,
- Logistics and Resupply - identifies where to obtain any supplies required during implementation of the plan,
- Stranded Travellers - provides guidelines on establishing contact between stranded travellers and their concerned relatives or friends.

The Recovery section outlines the activities which need to be undertaken after the event as part of the clean up operation and restoring the situation to normal conditions. Looking after any evacuees will be the responsibility of the Shoalhaven Disaster Welfare Service. All evacuees are to be registered with the Illawarra-Shoalhaven Police District Headquarters.

It is recommended that this Local Flood Plan should be reviewed or updated to incorporate the information and findings which have been collated as part of this study. This includes details of flood affected properties (based on floor/ground levels and GIS mapping) hazard mapping and evacuation planning in view of worst affected areas, road/route access, warning times and rates of rise. Further general discussion of Response Modification Measures such as Evacuation Planning and Flood Awareness and Readiness is included in Sections 6.5.2 and 6.5.3 respectively.

5.2.8 Council's Interim Flood Policy

In response to the original NSW State Government Policy on flooding and floodplain management (defined in the Floodplain Development Manual of 1986), Shoalhaven City Council adopted an Interim Flood Policy in 1987 which was last revised in August 2002.

The Interim Flood Policy defines Council's objectives with regard to flooding issues, the land to which the policy applies, as well as the general conditions and standards to be implemented for development affected by flooding.

The adopted flood standard (the new terminology is Flood Planning Level or FPL, as per the FMM 2001 - Reference 2) for the Shoalhaven LGA is stated to be the 1% AEP (1:100 year ARI), but some local areas have a specific flood level quoted (in mAHD) instead, or as well as the applicable AEP/ARI.

Freeboard for development in a floodway is set at 0.5 m for most areas and 0.3 m for the flood storage and fringe areas. Some particular areas are noted as exceptions to these rules, such as Sussex Inlet (commercial development freeboard 0.0 m), Browns Creek, Currambene Creek and Lake Conjola (freeboard all areas 0.3 m). There are usually very few sustainable reasons for such variations with more consistent values across the entire LGA easier to implement and administer.

Following on from some preliminary findings of this FRM study, Council have already initiated a process of reviewing and updating the LEP and associated flood related documents with a view to preparing a specific Flood DCP. With continuing advancements in floodplain management Best Practice and the release of the revised NSW Government Policy (in the form of the 2001 Floodplain Management Manual) Council's Interim Flood Policy is now dated and requires revision. Further discussion of this issue is included in Section 6.6.1.

5.2.9 Local Overland Flooding

Local overland flooding is inundation resulting from the inability of the local pipe and channel drainage system to contain or handle the stormwater runoff. 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 filling and building of low lying land, blocking the overland flow paths, as the major factors which result in local overland flooding affecting their properties.

This issue was raised several times by the community through their responses to the questionnaire as well as at the open shop days and public meetings. Issues relating to overland flooding and stormwater were also raised and addressed in the City of Shoalhaven Urban Stormwater Management Plan (Reference 9). This Management Plan recommends works such as:

- bank stabilisation,
- improved maintenance of silt fencing in table drains,
- improved building controls and erosion and sedimentation management,
- gross pollutant traps within the drainage network,
- formalised kerbside drainage, and
- sealing of road surfaces.

From a mainstream flooding point of view local overland flooding typically does not pose any significant threat to life or property and is more of a nuisance only. The above recommended stormwater management works should have little impact on “main stream” flood behaviour. For these reasons under the terms of the State Government Funding program administered by DNR, only works or measures which address problems associated with the broader mainstream flooding problems (such as risks to life or property) are eligible for subsidised funding as part of this Plan and regular maintenance of the works should also reduce the occurrence of localised ponding of water during rainfall events.

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6. FLOODPLAIN RISK MANAGEMENT MEASURES

6.1 Introduction

The floodplain risk management study aims to identify and assess management measures which will mitigate flooding and the associated risks or hazards to people and property as well as reduce flood damages. The risk management measures must be assessed against the social, legal, structural, environmental and economic conditions or constraints of the local area. The potential floodplain risk management measures can be separated into three broad categories as follows:

Flood modification measures modify the flood's physical behaviour (depth, velocity). Typical measures include flood mitigation dams, retarding basins, on-site detention, channel improvements, levees, floodways or catchment treatment.

Property modification measures modify the existing land use or building and development controls for future development. This is generally accomplished through such means as re-zoning, development control plans, flood access, flood proofing (house raising or sealing entrances), or voluntary purchase.

Response modification measures modify the community's response to the potential hazards of flooding. This is achieved by informing flood-affected property owners as well as the wider community about the nature of flooding so that they can make better informed decisions. Examples of such measures include provision of flood warning and emergency services, improved information, awareness and education of the community and provision of flood insurance.

A number of methods are available for judging the relative merits of competing measures. The benefit/cost (B/C) approach has long been used to quantify the economic worth of each option on a relative basis and also enable ranking (prioritisation) against similar projects in other areas. The benefit/cost ratio is the ratio of the Net Present Worth of the reduction in flood damages (benefit) to the cost of the works. The ratio generally only incorporates the reduction in tangible damage as it is difficult to accurately quantify and include intangibles such as anxiety, risk to life, ill health and other social or environmental effects. The reduction in tangible damage to all public utilities has not been specifically included in this study as there was insufficient information available to properly identify and quantify the extent of affectation and benefits to be achieved (refer Appendix A2.4).

The potential environmental or social impacts of any proposed flood mitigation works are often of great concern to society and these cannot be evaluated using the classical benefit/cost approach. The public consultation program (Appendix B) has ensured that all identified social and environmental factors have been considered in the decision making process. The

management measures discussed below include those which were identified in the study brief as well as those developed by Webb McKeown or brought up by the local community.

6.2 Discussion of Possible Management Measures Not Considered Further

A list of all possible floodplain risk management measures which could conceivably be applied in the study area was developed and presented to a workshop of various stakeholders for information and consideration. The workshop which incorporated the Floodplain Management Committee then considered each measure in terms of their suitability and effectiveness for reducing social, ecological, environmental, cultural and economic impacts. As part of this process, a number of measures were identified as not worthy of further consideration.

Table 10 contains the breakdown of the measures not considered further, those definitely considered and those requiring further investigation for potential consideration. Detailed discussion of the various measures is included in the sections below.

Table 10: Floodplain Risk Management Measures

Category	Not Considered	Potential	Considered
Flood Modification Measures	• Flood Mitigation Dams • Construction of Floodways to more efficiently convey floodwaters downstream	• Catchment Treatment • Levees	• General Channel and Creek Improvement Works • Sussex Inlet Channel Works • Monitor Filling of Floodplain • Fairview Crescent Levee
Property Modification		• Voluntary Purchase • House Raising	• Rezoning • The implications of sea level rises due to the Greenhouse Effect • Flood Proofing • Flood Planning Levels • Update LEP • Prepare Flood DCP • Update Local Flood Policy 33A
Response		• Flood Insurance	• Flood Warning • Evacuation Planning • Flood Awareness and Readiness

6.2.1 Flood Mitigation Dams, Retarding Basins, On-Site Detention

Flood storage dams, or dams which have significant flood storage capability, such as Glenbawn Dam in the Hunter River (approximately 120 gigalitres of temporary floodpain storage), can significantly reduce downstream peak flood levels. However dams are extremely expensive and can generally only be justified for flood mitigation in economic terms if combined with a water supply or power generation capacity. Construction of large dams will also have a significant environmental effect which should be evaluated on a catchment wide basis.

The two major creeks flowing into the Basin are Wandandian and Tomerong/Cockrow Creeks, contributing 49% and 13% respectively to the total catchment area, with the Basin itself making up approximately 10%. Flood mitigation dams or retarding basins on Wandandian Creek could potentially reduce flood levels in the Basin but there would be little other benefits since the Wandandian Creek catchment is relatively un-developed and a considerable distance from any major townships to be able to substantiate a significant water supply potential. Dams or retarding basins within the lower St Georges Basin floodplain would have little effect on reducing flood levels for the worst affected area of Sussex Inlet because the Inlet entrance and ocean conditions tend to be more dominant in influencing flood behaviour for this area by restricting the outflow from the Basin. The Basin itself already provides a significant area for temporary flood storage.

6.2.2 Floodways

Floodways are lower overbank areas which can carry significant flow volumes in times of flood. In some instances, on smaller streams, an artificial floodway can be created in an environmentally sensitive manner to achieve a reduction in upstream flood levels. However, given the existing development adjoining the tributaries for the basin and the relatively short duration of flooding for the main tributaries, floodways are not considered to be a viable management measure in this situation. A floodway through the Inlet is also not possible because the western bank is already developed and works on the eastern mound would cause too much environmental damage by destroying flora and fauna and altering the flow behaviour in the area (refer also Section 6.3.3).

6.2.3 Catchment Treatment

Catchment treatment modifies the characteristics of the catchment to reduce runoff contributing to the streams/tributaries and lower floodplain areas. For an urban catchment, this involves planning to maximise the amount of pervious area, maintaining natural channels where practical, and the use of on-site detention. For a rural catchment, this involves limiting deforestation or contour ploughing of hill slopes.

Again this is a measure which can be effective on smaller catchments such as Cockrow, Pats, Home and Badgee Creeks but would have negligible impact on the overall volumes of water contributing to the Basin particularly from the Wandandian sub-catchment. The contributing catchment area of the St Georges Basin study area is quite large (327 km^2) and predominantly consists of undisturbed natural bushland. As a general concept, catchment treatment techniques should be encouraged along with water quality and erosion/sedimentation controls (which are more appropriately addressed by the Stormwater Management Plan - Reference 9) but these will not affect the extent or duration of inundation.

6.2.4 Rezoning

The option to rezone flood prone land for higher density (flood compatible) development could encourage people to purchase and demolish existing flood liable property and redevelop the area in accordance with Council's design floor level policy and other acceptable best management practices. Such redevelopment could only be encouraged in areas where flood free access was readily available and there was a low flood hazard. The possibility of rezoning areas of flood prone land has not been considered on a whole of floodplain/catchment basis as there are no obvious areas which would be considered suitable and there appears to be sufficient alternative flood free areas for development within the surrounding region. Council's current policy does not allow for higher density development on flood prone land but population growth in the future may require this issue to be considered further.

This could only be done where areas are already zoned residential as the Ministerial Direction defined by Clause G25 (Flood Liable Land) of Section 117(2) of the EP&A Act prohibits the rezoning of flood liable land (described as rural, open space, etc.) to a zoning described for residential, business, industrial village or similar purposes.

6.2.5 Flood Insurance

Flood insurance (Reference 10) does not reduce flood damages but transforms the random sequence of losses into a regular series of payments. Many residents regard flood insurance as a preferred flood mitigation measure as indicated in the responses to the December 2000 Questionnaire (refer Section 4.2). At present however, flood insurance is not readily available for residential houses, although it is available for some commercial and industrial properties. As part of the education program the community should be informed about flood insurance and its limitations.

6.3 Assessment of Flood Modification Measures

6.3.1 The Wool Road - Sanctuary Point Bypass

Description

Consideration of the raising of The Wool Road to form a levee which would protect downstream properties from floodwaters was initially investigated in the Sanctuary Point Floodplain Management Study, October 1993 by Environmental Management (Reference 6). When considering the potential costs and benefits from purely a flooding perspective, the option was deemed to be impractical. However, the construction of the bridge and road embankment has greater strategic benefit as it forms part of the proposed bypass route around the built up areas of the Basin including Sanctuary Point.

A more detailed investigation of St Georges Basin Bypass: Section 4 Flood Analysis was then undertaken by Waterplan in June 1997 (Reference 11) which concluded that the bypass would provide a significant reduction in flood levels in The Wool Road area. In theory, the raised road embankment would provide levee protection to The Wool Road properties immediately to the south as well as create detention storage to attenuate the peak flow conveyed through the bridge opening to the downstream areas.

As the need for construction of the bypass was increasing in priority, further investigation of the proposal as part of the floodplain management process was warranted. The proposed road alignment is shown on Figure 9 together with the location of model cross-sections.

Since the initiation of this study for the Floodplain Risk Management Process, construction of the St Georges Basin Bypass has started with Stages 1 and 2 completed by 2003, and Stage 3 completed by 2005. Stages 3 and 4 include construction of the multi-span 100 metre bridge (Option A) over Tomerong Creek.

Hydraulic Modelling

The RUBICON model established for the St Georges Basin Flood Study (Reference 1) was utilised to assess the relative hydraulic impacts associated with the proposed bridge and road embankment options. Additional cross-sections based on the detailed survey information provided by Council were incorporated into the model to represent the floodplain immediately upstream and downstream of the bridge and road alignment (refer Figure 9). The original cross-section at The Wool Road (Section 15 - model gridpoint GWOOLBRID) was also updated to reflect the natural surface along the road centreline and the model was run to establish the existing base conditions. Section 15 (GWOOLBRID) was then modified to represent the proposed road embankment and various waterway opening configurations under consideration. The model was re-run to establish the relative impacts for the 1% AEP and PMF flood events.

Modelling of the proposed bridge and approaches has been based on preliminary design plans prepared by Connell Wagner (Drawing No. 5672-001 dated 8/4/97), and assuming the following dimensions:

- overall width of waterway opening:
  - Option A - 100 m,
  - Option B - 70 m,
  - Option C - 50 m,
- bridge spans of 20 - 25 m,
- pier width of 1 m,
- depth of bridge deck 1.3 m,
- minimum road surface (overtopping) level 5.1 mAHD.

Discussion

Table 11 presents a summary of the relative impacts (change in flood levels) for the 1% AEP and the section average velocities are shown in Table 12. It is evident from these results that none of the bridge opening widths modelled provide any significant reduction in flood levels for the reaches downstream. The potential upstream impacts (increase in flood levels) are significant for each option with the maximum impact of 0.40 m and 0.44 m for Options B and C effectively being twice that of Option A (0.21 m). Given the magnitude of impacts for even the 100 m bridge opening (Option A), further consideration of the implications of these impacts on upstream properties would seem warranted to ensure any potential future problems or liability claims on Council are minimised.

Table 11: 1% AEP Flood Level Results

Creek Location	Model Gridpoint (2)	Existing Conditions (mAHD)	Relative Impact (m) (1)		
			Option A	Option B	Option C
	G99TOM19U	5.20	*	*	*
U/s of Salinas St	G99TOM19	4.94	*	0.02	0.02
	G99TOM18	4.20	0.06	0.13	0.15
Opposite Vost Dr	G99TOM17	3.75	0.16	0.31	0.34
	G99TOM16	3.62	0.20	0.37	0.41
20m U/s of Bridge	GWOOLBRUS	3.50	0.21	0.40	0.44
The Wool Rd Bridge	GWOOLBRID	3.47	0.18	0.33	0.36
35m D/s of Bridge	GWOOLBRDS	3.40	0.12	0.21	0.29
	G99TOM14	3.02	*	-0.02	-0.02
	G99TOM13	2.72	*	-0.02	-0.02
	G99TOM12	2.51	*	-0.02	-0.02
	G99TOM11	2.34	*	*	-0.02
	G99TOM9U	2.18	*	*	-0.02
Paradise Beach Rd	G99TOM9BRI	2.14	*	*	-0.02
	G99TOM9D	2.04	*	*	-0.02
	G99TOM7	1.77	*	*	*

NOTES: * The change in flood level is ±0.01 m or less.

(1) The relative impacts shown upstream of the proposed bridge opening (The Wool Rd Bridge, GWOOLBRID) are only applicable to the vacant properties on the northern side of the road embankment (upstream of the bridge). The residential development located on the southern side would be protected from direct inundation by Tomerong/Cockrow Creek floodwaters.

(2) Refer to Figure 9 for the location of model gridpoints.

Table 12: 1% AEP Flood Velocities (m/s)

Creek Location	Model Gridpoint (1)	Existing	Option A	Option B	Option C
Opposite Vost Drive	G99TOM17	0.8	0.7	0.6	0.6
20 m U/s of Bridge	GWOOLBRUS	0.7	0.9	1	1
Wool Road Bridge	GWOOLBRID	0.7	1.7	2.4	3.2
35 m D/s of Bridge	GWOOLBRDS	0.8	1	1.2	1.2
	G99TOM13	0.9	0.8	0.8	0.8

NOTE: (1) Refer to Figure 9 for the location of model gridpoints.

The PMF event was also run through the model to quantify the order of magnitude of potential impacts in a much larger event where the road is overtopped. The results are presented in Table 13. For the largest bridge opening (Option A) the maximum impact is 0.39 m with an increase in flood level still evident some 600 m upstream at the boundary of the model. Floodwaters would overtop the roadway by more than 300 mm with velocities greater than 2.5 m/s.

Table 13: PMF Flood Level Results

Creek Location	Model Gridpoint (2)		Relative Impact (m)(1)		
		Existing	Option A	Option B	Option C
	G99TOM19U	6.37	0.11	0.23	0.27
U/s of Salinas St	G99TOM19	6.17	0.14	0.29	0.34
	G99TOM18	5.68	0.26	0.48	0.56
Opposite Vost Dr	G99TOM17	5.37	0.35	0.62	0.71
	G99TOM16	5.27	0.39	0.67	0.76
20 m U/s of Bridge	GWOOLBRUS	5.12	0.39	0.67	0.78
The Wool Rd Bridge	GWOOLBRID	5.09	0.32	0.56	0.64
35 m D/s of Bridge	GWOOLBRDS	5.01	0.19	0.32	0.30
	G99TOM14	4.53	*	-0.01	*
	G99TOM13	4.11	*	-0.01	-0.01
	G99TOM12	3.80	*	-0.01	*
	G99TOM11	3.70	*	*	*

Notes: * The change in flood level is ±0.01 m or less.
(1) The relative impacts shown upstream of the proposed bridge (The Wool Rd Bridge, GWOOLBRID) opening are only applicable to the vacant properties on the northern side of the road embankment (upstream of the bridge). The residential development located on the southern side would be protected from direct inundation by Tomerong/Cockrow Creek floodwaters.
(2) Refer to Figure 9 for the location of model gridpoints.

Conclusions

Construction of the proposed bridge and road embankment will not provide any significant flood benefit for the areas downstream of the bridge opening. The results suggest that the bridge opening width would need to be considerably less than the smallest (50 m) width considered for this investigation but the resulting increase in upstream flood levels would be completely unacceptable. Even the hydraulic impacts for the largest (100 m) opening modelled are significant and thus warrant further consideration of their potential implications for upstream properties. Currently, these properties are undeveloped and zoned for rural (1D, general rural). Thus the increase in flood level should not create any adverse social or economic impacts but this will need to be confirmed.

The proposed road embankment would provide some flood mitigation benefit in that the flood liable properties within the area bounded by The Wool Road, Vost Drive and Salinas Street would become protected from direct inundation by Tomerong/Cockrow Creek floodwaters. Particularly for the smaller events. However, this area could still be affected by local drainage problems and/or backwater effects in the larger events. Detailed consideration of these issues and provision of appropriate drainage measures will be required as part of the final design stage.

6.3.2 General Channel and Creek Improvement Works

Description

General channel and creek improvement works, such as desnagging or removal of hydraulic restrictions, reduce flood levels by increasing the hydraulic capacity of the channel but also increases the velocity which can increase erosion of the banks. Dredging could also improve the hydraulic capacity by increasing the inbank flow area. These issues were raised in a number of submissions received during the course of the project and dredging of the Sussex Inlet Channel rated the highest (56%) in the responses to potential mitigation options outlined in the December 2000 questionnaire. The general minor channel and creek improvement works are discussed below while the issue of significant works to improve the Sussex Inlet Channel are dealt with separately in Section 6.3.3.

Discussion

Desnagging and removal of vegetation may reduce flood levels on small creeks but would provide negligible benefit on the water level in St Georges Basin. Vegetation removal is likely to destabilise the banks. Realignment or reconstruction of channels and removal of hydraulic restrictions such as the sedimentation bars were considered but rejected due to:

- high cost,
- unlikely to be sustainable (i.e. will require ongoing maintenance dredging),
- likely impact on the erosional and sedimentation regime,
- environmental concerns,
- bank stability concerns.

The clearing of creeks has environmental implications for wildlife in and downstream of the creek. Clearing requires removal of tree logs and associated debris which may provide habitat, it also temporarily increases the turbidity of the water during the clearing which may have detrimental effects on the aquatic flora and fauna in the creek. The clearing of creeks and alterations to natural flow regimes are listed as key threatening processes in Schedule 3 of the Threatened Species Conservation Act 1995, and hence are not recommended for implementation as a floodplain risk management measure.

Conclusions

Dredging or clearing of the tributary channels and creeks will marginally reduce flood levels adjacent to the creeks, but will not greatly affect the inundation of buildings in large floods. It is not an effective floodplain risk management measure for the creeks as it provides only marginal hydraulic benefit, is expensive to implement, detrimentally affects the environment and is not a long term solution.

6.3.3 Sussex Inlet Channel Works

Description

The responses to the December 2000 Questionnaire indicated the possibility of dredging or enlarging the Sussex Inlet Channel was the mitigation option most favoured (56%) by the community. This was again confirmed by the feedback and discussions from the open shop days and public meeting held in June 2001. In principle, this option would involve increasing the available waterway area of the channel (through widening or deepening) to allow floodwaters to escape from the Basin more freely. Detailed modelling of this option was proposed so as to better quantify the order of magnitude of the potential hydraulic benefits.

Hydraulic Modelling

The RUBICON model established for the St Georges Basin Flood Study (Reference 1) was utilised to assess the relative impacts associated with enlarging the Sussex Inlet Channel. A maximum possible extent of channel enlargement was assumed in order to obtain an indication of the upper bound in potential flood level reduction. The existing model cross-sections were modified where possible and/or practical along the entire channel stretching from the Basin to the ocean entrance. The assumed relative changes in waterway area for selected cross-sections (model gridpoint locations indicated on Figure 1) are shown on Figure 10.

Discussion

The relative change in flood level associated with enlarging the Sussex Inlet is summarised in Table 14 for a range of flood magnitudes. The greatest benefit (reduction in level) is achieved for the much larger extreme event while the average benefit is around -0.09 to -0.16 m for the 1% and 2% AEP event range. In the more frequent events there is no obvious benefit for the 10% AEP flood and a maximum of -0.07 m for the 5% AEP flood.

Table 14: Relative Impacts of Enlarging Sussex Inlet Channel (m)

Location (1)		Model Gridpoint	Flood Event (AEP)				
			Extreme	1%	2%	5%	10%
1.	Basin	GSect29	-0.42	-0.06	-0.05	*	0.05
8.	Badgee Lagoon Jtn	GSect27	-0.43	-0.09	-0.08	-0.04	*
9.	Jacobs Drive	GSect22	-0.45	-0.15	-0.12	-0.07	*
10.	Cater Canal	GSect21	-0.49	-0.16	-0.12	-0.07	*
11.	Coastal Patrol	GSect12	-0.60	-0.13	-0.09	-0.04	*
2.	The Haven	GSect4	-0.85	0.02	0.01	0.01	0.01

Note: * The change in flood level is ±0.01 m or less which is within the limits of model accuracy.
(1) Refer to Figure 1 for the location of model gridpoints.

It should be noted that these reductions in flood level are only achievable with extensive channel modification works. More moderate works would greatly reduce the potential benefits which could be realistically achieved.

The sand build-up at the ocean end of the Sussex Inlet channel is mainly from Wreck Bay and the longitudinal drift of sand on Bherwerre Beach is towards the channel. Human intervention to this process may cause adverse environmental consequences and would require ongoing maintenance.

Dredging is an extractive industry which requires an EIS to be prepared as part of the approval process. An EIS would probably cost in excess of $100 000 and would require the evaluation of a range of environmental and social issues. It is estimated that the extent of dredging assumed for the purposes of this modelling exercise would take several years to achieve and involve some 1.0 to 1.5 million cubic metres of material. Depending on the possible means for disposal, the cost of these works is likely to be well in excess of $5 million (assuming a rate of around $5/m^3) with a further ongoing maintenance allowance required. The net present value of the reduction in damages is estimated to be less than $50,000 which would give a B/C ratio of close to zero (0.0).

Further investigation would also be required to determine the long term effectiveness of dredging. It is possible that a subsequent flood would simply deposit material in the dredged area, thus negating the benefit. There is also the possibility that dredging may induce local bank failure as a result of affecting the sedimentation/erosional regime of the area.

The St Georges Basin Estuary Management Plan (Reference 3) recommended the following strategies be implemented to improve the entrance navigability and flow conditions:

- Remove “floaters” or large mobile surface rocks from the entrance channel
- Monitor channel location and relocate navigation markers as required.
- Undertake a feasibility study of entrance improvement works.
- Investigate boating access to Wreck Bay as an alternative to entrance works.

Conclusions

Significant dredging or enlarging of the Sussex Inlet channel would be required to provide a nominal flood benefit (0.1 to 0.16 m reduction in 1% AEP flood level) for the Sussex Inlet area. The extent of works required to produce this benefit are unlikely to be justifiable on either environmental or economic grounds and would be difficult and costly to sustain (maintain) in the longer term. Reducing the extent or scope of works to something which might be considered more acceptable would have insufficient benefit to reduce flood levels and flood damages.

6.3.4 Levees General

The benefits of levees in floodplain management have long been recognised, however in recent years a number of disbenefits have also become clear. Due to the nature of flooding and location of affected development within the floodplain, levees in general would not be applicable for resolving the flood problems experienced by the St Georges Basin.

Reports on flooding in other areas of New South Wales, have considered that levees should only be used to protect existing dwellings and should not be promoted to facilitate further development on the floodplain. The construction of a levee would also require amendments to Council's Flood Policy to appropriately control any further development or redevelopment behind the levee.

6.3.5 Fairview Crescent Levee

Description

The community consultation process identified the potential acceptance (request) for a relatively short levee to be constructed along Fairview Crescent at Sussex Inlet. The possible levee would help to prevent nuisance flooding experienced by some 16 properties, improve evacuation access times and reduce flood damages.

Fairview Crescent is located on the Sussex Inlet Channel just north of Badgee Lagoon (refer Figure 1). The roadway runs beside the Inlet Channel and the area is low lying with houses situated on the western side. A foreshore reserve area with significant stands of vegetation extends between the road and the main channel on the eastern side (refer Figure 11)

Discussion

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

- a levee would prevent the nuisance flooding currently experienced by the 16 properties affected (refer Table 15),
- the road is inundated in small events (10% AEP or smaller) causing evacuation access problems,

- the local topography, features and nature of the problem lend themselves favourably to the construction of a levee,
- a levee would not create any adverse impacts for surrounding development.

Levees do however have some issues such as:

- internal drainage problems,
- the potential to create a false sense of security against all flood events (levees can be overtopped in larger events),
- hazards are potentially increased should the levee overtop or fail,
- impact on aesthetics or amenity of the area along the foreshore.

Construction of a levee to protect the Fairview Crescent properties would involve raising the road to a level of approximately 2.7 mAHD over a length of some 410 m. Assuming a top width of 10 m, a minimum batter of 1:4 and average height of 1.5 m, the total construction cost would be in the order of $300,000 (including roadworks but not internal drainage requirements). To improve internal drainage problems and minimise future hazards in overtopping events, the area behind the levee could be allowed to be filled with redevelopment over time. This is on the proviso that conditions are not made worse for adjoining properties.

The crest level for the levee (2.8 mAHD) has been set at the 1% AEP level with 0.5 m freeboard. This would provide protection to nine (9) dwellings likely to be inundated above floor level and all sixteen (16) yards (refer Table 15). The Average Annual Damages (AAD) under existing conditions is around $11,000 with one (1) house and fourteen (14) yards inundated in the 10% AEP event. With the levee constructed the AAD would be reduced to $2,500 giving a benefit cost ratio of around 0.3 assuming a 50 year design life.

Table 15: Summary of Damages to Property in Fairview Crescent, Sussex Inlet

Flood	Existing			With Levee		
	Property Affectation [1]		Tangible Damages [2]	Property Affectation [1]		Tangible Damages [2]
	Yards	Buildings		Yards	Buildings	
Extreme	16	16	$505,000	16	16	$505,000
1% AEP	16	9	$171,000	0	0	-
2% AEP	16	5	$109,000	0	0	-
5% AEP	15	3	$51,000	0	0	-
10% AEP	14	1	$15,000	0	0	-
AVERAGE ANNUAL DAMAGES			**$11,000**			**$2,500**

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

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

The levee will not only reduce the frequency of inundation and tangible damages for the properties in Fairview Crescent but it will also increase the time the residents have to evacuate.

Conclusions

The raising of Fairview Crescent to form a levee would seem to provide a viable mitigation measure which would protect up to sixteen (16) properties from inundation and improve evacuation access. It is recommended that the feasibility of this option be investigated further by undertaking:

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

6.4 Assessment of Property Modification Measures

6.4.1 Voluntary Purchase

Description

Voluntary purchase involves the acquisition of flood affected properties (particularly those frequently inundated in high hazard areas) and demolition of the residence to remove it from the floodplain. It is mainly used in the more hazardous areas to free both residents and potential rescuers from the danger and cost of future floods but also to help restore the hydraulic capacity of the floodplain (storage volume and waterway area).

Discussion

Voluntary purchase of all the residential buildings situated in the St Georges Basin floodplain and inundated above floor level in the extreme flood would cost between $130 and $600 million and as such, cannot be economically justified. Generally, Government funding of voluntary purchase schemes is only available for situations where buildings are located in a high hazard area and are frequently flooded (20%, 10%, 5% AEP events) with limited alternative options available to manage the situation. The results of the December 2000 Questionnaire survey (refer Section 4.2) indicated that voluntary purchase is not favoured by the community. This is a common response as indicated by the recent example of the Brushgrove Levee Feasibility Study (on the Clarence River downstream of Grafton on the NSW North Coast) where voluntary purchase was estimated to be an economically viable measure of reducing flood damages to property. Despite its recommendation for implementation, the local community did not accept voluntary purchase because it would have a significant impact on their way of life.

Among their concerns are:

- it can be difficult to establish a fair market value (the State Valuation Office values the property as if it is not affected by flooding),
- in many cases residents may not wish to move for a reasonable purchase price,
- progressive removal of properties may impose stress on the social fabric of an area,
- it may be difficult to find alternative equivalent priced housing in the nearby area with similar aesthetic values.

While widespread voluntary purchase in the study area would not be viable, the possible purchase of certain isolated buildings in conjunction with other measures may be worthy of further consideration where there are no suitable alternatives. Analysis of the surveyed floor levels revealed that 63 properties (and excluding caravan parks) are inundated above floor level for the 10% AEP and larger flood events. A street by street summary of properties affected is included in the Table 16 with a more detailed property listing included in Table D2 of Appendix D.

Table 16: Summary of Properties Inundated above Floor Level in a 10% AEP Event

Location	Street Name	Floor Levels Inundated
Home Creek	FISHERMAN ROAD	1
Basin Foreshore	WALMER AVENUE	3
Sanctuary Point	KALLAROO ROAD	1
Sanctuary Point	LARMER AVENUE	1
Sanctuary Point	MACGIBBON PARADE	2
Sanctuary Point	MOUNTAIN STREET	3
Sanctuary Point	PRENTICE AVENUE	2
Sanctuary Point	ROULSTONE CRESCENT	1
Sanctuary Point	THE PARK DRIVE	20
Sanctuary Point	THE WOOL ROAD	1
Sussex Inlet	BANKSIA STREET	3
Sussex Inlet	ELLMOOS AVENUE	3
Sussex Inlet	FAIRVIEW CRESCENT	1
Sussex Inlet	JACOBS DRIVE	3
Sussex Inlet	NIELSON LANE	1
Sussex Inlet	POOLE AVENUE	2
Sussex Inlet	RIVER ROAD	9
Sussex Inlet	WUNDA AVENUE	6
	TOTAL	**63**

The costs associated with purchasing all 63 properties are likely to be in excess of $10 million which would exceed the likely benefits to be achieved. The net present value of the total damages is $9 million but even with the purchase of all properties, there would still be a residual damages cost. It is likely that the maximum B/C ratio would be up to 0.5. Such a large scale scheme would also be impractical to implement for a number of reasons and it is unlikely to be accepted by the majority of affected property owners. This should not preclude however, the

consideration of voluntary purchase for smaller numbers of properties which are potentially more isolated.

Historically, voluntary purchase schemes are reserved for situations involving high hazard floodway type areas. A review of the hazard classifications for the affected properties indicates that most properties are situated in flood fringe or storage areas and in many of these cases, house raising or future redevelopment may resolve most of their problems. The worst affected properties (high hazard type floodway) are those in the vicinity of Park Drive at Sanctuary Point. The cost to purchase the 20 properties identified as flood affected in a 10% AEP event would be in the order of $3 to $5 million. Many of the surrounding properties would remain which could create a range of social issues.

Conclusions

The adoption of a widespread voluntary purchase scheme is unlikely to be embraced by the majority of affected property owners and the associated social and economic costs would not justify the benefits.

Based on the hydraulic hazard categorisation applicable to most of the affected properties, there are very few high hazard areas to justify consideration of even small scale schemes for more localised problem areas. The only area where there are few alternative and viable risk management measures for protection is The Park Drive at Sanctuary Point. It is unlikely however that such a scheme would be embraced by all property owners and it is therefore not recommended for adoption.

6.4.2 House Raising

Description

House raising is suitable for most non-brick single storey buildings on piers and is particularly relevant to those situated in low hazard areas of the floodplain. The cost of house raising is typically of the order of $40,000 per houses and this approach provides more flexibility in planning, funding and implementation than the likes of voluntary purchase.

Discussion

A review of the floor level survey data and building types suggests that house raising could be suitable for approximately 6 properties which are inundated in the 10% AEP event. Details of these properties are highlighted in Table D2 of Appendix D.

Assuming each of these houses was raised 3 m (one floor), the estimated reduction in Average Annual Damages would be around $69,000. The cost of the measure would be up to $240,000 (assuming $40,000 per property). For a 50 year design life at a 7% discount rate the Nett Present Value (NPV) of these benefits would be of the order of $955,000 giving a B/C ratio of almost 4.0.

The grants for funding of this measure generally only cover the basic costs of raising the structure. Additionally, the subsidy is usually offered on a relative basis depending on the severity of the problem and potential damages cost. Residents will most likely have to contribute their own funds to make up any difference and to facilitate any associated works or modifications. The results of the questionnaire survey indicated a low level of community acceptance for house raising.

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.

Conclusions

House raising is a viable measure for those properties satisfying the criteria. Its adoption for implementation is however dependent on individual resident acceptance and funding availability. The 6 properties which have been flagged as potentially suitable (refer Table D2 of Appendix D) should be contacted to ascertain their current 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. An indication of the property's eligibility for house raising could be recorded on the Section 149 Certificate to ensure future potential purchasers are made aware of their options.

Commercial stock losses could also be reduced if businesses raised the level of their storage areas or stored stock above the flood planning level.

6.4.3 Flood Proofing

Description

Flood proofing involves the sealing of entrances, windows, vents etc. to prevent or limit the ingress of floodwater. It is generally only suitable for brick buildings with concrete floors and it can prevent ingress for outside depths up to approximately one metre. Greater depths may cause structural problems for the structure unless water is allowed to enter. An existing house could be sealed for approximately $10 000 while the cost for extensions could be much less. New buildings should have floor levels above the Flood Planning Level and should be built in a manner which reduces the risk of flood damage for events greater than the FPL.

Discussion

This measure is rarely used in NSW for residential buildings and is more suited to commercial premises where there are only one or two entrances and maintenance and operation procedures can be better enforced.

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.

It will not reduce the flood hazard and in fact the hazard may be increased if the measure results in residents staying in their houses 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 Questionnaire (Diagram 2 - Section 4.2) this measure was acceptable to approximately 12% of the respondents and rated higher than either house raising or voluntary purchase. The implementation of this measure would be at the discretion of the owners of property for which the process is suitable.

Conclusions

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.

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

6.5 Assessment of Response Modification Measures

6.5.1 Flood Warning

Description

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

Adequate flood warning gives residents time to move goods, stock and vehicles above the reach of floodwaters and to facilitate organised evacuation from those areas at risk. The effectiveness of a flood warning scheme depends on:

- the maximum potential warning time before the onset of flooding,
- the actual warning time provided before the onset of flooding, this depends on the adequacy of the information gathering network and the skill and knowledge of the operators,
- the flood awareness of the community responding to a warning.

Studies have shown that flood warning systems generally have high benefit/cost ratios if sufficient warning time is provided. Even with an effective flood warning system, some tangible and intangible flood damages will still occur.

Discussion

Currently no formal flood warning system is in place for St Georges Basin. The Bureau of Meteorology issues storm/rainfall predictions and there are level gauges currently located at Sussex Inlet and Wandandian Creek (upstream of the Princes Highway). A flood warning system would be of little substantial benefit to properties in the Tomerong/Cockrow Creek catchment as this area typically experiences flash flooding from short duration storms which leaves little time for effective warning. However, other areas of the Basin, such as Sussex Inlet and around the Basin foreshore areas would benefit.

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

Council does not have a facility to forecast flood levels for the St Georges Basin 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 action to protect its assets based upon its own forecasting rather than waiting for the official BOM warning.

The installation of additional rainfall and water level/stream gauges would primarily provide a benefit to the Basin foreshore areas, Sussex Inlet and the local SES preparedness. The possible locations for distributing rainfall stations across the catchment are indicated on Figure 12 along with an estimated order of priority. Up to seven additional rain gauge sites are shown but the ultimate arrangement will depend on finding suitable practical sites and the availability of adequate funds. There are also three existing daily read rainfall gauges within

the catchment and consideration should be given to upgrading these to telemetred pluviograph stations particularly one at Sussex Inlet. Tomerong/Cockrow and Wandandian Creeks should have telemetred rainfall gauges positioned in the middle to upper reaches of their catchment areas. Tomerong Creek typically experiences shorter duration flash flooding and Wandandian Creek is the largest tributary of the basin therefore rain gauges in these two catchments should take priority as indicated on Figure 12 as A and B. There should also be a rainfall gauge in the vicinity of the Basin edge (priority C) because the Basin itself makes up 10% of the total catchment.

While not essential, the presence of water level gauges at the upstream and downstream ends of the Sussex Inlet channel would help estimate the receedance of floodwaters and the prevailing tide or ocean conditions originating from Wreck Bay. There is already a gauge (operated by Manly Hydraulics Laboratory) located at the Volunteer Coastguard headquarters, towards the downstream end of the inlet channel. Telemetred access to the data from this gauge should be obtained and utilised as part of the flood warning/monitoring system (priority 6). The gauge proposed for the upstream end of the channel (priority 1) should be positioned to indicate the water level in the Basin as well as the level (and hence gradient) representative of the upstream end of the inlet. An alternative or secondary gauge to represent the Basin water level is shown at Island Point Jetty (priority 5). Siting a gauge at this location would not provide much additional information compared to that at the inlet (priority 1) and could be influenced by wave action. The gauge for Tomerong Creek (priority 2) is proposed to provide some indication of impending flooding at Sanctuary Point. The Tomerong Creek catchment is subject to flash flooding and the flood warning system may not provide enough time for evacuation but it should at least alert authorities of the potential for a flood event and direct emergency staff to the area to help.

While the gauge at Wandandian (priority 3) currently exists, we recommend upgrading this gauge to a telemetry system if this is not already the case. Data from this gauge will indicate what potential magnitude of inflows may be expected to the basin because the Wandandian Creek catchment is the largest tributary of the basin. The gauge at point 4 will also indicate upper catchment runoff and the impending potential for levels in the basin to rise. Its position in the upper reaches will allow for more warning time.

The combination of these rainfall and water level/stream gauges could be linked and the system could utilise current technology with the use of computer based models to generate real time flow estimates and (ultimately) flood levels which would allow for early warning of possible flooding for low lying areas and/or evacuation routes. The overall cost of this measure would be in the order of $5000 to $10,000 for each gauge established and $30,000 for the development of a model which could give some warning of high water levels for the properties at risk in the Sussex Inlet area and around the Basin foreshore.

Conclusions

A flood warning system should be designed to provide the maximum amount of warning time for the people most at risk and it needs to consider the nature of flooding, such as flash flooding or slow rising. The ALERT system with the use of sophisticated computer modelling and installation of appropriate gauges is a suitable approach for providing some form of flood warning advice for the St Georges Basin. The system should be continually monitored and upgraded as required. 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.

Aside from the warning issue, the lack of any suitable rainfall/runoff data to record and later evaluate actual flood behaviour for the St Georges Basin catchment during storm events is also a concern. In order to ensure accurate predictions, flood height and rainfall data need to be recorded immediately following each future flood event.

Council has recently (December 2005) prepared a program for upgrading of the Alert system. This is documented in Appendix I.

6.5.2 Evacuation Planning

Description

A comprehensive Local Flood Plan was initially prepared by the SES in November 1996 (refer Section 5.2.7) and subsequently updated in October 1999. It includes sections on:

- *Flood preparedness* - including public education, activation, flood intelligence, and warnings.
- *Response* - including control, operations centre, liaison, communications, information, road control, flood rescue, evacuation, logistics and re-supply, and stranded travellers.
- *Recovery* - including welfare, registration and inquiry, all clear, recovery co-ordination, and debrief.

Discussion

The effectiveness of the plan to evacuate the townships of St Georges Basin has not been tested. The main problems with all flood evacuations are:

- they must be carried out quickly and efficiently,
- they are hazardous for both the rescuers and the evacuees,
- residents are generally reluctant to leave their homes, causing delays and placing more stress on the rescuers and increasing the risk to the residents,
- the number of people to be evacuated,
- the mobility or any special requirements to evacuate residents,
- evacuation routes may be cut some distance from the village and people do not appreciate the danger.

The rate of rise of floodwaters in an area determines the amount of time the SES has to implement an evacuation plan. For the low lying areas around the Basin foreshore and at Sussex Inlet the rate of rise is relatively slow (refer Section 3) and this allows some time to commence evacuation of the properties most at risk. Some of the tributaries (particularly in the higher reaches) may experience flash flooding during which little if any time is available.

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 of buildings affected at various flood heights,
- road closures,
- the potential for bank erosion/collapse.

Aside from better planning for evacuation it is also important to consider the serviceability of the available access routes. Specific discussion of this issue is included in Section 6.5.3.

Another issue of concern to many residents is damage caused by the wash from sightseer's and/or emergency services vehicles travelling along roads which are inundated (refer Photograph 2 in Section 3.3).

At present the Plan only covers floods up to the 1% AEP event. Larger events up to the extreme or Probable Maximum Flood must also be considered as these pose the greatest risk to life and general disruption to the community at large.

Conclusions

The Local Flood Plan should be updated to provide information on the extreme flood as provided in the Flood Study (Reference 1), and the 0.2% and 0.5% AEP events. The Plan states that *no urban community is likely to require complete evacuation*. This may be true but if services are cut to the area then the whole community may have to be evacuated for health and safety reasons.

The floor level data obtained for this Floodplain Risk Management Study has been provided to the SES to enable officers to more accurately determine which houses require evacuation and in what order of priority. These details have already been linked to Council's GIS database as part of this study to assist with mapping of the affected properties. Appendices A, B and C of the Local Flood Plan should be upgraded to include the current maps and data sheets.

Vehicles should be prevented from travelling along closed roads as the wash generated by the vehicles can cause additional damages to property and the local environment. The consequent effects of driving through ponded water on closed roads should be included in the flood awareness and readiness programs discussed in Section 6.5.4.

It is also recommended that the Plan be reviewed and updated in an ongoing basis as additional or better 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.

6.5.3 Evacuation Access

Description

One of the main ways of improving evacuation (apart from more equipment, personnel or training) is to ensure that there are adequate evacuation access routes available and appropriate warning as to when the routes will become impassable. For example, roads could be raised or "low" spots eliminated to ensure trafficability.

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.

Discussion

As discussed in Section 3.3, within the St Georges Basin floodplain there are three different situations where access may present a significant problem during times of flood. These areas incorporate the settlement of Sussex Inlet and the development along The Park Drive adjoining the lower reaches of Cockrow Creek at Sanctuary Point.

At Sussex Inlet there is only one road (Sussex Inlet Road) leading in to the settlement. This joins with the main road (Jacobs Drive servicing most of the township) near the canal crossing on the fringe of the floodplain which is also the outskirts of the developed area. Jacobs Drive is relatively flat and low lying and is readily inundated in small or frequent flood events (refer 1991 flood photograph on front cover). Access for a majority of the township is therefore significantly restricted and likely to be lost early in the larger events. Alternative routes are available for the higher developed areas south of the canal estates but aside from the main township area itself, nearly 400 properties north of Badgee Lagoon would be isolated.

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

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

While the development located on high ground north of Badgee Lagoon may actually be flood free (except for those along the foreshore in Fairview Crescent - refer Section 6.3.5) the only access to or from the area would be cut at the Badgee Lagoon crossing. The residents of nearly 400 properties are likely to be isolated for extended periods of time (possibly days). The only solution would be to construct a separate route heading in a westerly direction to join Sussex Inlet Road independently (refer Figure 1). There are a number of environmental, social and economic issues associated with such a proposal which would require further detailed investigation to establish its feasibility.

At Sanctuary Point, there are some 180 properties around The Park Drive area adjoining the lower reaches of Cockrow Creek. A number of the properties are two-storey structures and/or have been constructed on raised/filled building pads. Access to the area along Larmer Avenue and/or The Park Drive will be cut in small or frequent events (typically less than 10% AEP - 1 in 10 ARI) and depending on the primary flooding mechanism (catchment runoff or elevated basin levels) there can be little warning time available. There is little if any opportunity to raise these roads to improve the evacuation situation. Raising Larmer Avenue would require the provision of considerable bridging/waterway area to minimise the potential for impacts to upstream properties. As properties in this area could become isolated with little warning by fast rising floodwaters, failsafe evacuation off-site is unlikely to be achievable. Properties should therefore be encouraged to ensure on-site precautions/measures are available. Such measures include ready access to elevated safe areas preferably higher than the extreme flood level. For two storey houses this is usually not a major issue but for single storey residences this may involve emergency ladder access to roof areas which requires a range of safety/comfort issues to considered and addressed in advance.

Conclusions

Where possible or practical the first 600 m to 800 m of Jacobs Drive at Sussex Inlet (Figure 1) should be raised to the same level as that of the adjoining canal development immediately downstream of the road. Appropriate waterway provisions (at 3 to 4 locations corresponding with the canals and potential overflow paths) should be incorporated to allow the passage of floodwaters and minimise upstream impacts. The feasibility of an alternative evacuation route for the development north of Badgee Lagoon (Figure 1) should also `be investigated in detail. Properties in the Park Drive area at Sanctuary Point should be alerted to the need for access to safe elevated areas on-site.

6.5.4 Flood Awareness and Readiness

Description

The success of any flood warning system depends on:

Flood Awareness: How aware is the community to the threat of flooding? Have they been adequately informed and educated?

Flood Readiness: How prepared is the community to react to the threat? Do they (or the SES) have damage minimisation strategies (such as sand bags, raising of possessions) which can be readily implemented?

Flood Evacuation: How prepared are the authorities and the evacuees to evacuate households to minimise damages and the potential risk to life? How will the evacuation be implemented, where will the evacuees be moved to?

Discussion

A community with high flood awareness will suffer less damage and disruption during and after a flood because people are aware of the potential of the situation and listen carefully to official warnings on the radio and television. There is often a large, local, unofficial warning network which has developed 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 have “survived” previous floods and know how to handle both the immediate emergency and the post flood rehabilitation phase in a calm and efficient manner.

The level of flood awareness within a community is difficult to evaluate, although the responses to the December 2000 Questionnaire suggest that nearly 70% of the St Georges Basin inhabitants believe they are “flood aware”. This will vary over time and depends on a number of factors including:

- *Frequency and impact of previous floods.* A major flood causing a high degree of flood damage in the previous few years will increase flood awareness. However if no floods have occurred, or there has been a number of small floods which cause little damage or inconvenience, then the level of flood awareness for large events may be low.

- *History of residence.* Families who have owned properties for generations will have established a considerable depth of knowledge regarding flooding and a high level of flood awareness. Residents that predominantly rent homes and stay for a short time will have a low level of flood awareness. Residents of flood affected rental properties also only tend to move following a flood. As discussed in Section 2.2.7, the study area is a popular holiday/tourist destination which can produce a large "transient" population with almost no flood awareness.

- *Whether an effective public awareness program has been implemented.*

For floodplain risk management to be effective it must become the responsibility of the whole community. A public consultation program was therefore incorporated into this present study to involve the public and various organisations in the decision making process. An important part of the program was simply to inform the community that there is a flood problem. It is difficult to accurately assess the benefits of an awareness program but it is generally considered that the benefits far outweigh the costs. The perceived value of the information and level of awareness, diminishes as the time since the last flood increases. A major hurdle is often convincing residents that large floods will occur in the future. Some residents may oppose an awareness program because they consider it reduces the value of their property.

Conclusions

Based on feedback from the questionnaire, public meetings and general discussions, the majority of residents of the St Georges Basin floodplain believe they have a medium level of flood awareness. 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 and or less severe floods.

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 major flood (1971) increases, the experience and knowledge of the SES units will diminish. More consideration possibly should be given to the problems of evacuating large numbers of residents from the Sussex Inlet area. In particular, special attention may need to be given to those flood free properties which may become isolated. It is imperative that relevant elements of this FMS (and Plans) be integrated into the local SES flood planning.

A suitable Flood Awareness Program should be implemented by Council using appropriate elements from Table 17. The details of the program and necessary follow up should be properly documented to ensure that they do not lapse with time and to establish the most effective methods of communication.

Table 17: 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 subsidies, 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 water quality, estuary management, 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. 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 can be prominently displayed in parks, on telegraph poles or such like to indicate the level reached in previous floods. Depth indicators on roads advise drivers of the potential hazards. Particularly appropriate near local waterways and low points which become flow paths during large events.
Articles in Local Newspapers	Ongoing articles in the newspapers will ensure that the problem is not forgotten. Historical features and remembrance of the anniversary of past events (1971, 1991) make good newspaper articles.
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 (Appendix E) documents the steps to be taken following a flood.
Notification of 149 Certificate Details	Floodplain property owners were indirectly informed that they were potentially flood affected as part of the public consultation program and floor level survey. 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 that their property was flood affected on the 149 Certificate during the purchase process. 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 and the cost.
Establishment of a Flood Affectation Database	The database developed from the information collected in this study could 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 reviewed after each flood event and could be maintained by various relevant authorities (SES, Police, Council).
Flood Readiness Program	Providing information to the community regarding flooding informs it of the problem. However, it does not necessarily prepare people to react effectively to the problem. A Flood Readiness Program would ensure that the community is adequately prepared for the event of flooding. The SES would take a lead role in this.
Foster Community Ownership of Flood Issues	Flood damage in future events can be minimised if the community is aware of the flood issues 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.

6.6 Planning and Future Development Control Measures

Flood related planning issues have been considered in detail for this study by Nexus Environmental Planning with the key findings, including a range of suggested planning options (Appendix F4), presented in Appendix F. Discussion of some of the issues is presented below.

6.6.1 Review and Formalise the Current Interim Flood Policy

Description

In 1986 the NSW Government released guidelines for controlling development of floodplains (the Floodplain Development Manual) as part of its overall Policy on flooding. As a consequence Councils were required to prepare and adopt their own specific Interim Flood Policy in order to provide some indemnity protection against possible future damages claims. The government has since released a revised and updated manual (2001-Reference 2) which has changed some of the terms and definitions as well as the fundamental principles for guidelines for managing the flood risks associated with development on the floodplain. The interim policy has subsequently been revised in August 2002 but due to the passage of time and interrelationship with a number of Council's other planning documents, the overall policy approach and implementation is becoming inconsistent and out of date compared with current best practice. The Policy therefore needs to be updated and formalised in accordance with current standards in order for Council to maintain the indemnity cover afforded by the NSW Government legislation.

Discussion

A review of Council's Interim Flood Policy was undertaken as part of this Floodplain Risk Management Study and the outcomes are summarised in Table 18. As a result of the review, Council have already initiated a number of actions to address the situation. These actions include the preparation of a generic Development Control Plan for flood prone land and revision of the LEP.

Table 18: Review of Current Flood Policies and Related Issues

Issue	Change			Comment
	No	Possibly	Yes	
FLOOD POLICY:				
Formalise Flood Policy Documentation			✔	Council's interim policies document the relevant conditions but this could be expanded upon (to include a number of issues detailed below) and include current flood level information. This would assist residents in understanding them.
Current Flood Standard (taken as the 1% AEP)			✔	The philosophy and terminology of a single "Flood Standard" has now been superseded by the application of appropriate "Flood Planning Levels" for different development types. This issue is discussed further in Section 6.6.2.
More Flexibility for Non-Residential Properties	✔			A more flexible policy was considered for non residential property.
Effect of Wave Runup		✔		Previously not considered an issue for the St Georges Basin floodplain.
Adopt a consistent Freeboard of 0.5 m.			✔	This is an acceptable freeboard to adequately account for any reasonable variation above the adopted flood level. It is noted that Shoalhaven Council currently allows a variation to 0.3 m freeboard in certain circumstances and 0.0 m for commercial properties at Sussex Inlet. A single value is recommended for consistency and ease of implementation.
Expand to include all Land Use categories. This may be required to cover expansion of existing uses.			✔	The interim policies only mention residential, commercial and industrial developments. It could be expanded to include Special Uses such as hospitals, police stations or Council offices or infrastructure which may experience significant damages if flooded. For example, there are some 9 sewerage pumping stations inundated in a 1% AEP event and 19 in the extreme flood.
Minimum Set Back from Normal Water Level		✔		At present the policies do not specify a minimum setback from the banks of a watercourse or foreshore. This issue is likely to be covered by the Rivers and Foreshore Improvement Act but could be highlighted for new development in areas where erosion is potentially an issue.
The Greenhouse Effect (see also Section 6.6.7)			✔	The Greenhouse Effect (raising of ocean levels) has the potential to impact upon design flood levels. Council's policies should state the importance of the Greenhouse Effect on design flood levels and monitor the situation.
Adopt the Floodplain Management Plan as a Development Control Plan (DCP)			✔	Although the St Georges Basin Floodplain Risk Management Plan will be a stand alone document, it should be directly linked or form part of a generic Flooding DCP applicable to the overall LGA. This is to ensure that local floodplain management is fully incorporated into Councils' planning framework and utilised in the assessment of Development Applications. The process to develop a Flooding DCP commenced early in 2002.

Issue	Change			Comment
	No	Possibly	Yes	
Effect of Fill on Local Drainage (for building pads)			✔	Fill for building pads may affect local drainage and adversely affect adjoining properties. The cumulative affects of such filling can be much greater and therefore individual filling cases need to be considered in a much broader context relating to the overall floodplain. Guidelines to control any filling on the floodplain need to be formalised.
SECTION 149 PLANNING CERTIFICATE:				
Revise Wording		✔		The wording could be revised to more precisely describe what is intended and the implications. Many residents throughout NSW complain that they do not understand the wording on 149 Planning Certificates.
Criteria Used to Identify Lots		✔		The floor, ground and flood level information should be continually updated as more accurate survey information becomes available.
Include flood prone lands up to the Extreme or PMF		✔		The Floodplain Management Manual requires greater recognition of the floods larger than the 1% AEP. Consideration should be given to identifying affected properties up to the PMF. This will require examination of the implications throughout the local government area.
LOCAL FLOOD PLAN - SES:				
Review and Update			✔	This plan should be reviewed and updated to include the surveyed floor level information and flood affectation produced as part of this study. The GIS information is to be made available for the SES to assist with planning, management and control of flood evacuation procedures.
Improve Flood Awareness and Education Program			✔	This is a relatively inexpensive measure which provides significant benefits with few adverse social or environmental consequences.
Undertake a Workshop to update the SES, Police, banks, building societies and other authorities.			✔	This will ensure that all appropriate authorities are fully informed of the flood hazard and extent of affectation. At present there appears to be some concern regarding the use of “flood information” by the lending authorities.
POST FLOOD EVENT EVALUATION PROGRAM:				
Formalise Documentation			✔	A suggested program has been included in this Report (Appendix E) and should be included within Council’s Floodplain Management Program. It is essential that the Evaluation Program is acted upon immediately following a flood event and should include utility impacts, warning effectiveness, evacuation issues as well as any positive feedback.

Conclusions

Amongst many other things, the local Flood Policy needs to set standards for development within the floodplain which will minimise damage to property whilst also ensuring minimal effect on the hydraulic behaviour of floodwaters. Council are in the process of updating the LEP to suit the current planning requirements and standards associated with floodplain risk management (as per FMM 2001 - Reference 2). As part of this process a generic DCP which deals with flood related development controls is also being prepared. This DCP will effectively provide the framework of Council's Flood Policy for the overall Shoalhaven LGA. The outcomes from this study process will then be referred to provide the specific controls applicable to the local St Georges Basin floodplain area.

6.6.2 Flood Planning Levels

Description

Under the former NSW Government approach as outlined in the Floodplain Development Manual (1986), the term *Standard Flood* was adopted to indicate the area within a floodplain that was subject to planning controls. In most cases, the *Standard Flood* equated to the 1% AEP or 1 in 100 ARI flood level. The previous use of a particular or set flood level to determine the *Standard Flood* resulted in there being little or no variation to the criteria used when determining if planning controls should apply to a specific floodplain, or indeed if they should apply to specific areas within a floodplain. In essence, if a parcel of land fell within the *Standard Flood* level, then set planning controls applied to that land.

Flood Planning Levels (FPLs), however, have replaced the *Standard Flood* (as outlined by the FMM 2001 - Reference 2) as the means by which a Council determines the extent of land that is subject to flood related controls or the nature of controls that apply. They differ from the Standard Flood approach as FPLs are a combination of flood levels and freeboard allowance. The use of FPLs has now been adopted as opposed to the previously used term *Standard Flood*, in order to signify that a more wide ranging assessment is adopted in their selection. Unlike the adoption of the *Standard Flood* level that applied to the entire Local Government Area, individual FPLs can be adopted for an individual floodplain or even a local area within the floodplain. It may well be that the 1% AEP (1 in 100 ARI) flood level (plus freeboard) is an appropriate FPL for one floodplain, whereas the 2% AEP (1 in 50 ARI) flood level (plus freeboard) may be appropriate for another floodplain. As discussed in the review of current planning documents relating to the St Georges Basin Floodplain area (Appendix F), the definition of FPL allows for the adoption of different flood levels as determined by Floodplain Risk Management Studies and contained in Floodplain Risk Management Plans. This approach allows for data collected within a specific floodplain to be utilised to streamline the establishment of an FPL for that floodplain, rather than relying on a single Council-wide *Standard Flood* level.

Since August 2002, Shoalhaven City Council has adopted the use of FPL's and specified it to be the 1% AEP flood level plus freeboard.

Discussion

The selection of appropriate FPLs involves consideration of:

- social,
- economic,
- environmental, and
- risk to life and limb,

consequences associated with the occurrence and mitigation of various size floods.

Selecting the appropriate FPL for a particular floodplain involves trading off the social and economic benefits of a reduction in the frequency, inconvenience, damage and risk to life and limb caused by flooding against the social, economic and environmental costs of restricting land use in flood prone areas and of implementing management measures. It is one of the main means of minimising flood damages from new developments. Some of the flood related issues which should be considered are shown in Table 19.

Table 19: Flood Related Issues to be Considered in the Selection of Flood Planning Levels

ISSUE	COMMENT
Flood Behaviour up to the PMF	Relative change in behaviour over the full range of events up to the PMF. Depth and velocity which define hazard.
Old Standard Flood or FPL	Is it accepted by the community? How significant will any change be and what are the implications for existing versus future development?
Wind Wave Effects	The flood study identified the potential for the flood levels in some areas around the Basin foreshore to be increased by the effects of wind waves. A maximum value of 0.6 m was identified at Site 3 (see Figure 1) but this is unlikely to have any impact on existing or future development in this particular area. For the other sites 1 and 2, the wave set up was estimated to range from 0.1 m to 0.3 m. It is suggested that such values could possibly be accounted for within the freeboard allowance of 0.5 m and therefore, no additional increase in Flood Planning Level would be required.
Land Use	Existing and potential. How will this be affected?
Freeboard	The value of freeboard to be added to the adopted base flood level to establish the FPL. Freeboard is intended to account for a range of factors including any uncertainties in the estimated flood levels. A value of 0.5 m is typically adopted.
Availability of Land	Is there other land suitable for development in the area?
Impact of Floodplain Management Strategies	How will these impact upon existing and future development?
Land Values and Social Equity	Will changes affect other land owners?
Impact of Future Flooding	How will this affect existing and future development.
Impact of Future Development	How will this affect flood behaviour.
Resultant Change in Flood Damages	Percentage and absolute change.
Flood Awareness and Preparedness of the Community	Consider present community awareness and to enhance or maintain it in the future.
False Sense of Security	Will this be created?
Flood Warning/Flood Evacuation	Effectiveness of emergency response in small and large events. Availability of evacuation access.
Environmental and Ecological Issues	Will these be affected? Aesthetics of streetscape or amenity considerations.
Interrelationship with other Planning and/or Building Controls	The potential to create conflict with other controls (such as height restrictions) needs to be considered.
Duty of Care	How has this been taken into account?

Conclusions

FPLs are generally required to be 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:

- 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 floor level of a residential building may be set at the 1% AEP flood level + 0.5 m freeboard, 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 effective warning time, the type of development and flood duration.

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 St Georges Basin floodplain. This level is considered to incorporate an appropriate level or balance of risk versus cost to the community for general residential development. Variations of the FPL have been recommended for alternative types of development in accordance with the potential risks or costs involved. The adoption of such a level is also in accordance with accepted standards which have been implemented in similar situations throughout NSW.

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

The proposed development requirements indicated in Table 20 demonstrate the potential interaction of development categories with applicable controls/requirements and relevant Flood Planning Levels. The development types correspond to those outlined in the generic Flood DCP.

Table 20: Flood Related Development Controls - General Development

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

NOT SUITABLE FOR DEVELOPMENT

NOT REQUIRED

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

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

6.6.3 Review and Update Section 149 Certificates

Description

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

Discussion

As part of the FPMS process a floor level survey (refer Appendix D) was undertaken to identify the number of properties in the floodplain affected by floodwaters up to the Extreme event. The floor and ground level data collected as part of this study has been incorporated into Council's GIS database and related to the applicable design flood level information to assist Council in defining the potential flood affectation of the property so that it can be included in the Section 149 Planning Certificate.

It should be noted that the Section 149 Planning Certificates should not be the only form of acknowledgment 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.

Conclusions

The flood affected properties identified by this 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 the flooding implications and/or planning/building restrictions in a consistent manner based on the outcomes of this FPRM process. Details of flood level information should be continually updated as more accurate survey/flood level information becomes available.

6.6.4 Review and Update Local Environmental Plans and Development Control Plans

[Note: This Section currently affected by parallel DCP process - information will need to be revised depending on outcomes.]

Description

The detailed review of existing planning documents and policies undertaken as part of this study (Appendix F), has highlighted a number of issues and/or inconsistencies with the respect to flood related development controls and the principles outlined in the new Floodplain Management Manual (Reference 2).

Council's Local Environmental Plan (LEP 1985) and the various related Development Control Plans (DCP) need to be reviewed and updated to incorporate the latest terminologies and approaches to controlling development within the floodplain.

The LEP usually specifies the nature of development allowable on any area of land and whether Council consent is required. A DCP prior to 2005 usually applied to a particular issue or locality where specific development controls are imposed. However under the NSW Government's 2005 planning reform a single DCP is proposed. Council has prepared Flood DCP No. 106 which incorporates general flood related development controls while the specific issues or problems pertaining to the different floodplain areas will be addressed by the individual Floodplain Risk Management Plans. DCP No. 106 only applies to those areas where a Floodplain Risk Management Plan has been prepared. For all other flood liable areas a DCP is being prepared to replace the Interim Flood Policy.

Discussion

The primary objective of the NSW Government Flood Policy is *"to reduce the impact of flooding and flood liability on individual owners and occupiers, and to reduce private and public losses resulting from flooding, utilising ecologically positive methods wherever possible"*.

Appropriate development controls involve consideration of the social, economic, environmental and risk to life and limb consequences associated with the occurrence and management of floods ranging in magnitude. This involves trading off the various benefits of reducing the impacts of flooding on development against the costs of restricting land use in flood prone areas and of implementing appropriate management measures.

Based on the outcomes from the preliminary planning review for this study (Appendix F) and a separate investigation assessing the risks associated with floodplain management for the entire Shoalhaven LGA (Reference 12), Shoalhaven City Council are actively addressing all planning/development related issues and policies pertaining to floodplain management.

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 a DCP relating to Floodplain Management issues has also been recommended and subsequently DCP No. 106 has been prepared and is effective from October 2006.

DCP No. 106 will provide guidance for the preparation and assessment of development applications in the floodplain within those areas covered by a Floodplain Risk Management Plan. A new DCP will supercede the Interim Flood Policy and will address situations where no formal floodplain risk management plan exists. It will also incorporate the relevant outcomes of FRM Plans that have been prepared for specific floodplains (such as this study).

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

Conclusions

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 specifically identified for the St Georges Basin Floodplain as part of this study (refer Table 20). Council should also review all other DCP's or relevant planning documents to ensure any flood related references are up to date and consistent.

6.6.5 Planning Regulations - Caravan Parks

Description

There are some 16 caravan parks located in the St Georges Basin floodplain area, as shown on Figure 13, with 15 of these located in the Sussex Inlet area. The floor level database information gathered by Council includes summary details for each Park (such as amenities/administration buildings and number of sites) but does not include detailed information on individual caravan sites within these parks. A summary of the key information relating to each Park (including applicable flood levels) is presented in Table D3 of Appendix D.

Discussion

Caravan parks within the floodplain present their own unique problems, and any one of the following may increase the risk to people and property within the park:

- evacuation access is typically limited with only a single entrance/exit which may be controlled by boom gates,
- only a poor quality (or no) site map is generally available to show emergency services the internal road system with the layout of van sites or the types of vans,
- permanent van sites often have fixed annexes which may contain high cost equipment such as fridges, freezers, stoves and lounges,
- there is poor internal lighting which may fail during a flood,
- there may be no flood emergency plan or it has not been tested in recent times,
- there is generally a problem in communicating to the residents due to the lack of or failure of the public address system or telephone network,
- short term residents will have little awareness of the flood risk or damage minimisation measures,
- a large number of vans may be vacant thus increasing the workload and possible risk to life of the "rescuers" in removing vans,
- vans are typically left on site permanently with their mobility for movement restricted by tie downs, poorly maintained or missing wheels and/or draw bars,
- there is the risk that vans may float and crash into each other or obstruct exit routes,
- caravans have little structural integrity and thus can easily be damaged or completely destroyed by flowing floodwaters,
- the internal fittings (cupboards, fridges, beds) are usually non-removable and easily damaged by floodwaters.

In theory caravans are “mobile” or “moveable dwellings” and can be moved to high ground in a flood. In practice however, experience has shown that this is unlikely to occur for some of the above reasons.

For a large number of caravan parks in the Sussex Inlet area there are few vans that can be easily moved to higher ground. Most of the vans are situated on relatively low lying land along the edge of the Sussex Inlet Channel and access to higher ground can be some distance away and difficult to reach during floods. Fortunately, St Georges Basin has a much slower rate of rise than a river system.

While all of the parks are at risk in the 1% AEP flood (1 in 100 ARI), the most vulnerable parks for the 10% AEP (1:10 ARI) flood event appear to be:

- Riverside Van Park (No. 1 - refer Figure 13 for site locations) and Riverside (Seacrest) (No. 15),
- Badgee Van Park (No. 4),
- Riviera Van Park (No. 5),

with Talofa Van Park (No. 11) and Laguna Lodge (No. 6) also of concern from an evacuation access point of view.

Shoalhaven City 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 parks in the SES Local Flood Plan.

Council are responsible for implementing development controls on a park by park basis. Table 21 summarises the controls applicable for the different types of development associated with caravan parks depending on its hazard categorisation.

In principle the provisions outlined in Table 21 should ensure minimal damage to caravans during flood. However, it is likely that the Interim Flood Policy is not fully enforced and if so, many caravans will suffer damage. There is also a risk to life as residents attempt to save their property.

Conclusions

Caravan parks on the floodplain can represent a significant hazard to occupants and rescuers alike during a flood event. Within the St Georges Basin floodplain study area, the hazard is high because a majority of the caravan parks are situated in the high hazard flood risk areas along the bank of the Sussex Inlet Channel. Council's Interim Flood Policy and the development controls outlined in Table 21 provide suitable guidelines to minimise damages but only if they are rigidly enforced. It is recommended that the flood related caravan park controls outlined in Table 21 be incorporated into the generic Flood DCP currently being prepared by Council, and also appropriately cross-referenced in any specific caravan park DCP's.

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 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 specific resourcing requirements or outstanding issues for dealing with that park.

Table 21: 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

6.6.6 Filling of the Floodplain

Description

Filling of the floodplain is often used to provide a raised building platform which in turn facilitates simple construction methods for achieving raised floor levels and thus reduce the potential flood damages experienced by new development. Filling of land within the floodplain affects the temporary storage volume available and may also impact upon the local flow paths. Isolated instances of filling may be able to demonstrate a negligible impact on local flooding but, the cumulative impacts from several individual developments creeping into the floodplain can be much more significant. These potential impacts on flood behaviour must therefore be strategically managed.

Discussion

Filling of flood liable land is generally considered a viable method for reducing the potential damages for new development on the floodplain (either filling of a building pad or as a stock refuge). However the possible adverse hydraulic impacts need to be properly considered and addressed. Council needs to adopt a process whereby the effects of possible filling of flood liable land can be strategically managed to ensure that a number of small developments do not result in a major hydraulic impact overall.

It is difficult to estimate or predict the location and likely extent of future development proposals involving filling of the floodplain. For the St Georges Basin Study area, there are three (3) main problem areas for consideration:

- the foreshore fringes around the Basin,
- the lower lying areas of the original Sussex Inlet township,
- the existing residential zoned land in The Park Drive area at Sanctuary Point.

The Basin itself with a surface area of some 37km^2 (11% of the total catchment) has a significant storage volume available. Any filling of the foreshore fringe areas is therefore likely to represent only a very small percentage loss of storage within the overall context of the Basin floodplain. Filling of this area would have zero impact on Basin flood levels.

For the Sussex Inlet and Park Drive areas there is a greater potential for hydraulic impacts to occur. In order to quantify the order of magnitude of these cumulative impacts it was decided to assume that all existing residential zoned land was filled to the FPL. The extent of fill areas assumed for modelling purposes is indicated on Figure 1 and the results are summarised in Table 22.

Table 22: Relative Impacts of Cumulative Filling (m)

Location	Description	Model Gridpoint	Flood Event (AEP)				
			Extreme	1%	2%	5%	10%
Sanctuary Point	upstream of filled area	G99TOM19 (2)	0.04	*	*	*	*
	filled area	G99TOM13 (2)	0.04	0.12	0.01	0.07	0.05
	downstream filled area	G99TOM7 (2)	0.04	*	*	*	*
Sussex Inlet	8 (1) Badgee Lagoon Jtn	GSECT25	0.04	*	*	*	*
	9 (1) Jacobs Drive	GSECT22	0.04	*	*	*	*
	11 (1) Coastal Patrol	GSECT11	*	*	*	*	*

Note: * The change in flood level is ±0.01 m or less which is within the limits of model accuracy.
(1) Refer to Figure 1 for the location of model gridpoints.
(2) Refer to Figure 9 for location of model gridpoints.

It is evident from the above results for Sussex Inlet that filling of the low lying areas would generally not have any significant impact on flood levels for existing development or FPL's for future development. However, any filling has the potential to impact on flood levels and flow behaviour for surrounding properties. Particularly in the immediate vicinity of the filling and/or when the filling is undertaken in a piecemeal or adhoc fashion.

At Sanctuary Point, the impacts are greater and consequently if Council was to allow filling of this area then the local FPL's should be adjusted to account for the anticipated increase in level. While future development would not be adversely affected by this gradual filling process, the surrounding and upstream existing development would be impacted upon. Council therefore needs to consider the implications of this issue carefully before allowing wholesale or even adhoc filling within this area to commence.

Each individual application for filling must be considered on its merits and this can only be achieved if an appropriate hydraulic assessment has been undertaken to quantify the local and cumulative impacts for the surrounding area. As a general rule, within the context of the overall St Georges Basin floodplain, a small fill volume suitable for creating a building pad of around half a normal residential block (say 20 x 15 x 1.5 m depth = 450 m^3), or preferably less, represents a very small percentage of the total basin floodplain volume and is unlikely to have any significant impact on flood levels but it may have a very localised affect on flow paths.

Strategic management of filling could include:

- identifying lots with filling in a theme layer of Council's GIS. This task should be initiated at the DA stage and finalised with the Construction Certificate. This task is essential to ensure that cumulative impacts are considered,
- ensuring consideration of both local drainage and mainstream flooding impacts,
- ensuring that developments of subdivisions on flood liable land (if applicable) incorporates local overland flow paths in their design,
- educating the community about flooding and the need to evacuate even if the house is above the FPL.

Conclusions

Council's generic flood policy should include some general limits on filling and excavation within the floodplain and keep a record of the cumulative fill and excavation over time. The predominant hydraulic classification for the St Georges Basin floodplain area is "Flood Storage". Nominal filling of individual lots around the Basin foreshore areas (as infill development or redevelopment) would have negligible impact on flood levels in general and therefore should be permissible provided there are no adverse impacts on local flow paths or surrounding properties. For areas outside these limits a rigorous hydraulic investigation will be required. This latter approach is required because it is impossible to foreshadow the likely extent of future filling across the overall floodplain and the reasons for it. Ideally, a balanced cut/fill exercise for each development is to be preferred but realistically there may be extenuating site conditions where this will not always be possible. The other alternative to filling around the flood liable fringe areas is to construct the buildings on piered foundations to minimise the loss of floodplain storage.

It is recommended that guidelines for fill encompassing the above are included in the Floodplain Risk Management Plan.

6.6.7 The Greenhouse Effect

Description

The Greenhouse Effect is associated with the presence of certain gases in the atmosphere which allow the sun's rays to penetrate to the earth but reduce the amount of energy being radiated back. It is this trapping of reflected heat which has enabled life to exist on earth.

Recently, there has been concern that increasing amounts of greenhouse gases resulting from human activity may be raising the average surface temperature. As a consequence, this may affect the prevailing climate conditions and cause a rise in sea level. The extent of any permanent climatic or sea level change can only be established through scientific observations over several decades. Nevertheless, it is prudent to consider the possible range of impacts with regard to flooding and the level of flood protection provided by any mitigation works.

Discussion

The Bureau of Meteorology has indicated that there is no intention at present to revise design rainfalls to take account of the Greenhouse Effect, as the possible mechanisms are far from clear and there is no indication that the changes would in fact increase rainfalls in major storms. Even if an increase in total annual rainfall does occur, the impact on storm rainfalls may not be adverse.

It has also been suggested that the cyclone belt may move further southwards. The possible impacts of this on design rainfalls cannot be ascertained at this time as little is known about the mechanisms that determine the movement of cyclones under existing conditions.

Another possible consequence of the Greenhouse Effect could be a rise in sea level. This issue is complicated by other long term influences on mean sea level changes. The available literature suggests that a gradual increase in sea level is likely to occur with a rise of perhaps 0.05 m to 0.3 m within the next 50 years (Reference 13, pg 27).

Of more significance will be the impact on the erosional and sedimentation regime at Sussex Inlet. The Greenhouse Effect may vary the frequency and length of closures but, at this stage, there is not enough information to allow any definite conclusions on this.

Raising the minimum floor level by the likely magnitude of the rise in sea level for new developments at Sussex Inlet was considered but rejected for two reasons. Firstly, the freeboard allowance to some extent already includes a nominal allowance for this factor.

Secondly, the increase will be a gradual rise over 50 years. As the life of a modern house is probably 50 years or less it is likely that the bulk of houses constructed today will not be around to experience the flood implications of a 0.3 m rise (if it occurs). As we learn more about the impacts of the Greenhouse Effect, Council's Flood Policy can be progressively updated.

Conclusions

The Greenhouse Effect may affect design flood levels in the St Georges Basin, however, preliminary investigations have indicated that the impact in the study area will be minor. The impact on the Sussex Inlet entrance and channel may be more significant but there is no definitive information at this stage. Council should continue to monitor the available literature and reassess Council's Flood Policy as appropriate. Accordingly, the outcomes from this Floodplain Risk Management Study, the Management Plan and the adopted Flood Planning Levels should be reviewed on a regular basis with a minimum of every five (5) to ten (10) years or as appropriate.

7. ACKNOWLEDGMENTS

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

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

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FIGURE 1

LOCALITY MAP AND STUDY AREA

WANDANDIAN

Princes Highway

The Wool Road

WANDANDIAN CREEK

TOMERONG CREEK

PATS CK.

HOME CK.

PATS BAY

BASIN VIEW

HOME BAY

PELICAN POINT

ST GEORGES BASIN

Wool Road

WORROWING CK

EROWAL CK

EROWAL BAY

Naval College Road

Deakin St

STONEY CK

ISLAND POINT JETTY

GARDEN ISLAND

PARADISE BEACH

SANCTUARY POINT

TULLARWALLA CREEK

COW CREEK

SWAN BAY

ST. GEORGES BASIN

Sussex Inlet Road

Alternate Evacuation Route

Fairview Crescent Levee

BHERWERRE

COMMONWEALTH TERRITORY

BADGEE LAGOON

Raise Jacobs Drive

SUSSEX INLET

SUSSEX INLET

BHERWERRE BEACH

FARNHAM

SWAN LAKE

WRECK BAY

3 4 5 6 7 1 8 9 10 11 2

SITE 3 SITE 2 Site 1

New South Wales

Study Area

Sydney

N

LEGEND:

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

0.5 0 0.5 1 1.5 2 2.5km

SCALE

FIGURE 2

ENVIRONMENTAL ISSUES

WANDANDIAN
Princes Highway
The Wool Road
PATS BASIN BAY
PATS CK.
HOME CK.
PELICAN POINT
HOME BAY
ST GEORGES BASIN
TOMERONG CREEK
Wool Road
WORKSHOP CK.
EROWAL BAY
Naval
STONEY CK
CREEK
WANDANDIAN CREEK
Highway
Princes
TULLARWALLA CREEK
ISLAND POINT JETTY
GARDEN ISLAND
PARADISE BEACH
SANCTUARY POINT
SWAN BAY
ST. GEORGES BASIN
COW CREEK
Sussex Inlet Road
BHERWERRE
BADGEE LAGOON
COMMONWEALTH TERRITORY
FARNHAM
SUSSEX INLET
SUSSEX INLET
BHERWERRE BEACH
WRECK BAY
SWAN LAKE

LEGEND:

Acid Sulphate Soils
- High Potential Acid Sulphate Soils
- Low Potential Acid Sulphate Soils
- No Known Occurence
- Disturbed Terrain
- None

Environmental Issues
- Heritage
- Threatened Fauna
- Other Flora
- Melaleuca
- SEPP14 Wetlands

N

0.5 0 0.5 1 1.5 2 2.5km

SCALE

FIGURE 3

LAND USE

WANDANDIAN

TOMERONG CREEK

Princes Highway

The Wool Road

PATS CK.

HOME CK.

PATS BAY

HOME BAY

BASIN VIEW

PELICAN POINT

ST GEORGES BASIN

Wool Road

WORROWING CK.

EROWAL CK.

EROWAL BAY

WANDANDIAN CREEK

Princes Highway

ISLAND POINT JETTY

GARDEN ISLAND

PARADISE BEACH

SANCTUARY POINT

Naval College

Deakin St.

STONEY CK

TULLARWALLA CREEK

COW CREEK

SWAN BAY

ST. GEORGES BASIN

Sussex Inlet Road

BHERWERRE

BADGEE LAGOON

COMMONWEALTH TERRITORY

FARNHAM

SUSSEX INLET

SUSSEX INLET

BHERWERRE BEACH

SWAN LAKE

LEGEND:

LEP Zoning

- Rural
- Residential
- Business
- Industrial
- Special Use
- Open Space
- Environmental Protection
- National Park
- Natual Hazard
- Excluded From LEP

N

0.5 0 0.5 1 1.5 2 2.5km

SCALE

FIGURE 4

HYDRAULIC & HAZARD CATEGORISATION ST GEORGES BASIN FLOODPLAIN

WANDANDIAN

(c) Pats and Home Creeks

(d) Tomerong and Erowal Creeks & Worrowing Waterway

(b) Cow, Tullarwalla and Wandandian Creeks

(a) Sussex Inlet

ST. GEORGES BASIN

BHERWERRE

COMMONWEALTH TERRITORY

SWAN BAY

SWAN LAKE

FARNHAM

Princes Highway

The Wool Road

TOMERONG CREEK

Wool Road

Naval College Road

Deakin St

Sussex Inlet Road

BHERWERRE BEACH

PATS CK

HOME CK

PATS BAY

HOME BAY

BASIN VIEW

PELICAN POINT

ST GEORGES BASIN

ISLAND POINT JETTY

GARDEN ISLAND

PARADISE BEACH

SANCTUARY POINT

EROWAL BAY

WORROWING CK

EROWAL CK

STONEY CK

WANDANDIAN CREEK

TULLARWALLA CREEK

COW CREEK

BADGEE LAGOON

SUSSEX INLET

SUSSEX INLET

LEGEND:

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

Note: Refer to Section 3 for definiton 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)

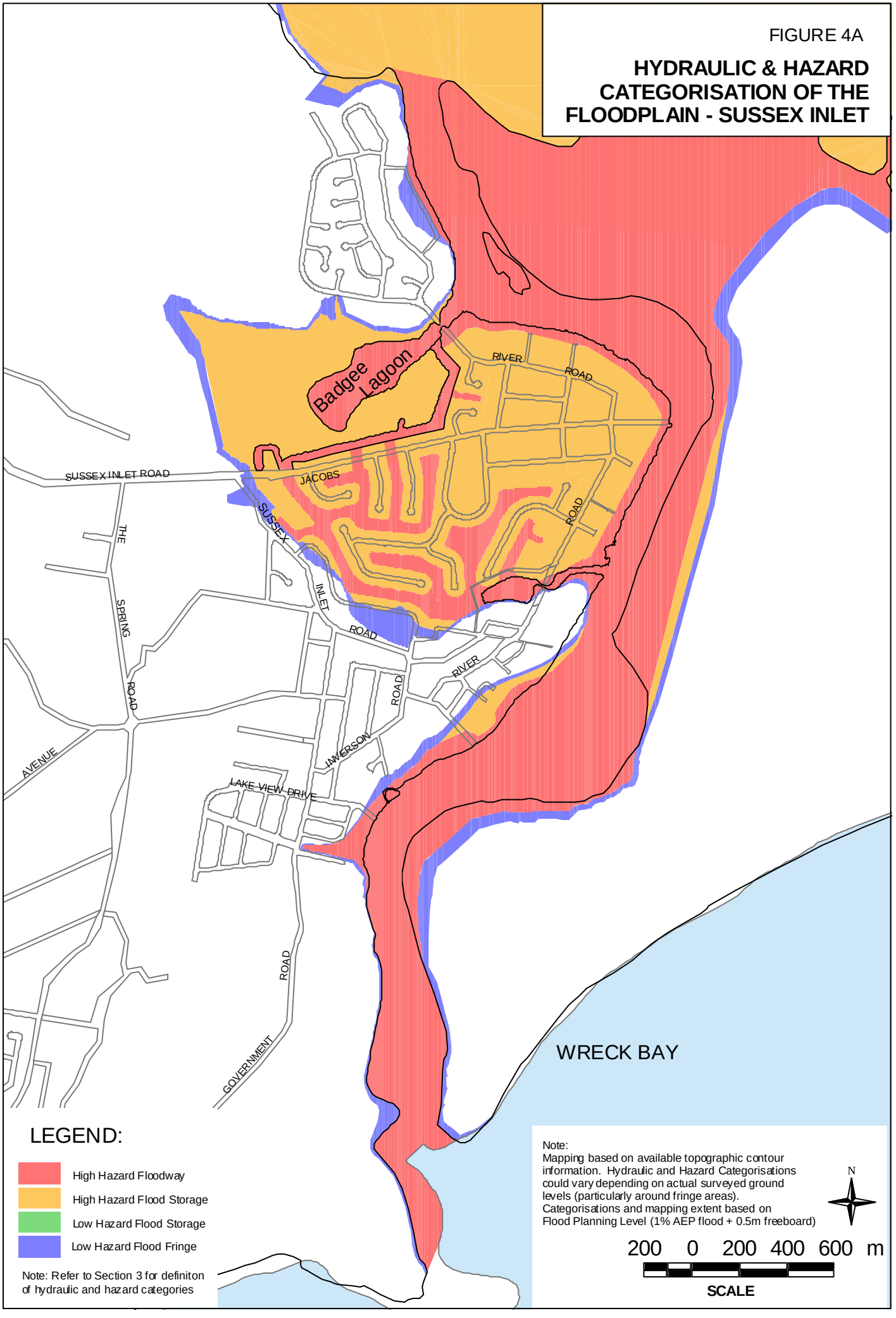
N

0.5 0 0.5 1 1.5 2 2.5km

SCALE

FIGURE 4A

HYDRAULIC & HAZARD CATEGORISATION OF THE FLOODPLAIN - SUSSEX INLET



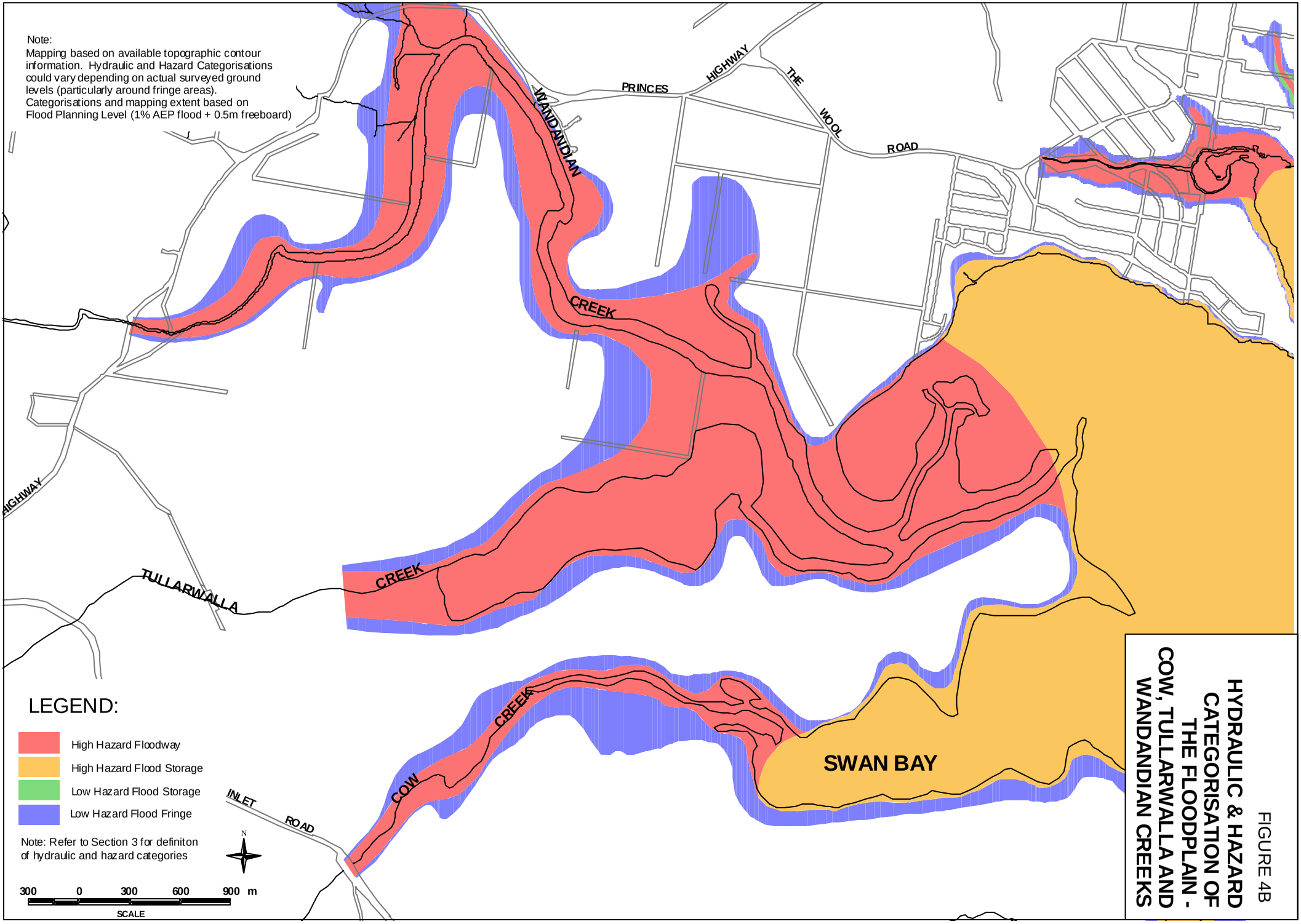


FIGURE 4B

HYDRAULIC & HAZARD CATEGORISATION OF THE FLOODPLAIN - COW, TULLARWALLA AND WANDANDIAN CREEKS

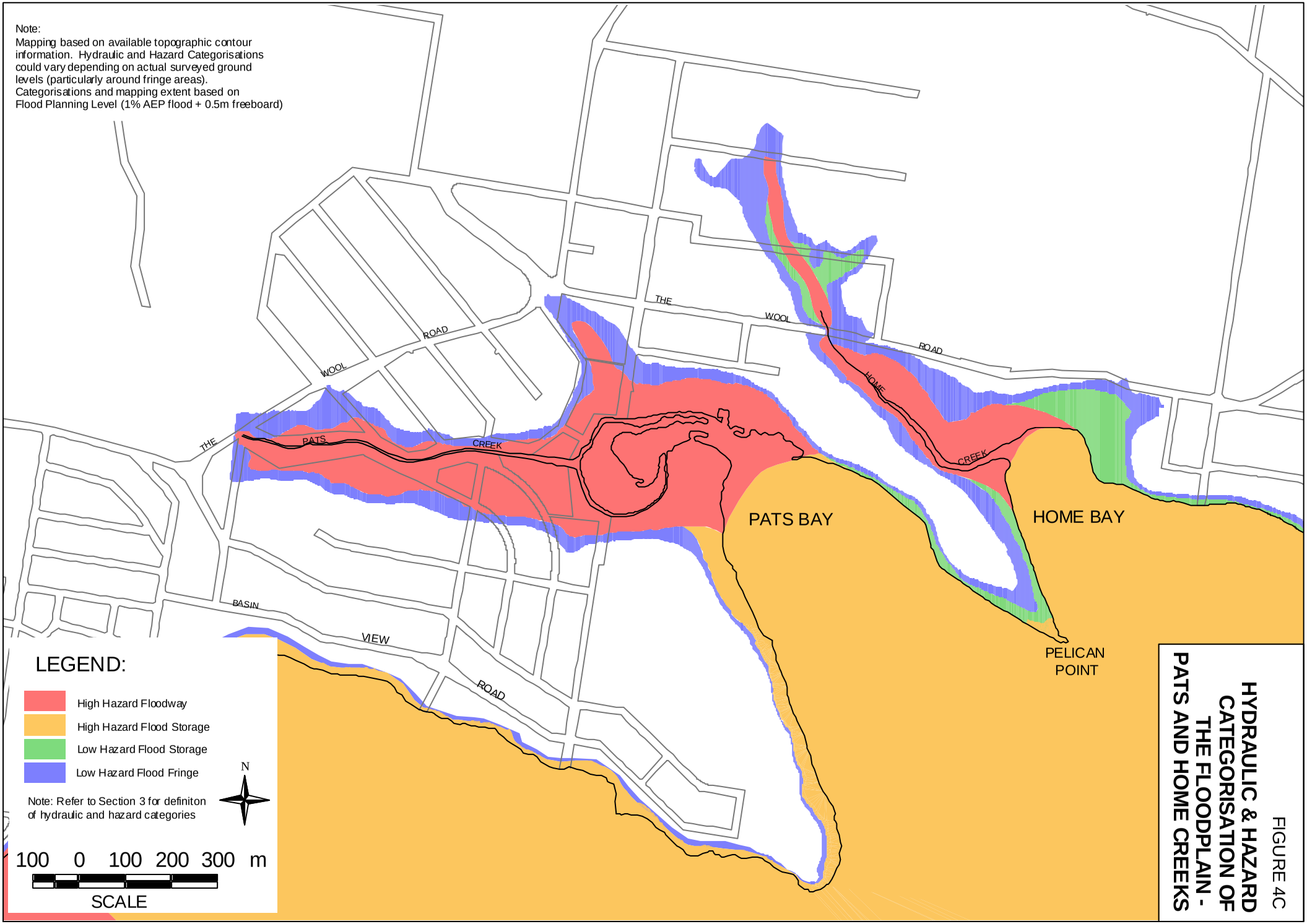
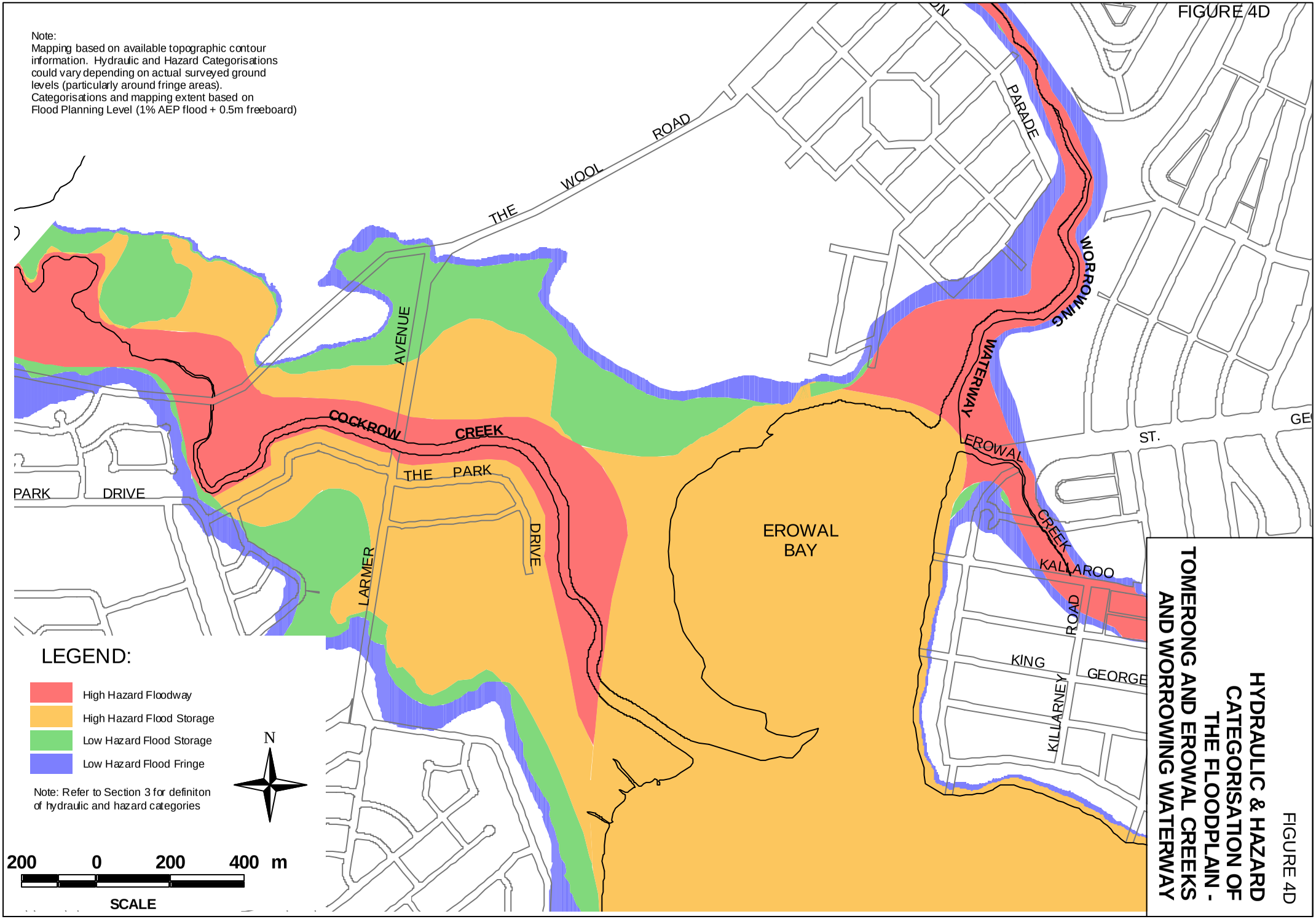


FIGURE 4C

HYDRAULIC & HAZARD CATEGORISATION OF THE FLOODPLAIN - PATS AND HOME CREEKS

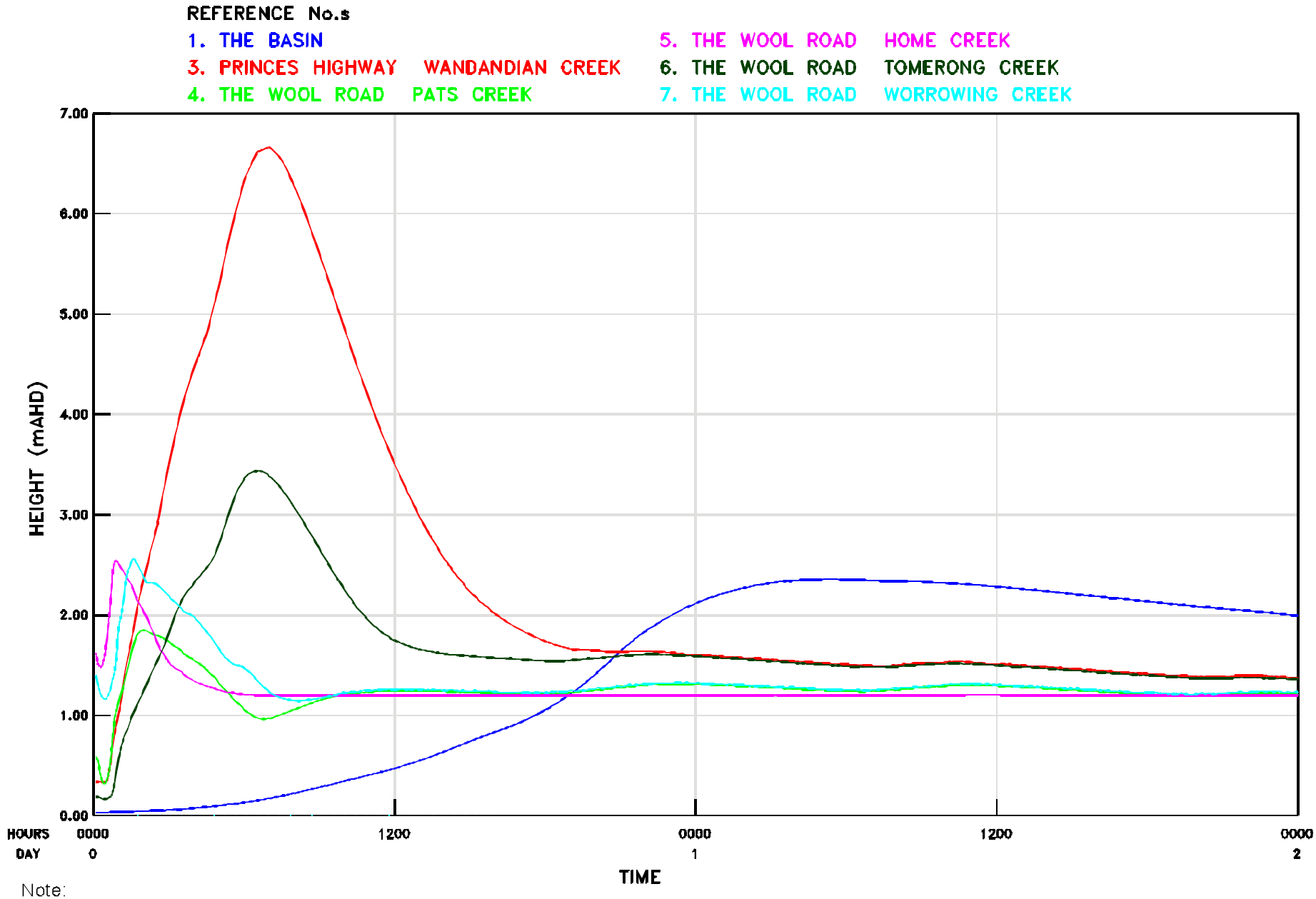
FIGURE 4D

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)



HYDRAULIC & HAZARD CATEGORISATION OF THE FLOODPLAIN - TOMERONG AND EROWAL CREEKS AND WORROWING WATERWAY

FIGURE 4D

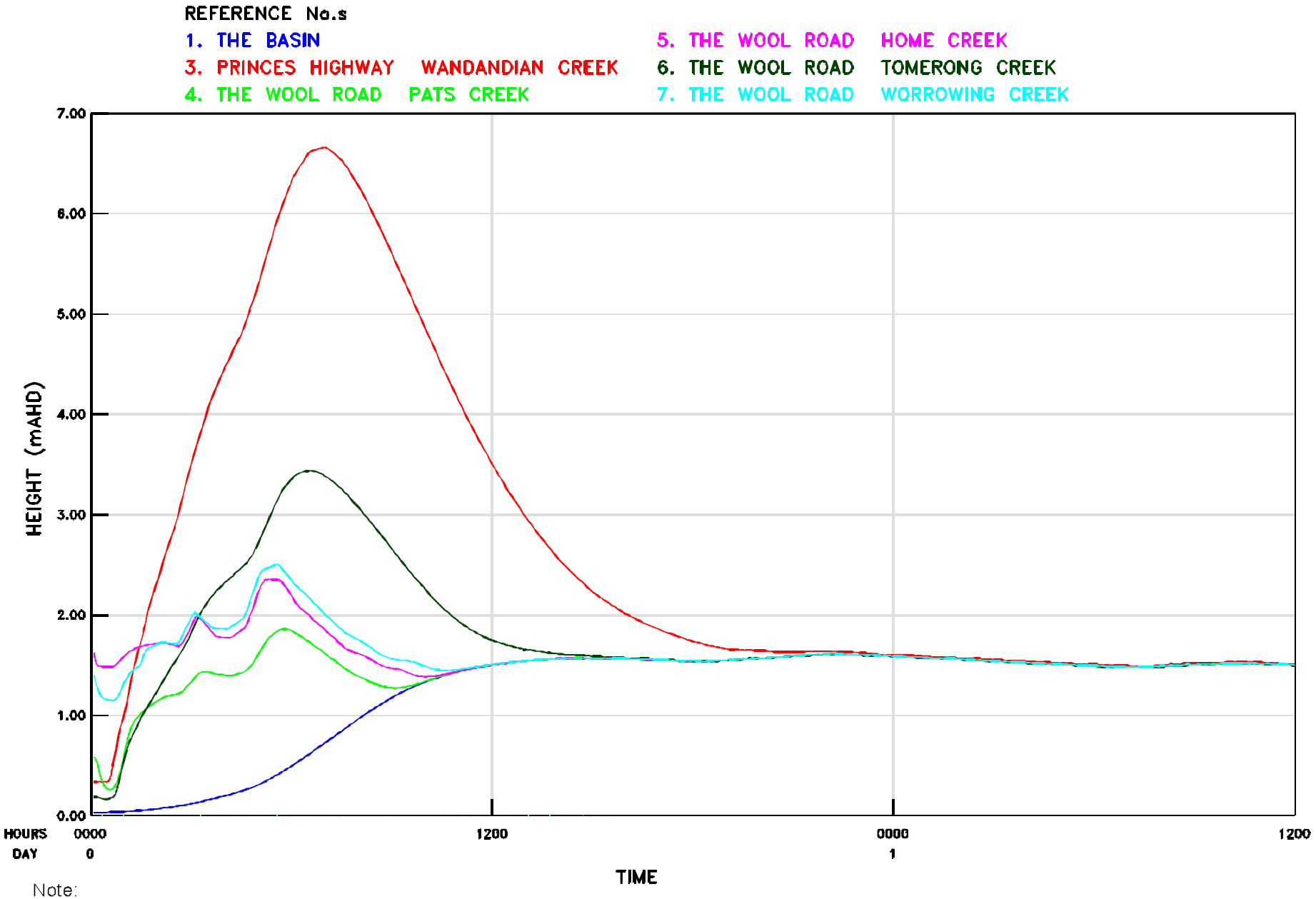


STAGE HYDROGRAPHS
1% AEP DESIGN FLOOD
CRITICAL DURATIONS

FIGURE 5

Note:

- Refer Figure 1 for location of Hydrographs (model grid points reference No.s).
- Locations 2, 8, 9, 10 and 11 not graphed.



Note:

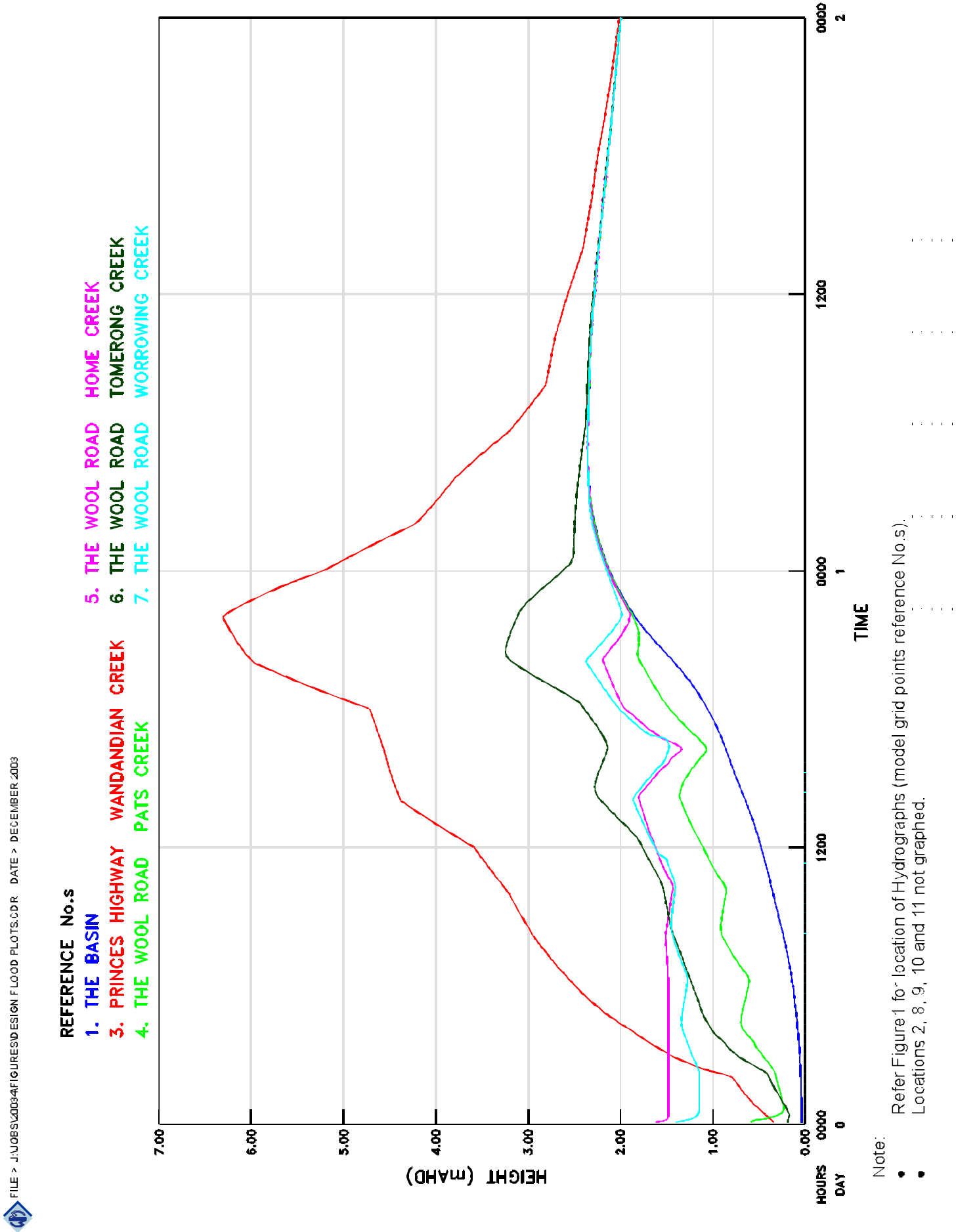
- Refer Figure 1 for location of Hydrographs (model grid points reference No.s).
- Locations 2, 8, 9, 10 and 11 not graphed.

STAGE HYDROGRAPHS
1% AEP DESIGN FLOOD
9 HOUR STORM DURATION

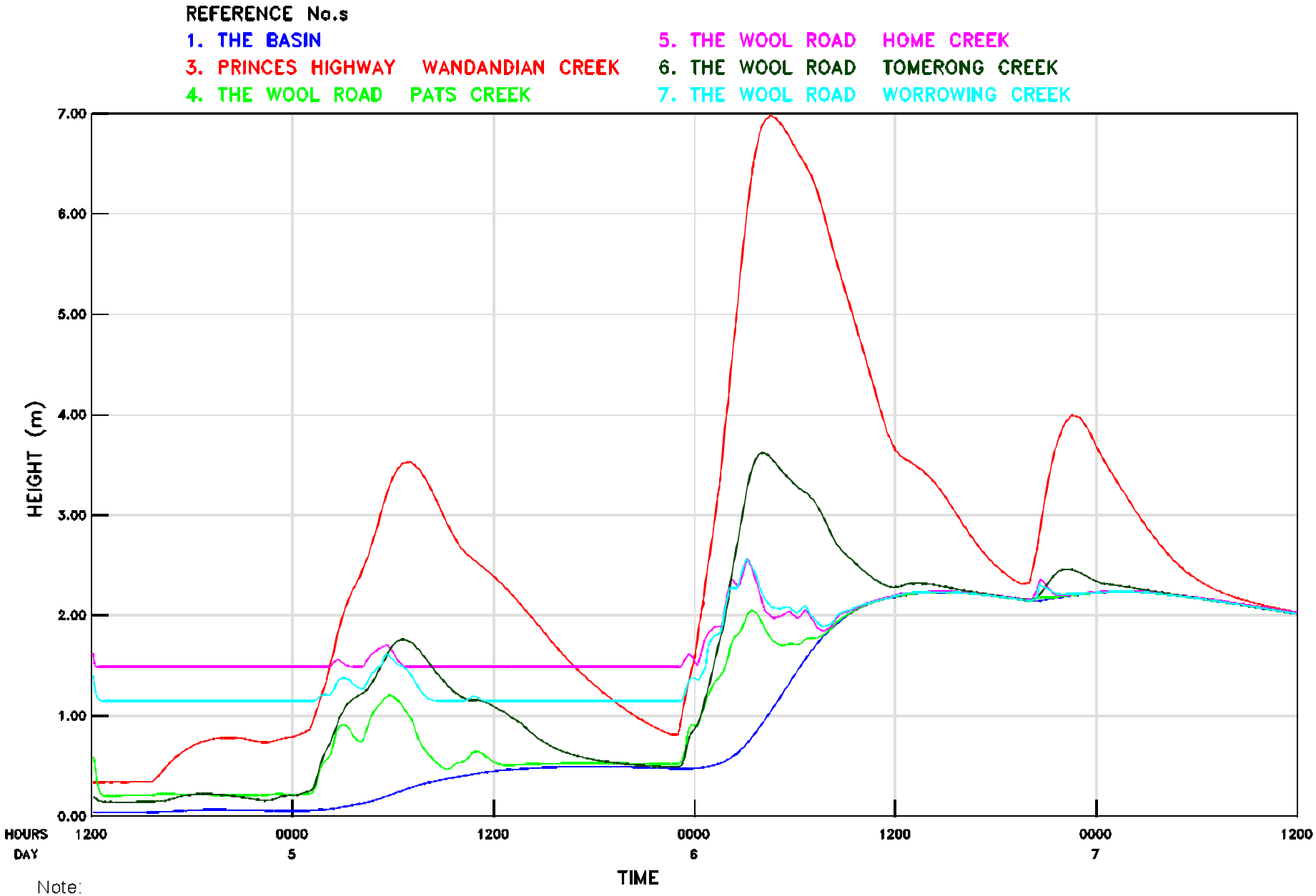
FIGURE 6

FIGURE 7

STAGE HYDROGRAPHS
1% AEP DESIGN FLOOD
48 HOUR STORM DURATION



Note:
- Refer Figure 1 for location of Hydrographs (model grid points reference No.s).
- Locations 2, 8, 9, 10 and 11 not graphed.

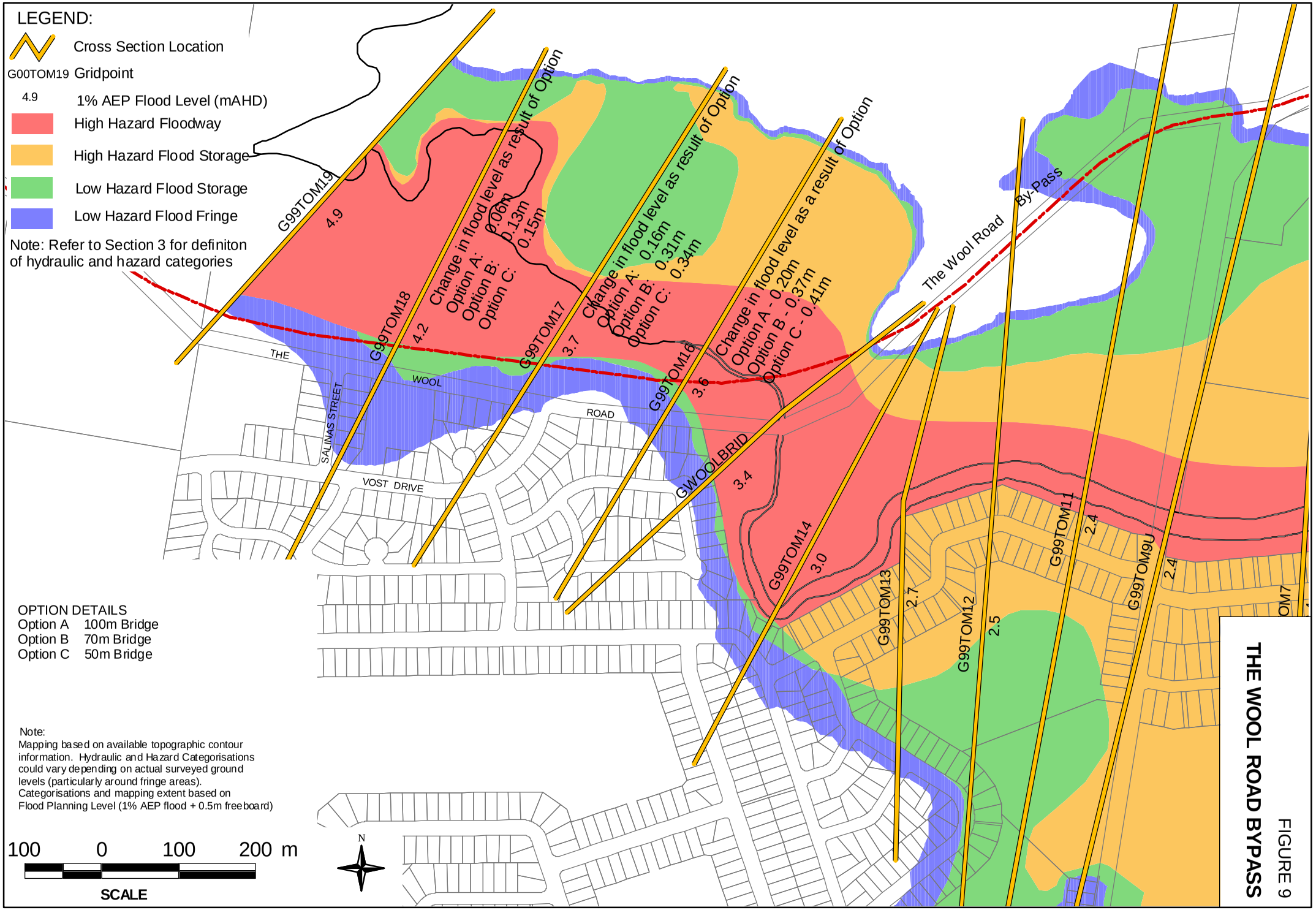


Note:

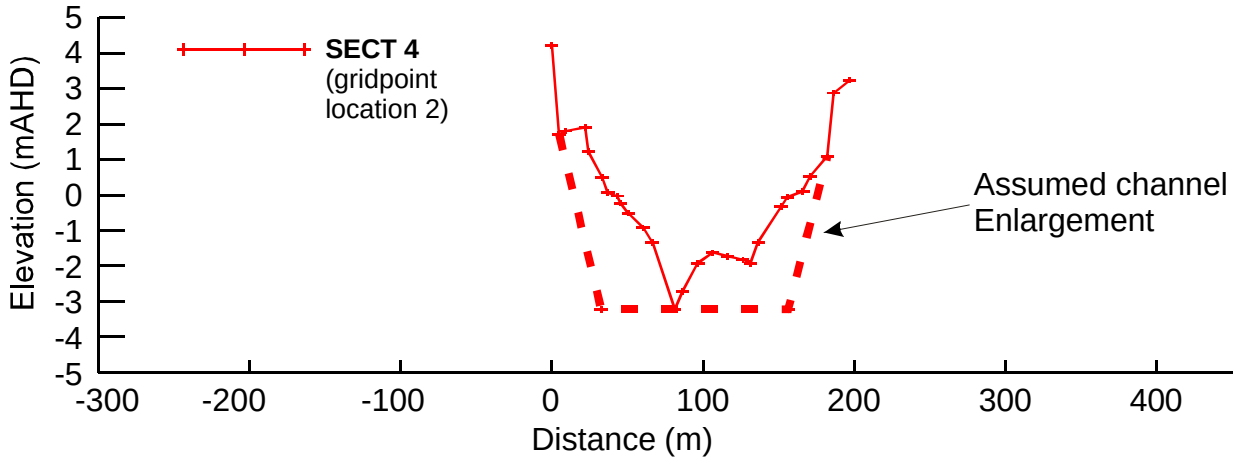
- Refer Figure 1 for location of Hydrographs (model grid points reference No.s).
- Locations 2, 8, 9, 10 and 11 not graphed.

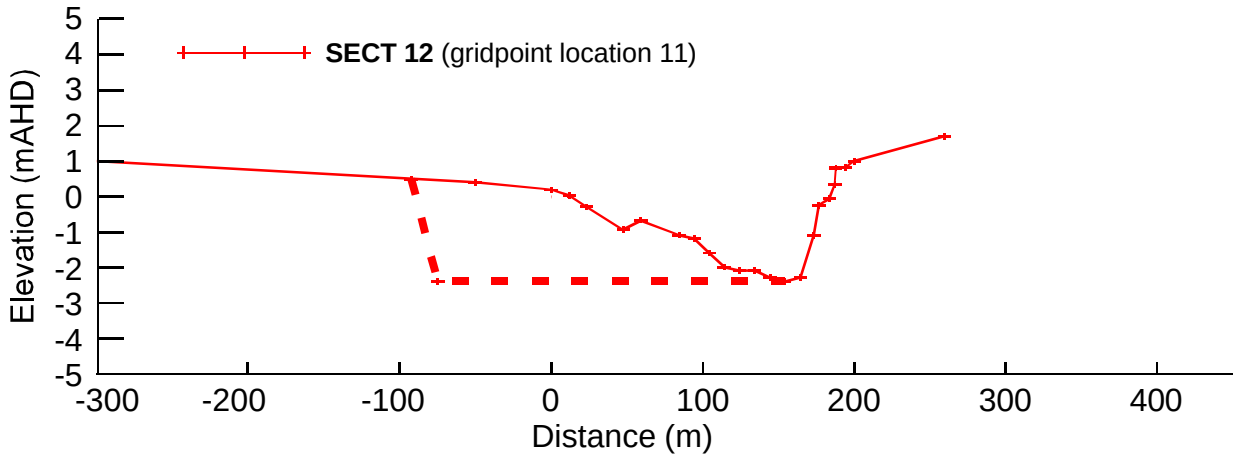
STAGE HYDROGRAPHS 1971 FLOOD EVENT

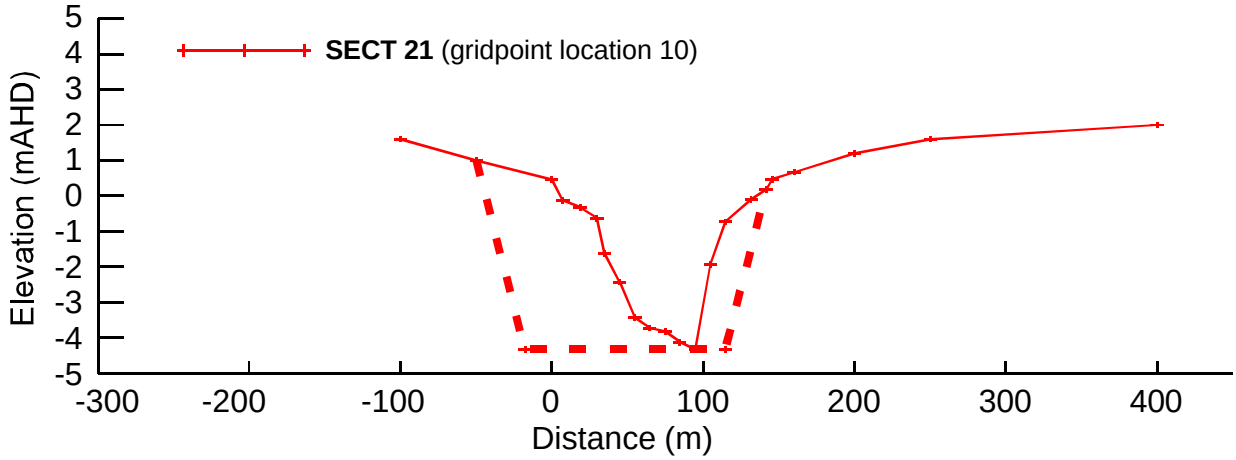
FIGURE 8

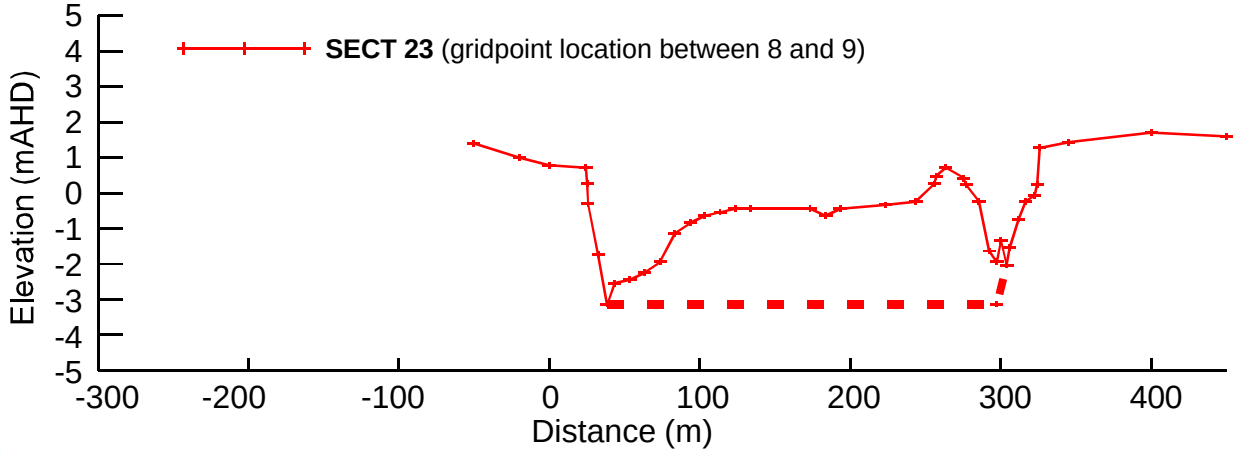

LEGEND:
Cross Section Location
G00TOM19 Gridpoint
4.9 1% AEP Flood Level (mAHD)
High Hazard Floodway
High Hazard Flood Storage
Low Hazard Flood Storage
Low Hazard Flood Fringe
Note: Refer to Section 3 for definiton of hydraulic and hazard categories
G99TOM19
4.9
Change in flood level as result of Option
Option A: 0.06m
Option B: 0.13m
Option C: 0.15m
G99TOM18
4.2
G99TOM17
3.7
Change in flood level as result of Option
Option A: 0.16m
Option B: 0.31m
Option C: 0.34m
G99TOM16
3.6
Change in flood level as result of Option
Option A - 0.20m
Option B - 0.37m
Option C - 0.41m
The Wool Road By-Pass
THE WOOL ROAD
SALINAS STREET
VOST DRIVE
G/WOOLBRID
3.4
G99TOM14
3.0
G99TOM13
2.7
G99TOM12
2.5
G99TOM11
2.4
G99TOM9U
2.4
OPTION DETAILS
Option A 100m Bridge
Option B 70m Bridge
Option C 50m Bridge
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)
100 0 100 200 m
SCALE
N
THE WOOL ROAD BYPASS
FIGURE 9

SUSSEX INLET CHANNEL
CROSS SECTIONS









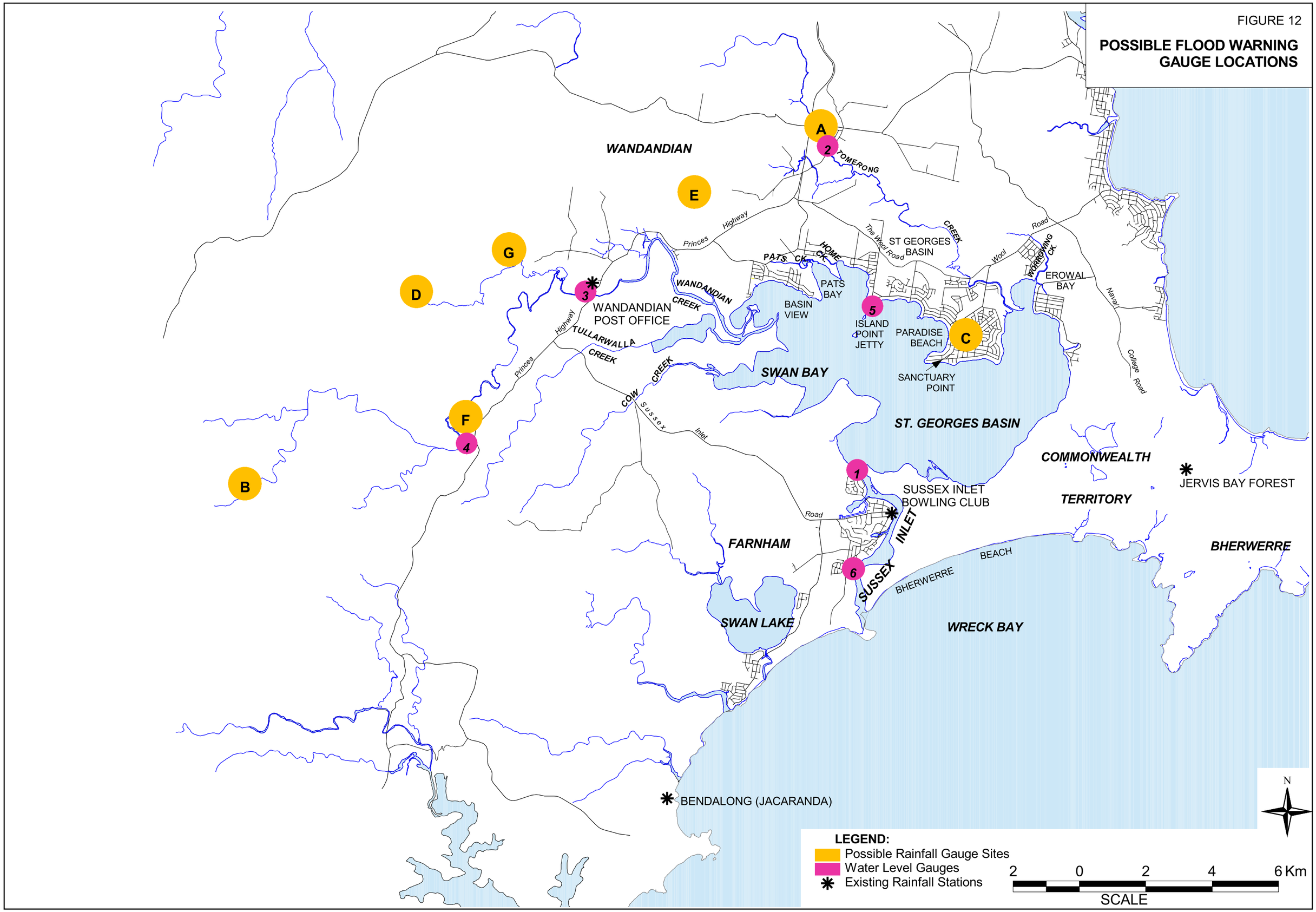
19/02/02 14:39

Note: Model grid point locations are indicated on Figure 1.


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

FIGURE 12

POSSIBLE FLOOD WARNING GAUGE LOCATIONS



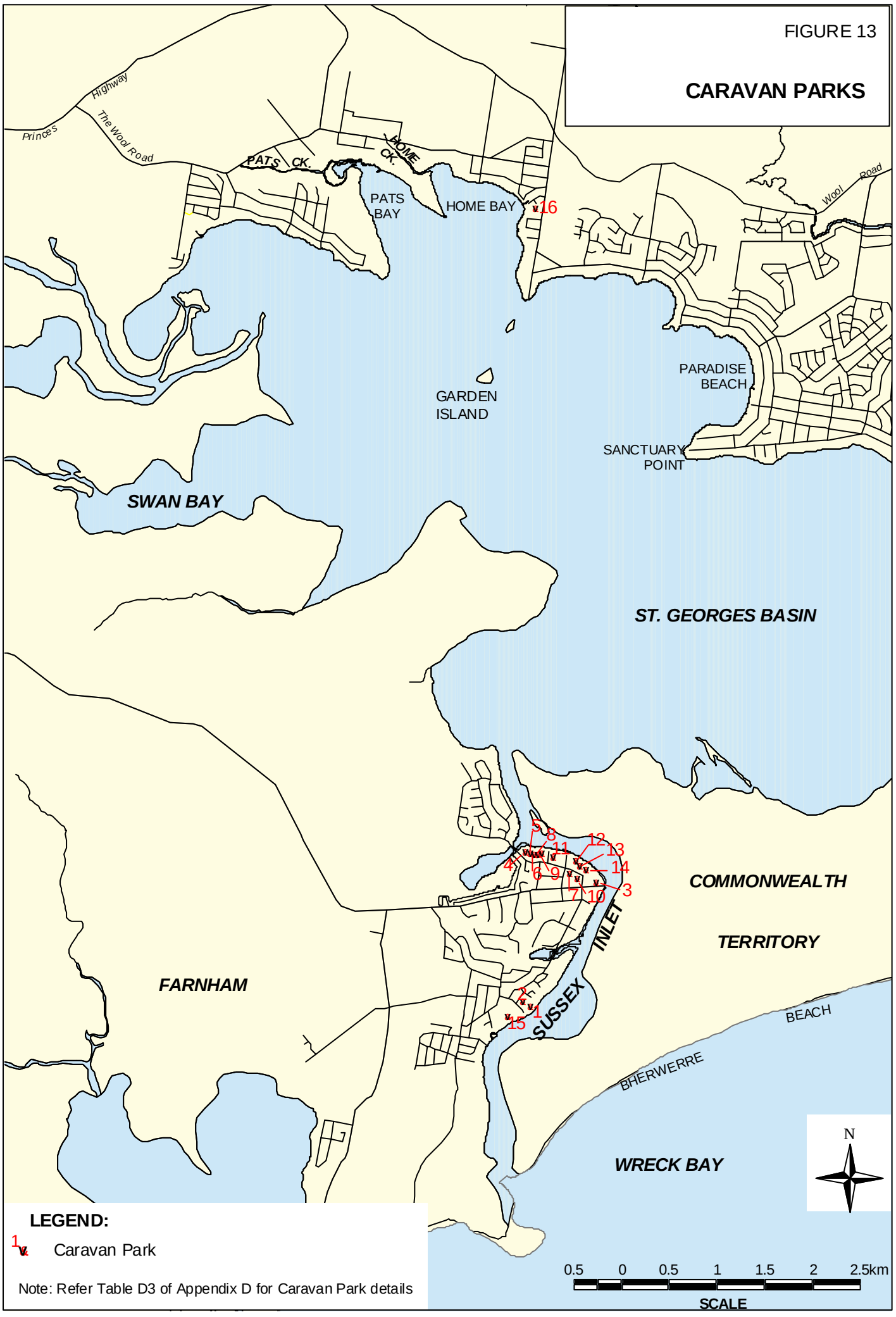


FIGURE 13
CARAVAN PARKS
Princes Highway
The Wool Road
PATS CK.
HOME CK.
PATS BAY
HOME BAY
16
Wool Road
PARADISE BEACH
GARDEN ISLAND
SANCTUARY POINT
SWAN BAY
ST. GEORGES BASIN
COMMONWEALTH TERRITORY
FARNHAM
SUSSEX INLET
BHERWERRE BEACH
WRECK BAY
5
8
12
11
13
4
14
6
9
7
10
3
2
1
15
N
LEGEND:
Caravan Park
Note: Refer Table D3 of Appendix D for Caravan Park details
0.5 0 0.5 1 1.5 2 2.5km
SCALE

APPENDIX A: DESCRIPTION AND ASSESSMENT OF FLOOD DAMAGES

APPENDIX A: DESCRIPTION AND ASSESSMENT OF FLOOD DAMAGES

A1. DESCRIPTION OF FLOOD DAMAGES

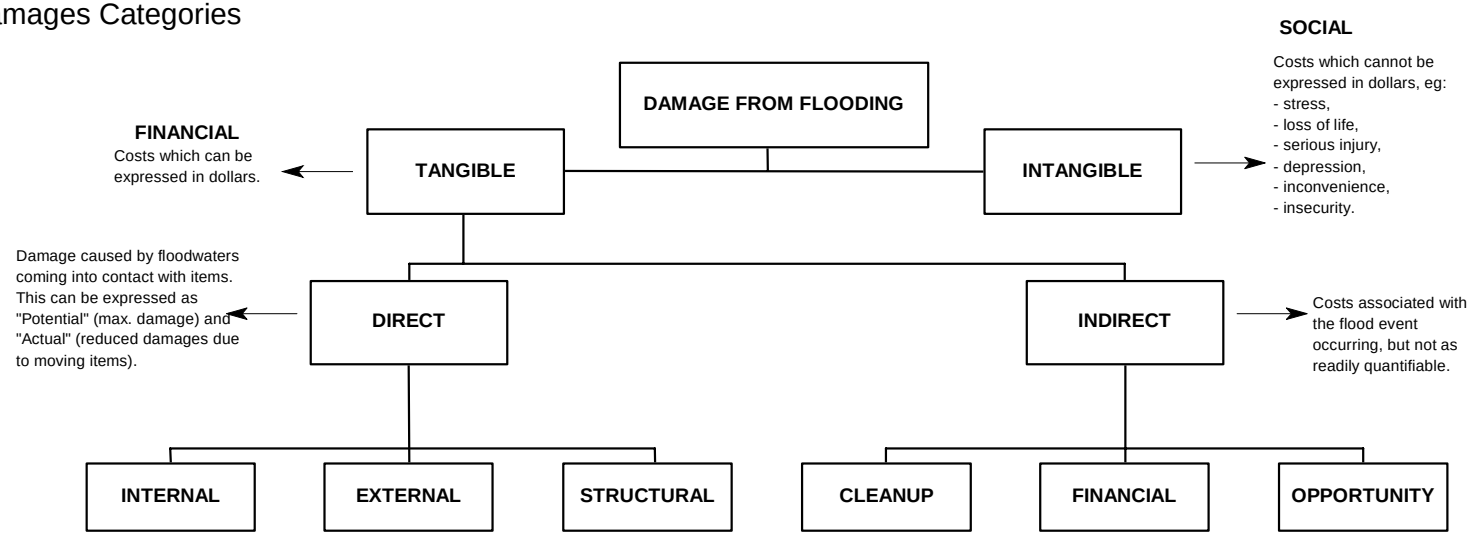
A1.1 General

A database provided by Shoalhaven City Council (Appendix D) has been used to identify the number of buildings inundated above floor level for various design events. For each property a habitable floor level (or work floor level for non-residential buildings) and a typical ground level were obtained. The typical ground level value was used for estimation of damages to the grounds, garage, etc.

Flood damages can be defined as being *tangible* or *intangible* and a schematic breakdown of the damages categories is provided as Table A1. 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.

There are few records of actual flood damages to buildings or private property although these undoubtedly occurred in the 1971 event and floods of the early 1990's.

Table A1: Flood Damages Categories



RESIDENTIAL	Contents of Buildings: Clothes, Carpets, Furniture, Valuables, Fittings, Appliances	External Items: Vehicles, Laundries, Caravans, Sheds, Tools, Gardens, Fences	Physical Damage to Buildings: Gyprock, Cupboards, Scour of Footings, Houses becoming buoyant (floating off footings)	Clean Carpets, Walls, Clothes; Re-instate Furniture; Remove Mud and Debris	Loss of wages, Living costs (temporary accomodation and food), Time to repair/replace damaged items	Not Applicable
RURAL	Contents of Buildings: Clothes, Carpets, Furniture, Valuables, Fittings, Appliances	External Items: Vehicles, Sheds (stables/barns), Machinery, Tools, Fences, Feed storage, Saddles, Crops &/or Stock, Irrigation Systems	Physical Damage to Structures: Damage to Homestead, Sheds, Access tracks, Protection levees	Clean Homestead and Out-buildings; Remove Debris; Dispose of affected crops &/or stock	Loss of Farm Production and Income, Re-instatement of Pastures, Supplementary feeding of stock (by hand or outside agistment), Stock movement/ transport, Living costs (temporary accomodation and food)	Sowing or harvesting of Crops, Sale of Stock (at depreciated value or dependent on market influences)
COMMERCIAL	Contents of Buildings: Products, Stock, Fittings, Tools, Machinery, Raw Materials	External Items: Vehicles, Machinery, Display, Raw Materials/Stockpiles, Fences	Physical Damage to Buildings	Dispose of damaged products, stock, materials; Cleaning and Re-instatement	Loss of Productivity and Income, Bank Interest Charges	Loss of existing &/or Potential Trade
PUBLIC AUTHORITIES	Contents of Public Buildings and Facilities	Public Property and Facilities: Parks, Signs, Machinery, Equipment	Physical Damage to Infrastructure: Electricity, Water, Telephone, Gas, Road & Rail Transport Links	Remove Mud & Debris from Facilities, Public & Private Property Repairs (temporary & permanent)	Disruption of Services, Community Service Relief Grants	Provision of Public Service

A1.2 Tangible Damages

Tangible damages can be sub-divided into *direct* damages, which occur due to physical contact with the floodwaters, and *indirect* damages which occur as a result of the disruption of business, trade and other activities. Direct and indirect damages may be referred to as *Potential* or *Actual* damages. Potential damages are the assumed damages if no damage reduction measures are employed and are thus greater than the actual damages. The ratio of actual to potential damages depends upon a number of factors including:

- magnitude of the flood,
- prior flood experience of the community,
- length of warning time.

Direct Damages

Direct damages can be sub-divided between the rural and urban sector. Under direct urban damages there are three broad categories: *Residential, Commercial* and *Public Sector*.

The direct damages under these categories can be grouped under the following headings:

- *Internal* - building contents,
- *Structural* - structure and building fabric,
- *External* - yard, garage, vehicle and other machinery (air conditioning).

Damages to commercial and industrial buildings are much more difficult to quantify for two reasons:

- damages to a given property vary much more than with houses, as they are heavily influenced by the type of business being carried out and the amount of stock carried. This will also vary over time as different businesses use the building,
- industrial enterprises in particular cannot simply be averaged out. Where large factories or warehouses are involved, the only way to get a good estimate of potential damages is to do a site specific survey of the enterprise.

As flood damages can vary greatly between areas depending upon the type of buildings and contents, an average damages figure is estimated for each of the above categories (residential, commercial and public sector) following a flood. This is generally presented as a flood depth versus flood damages function.

Public sector (non-building) damages include:

- recreational/tourist facilities,
- water and sewerage supply,
- gas supply,
- telephone supply,
- electricity supply including transmission poles/lines, sub-stations and underground cables,
- roads and bridges including traffic lights/signs,

- railway line and associated structures,
- costs to employ the emergency services.

Damages to the public sector can contribute a significant proportion of the total flood costs. In the Inverell flood of February 1991, direct costs to the local Council accounted for 10% of the total direct damages. A single item such as a bridge or a sub-station may account for a large proportion of the damages bill in a particular flood.

Indirect Damages

Indirect damages are more difficult to quantify. They can be sub-divided into three broad cost categories:

- *Clean-up* - clean carpets, furniture, refrigerator, etc. It also includes the cost of alternative accommodation,
- *Financial* - loss of wages, loss of trade for the commercial/industrial sector,
- *Opportunity* - non-provision of commercial and public services.

In a particular locality it would require an extensive survey to evaluate the costs of lost working hours, disruption to business and trade. Nevertheless an indication of the damages can be obtained from previous studies. Generally the indirect damages have been expressed as a percentage of the direct damages. The figure varies greatly depending upon a number of factors including:

- magnitude of flood,
- time away from home/work,
- category (residential, commercial, industrial).

An average percentage (indirect as a percentage of direct) from a number of post flood surveys is:

- Residential - 15%,
- Commercial - 30%,
- Industrial - 50%.

It should be noted that there can be a considerable range (± 100%) around the above figures for commercial and industrial properties in different locations.

A1.3 Intangible Damages

Intangible damages are those flood damages which by their nature are difficult to quantify in monetary terms. An example of a *direct* intangible damage is the "loss of visual quality" of an area or the "loss of a heritage item". Most intangible damages are *indirect* and commonly occur after the flood peak has passed.

Intangible damages can be categorised as follows:

Residential

Post flood damages surveys have linked flooding to stress, ill-health and trauma in the residents. For example the loss of memorabilia, pets, insurance papers, etc., may cause stress and subsequent ill-health. In addition, flooding may affect personal relationships by contributing to marriage breakdowns and lead to stress in domestic/work situations. Residents may worry each time heavy rain occurs and there is a threat of flooding. This may be reflected in increased sickness or depression requiring psychiatric help. These effects can induce a lowering in the quality of life of the flood victims.

Flood victims may also suffer injuries during a flood or during the clean-up process. Whilst the direct costs of the injuries may be accounted for in the flood damages survey, the psychological effect or discomfort may last for a long time.

The most extreme “intangible damage” that can arise from flooding is death, and unfortunately this is not a rare occurrence. There are many examples of deaths of local residents and rescue workers during floods.

Commercial/Industrial/Rural

Whilst a large number of businesses carry insurance for loss of trade during and following a flood until the clean-up is complete, they may still suffer a financial loss. For example the confidence in the business of regular clients may be reduced permanently. Clients may take their business elsewhere during the flood/clean-up period and may never revert to the original supplier.

Services

The loss of services to customers, e.g., transport disruption, loss of education, loss of power, etc., occur as a result of floods and these are generally not costed within the tangible damages category.

Environmental

Environmental damage may occur as a result of flooding, for example flora and fauna may be lost. However the riverine environment is a natural system and it is difficult to quantify the effects of flooding on natural processes. Some flora and fauna can in fact benefit from flooding. Also in the short term there may be a deterioration in water quality or vegetation, which may recover in the long term. Wetlands develop over time as a result of flooding and require periodic flooding for their long term survival.

Probably the most significant potential environmental impact is the release of pollutants as a result of flooding. Generally this is as a result of flooding of commercial/industrial establishments.

The loss of man-made structures which have a "heritage" or non-replaceable value are a real cost which cannot be quantified. Modifications to the pattern of flooding through flood mitigation works may change the existing ecosystem. Although the changes can be beneficial or adverse.

In summary, there is a comprehensive body of available literature on intangible damages which provides many examples. However the costing of such damages in dollar terms is often not possible. These "costs" should not be ignored when determining floodplain management options. The literature suggests that the value of intangible damages may equal or exceed tangible damages. It is therefore often necessary to imply a value for the intangible damages to achieve a better appreciation of proposed works and measures.

A2. ASSESSMENT OF FLOOD DAMAGES

A2.1 General

A2.1.1 Introduction

Quantification of flood damages is generally based upon post-flood damage surveys. An alternative procedure is to undertake a self-assessment survey of the flood liable residents. This latter approach is more expensive and may not accurately reflect what actually occurs in a flood. Floods by their nature are unpredictable and it is unlikely that a self-assessment survey would have predicted the scale of the damages which occurred in Nyngan in 1990. For this reason it was decided to use the post-flood damage approach in assessing flood damages. A listing of the most widely known post flood damage surveys is shown in Table A2. More recent information from the November 1996 flood at Coffs Harbour is also available but this has not been critically analysed for the purposes of establishing relationships of depth vs damage.

Table A2: Residential Flood Damage Surveys

Location	Year of Flood	Comments
Brisbane	1974	400 residential properties.
Lismore	1974	100 properties. The data were obtained several years after the last major flood.
Forbes	1974	35 properties. The data were obtained several years after the latest major flood.
Sydney (Georges River)	1986	96 properties (2 studies undertaken)
Nyngan	1990	24 residential, 14 commercial and 6 public properties, 4-5 weeks after the flood.
Inverell	1991	4 residential, 20 commercial and 10 public properties, 2-3 weeks after the flood.

The most comprehensive surveys are those carried out for Sydney (Georges River), Nyngan and Inverell. Some of the problems in applying data from these studies to other areas can be summarised as follows:

- varying building construction methods, e.g. slab on ground, pier, brick, timber,
- different average age of the buildings in the area,
- the quality of buildings may differ greatly,
- inflation must be taken in account,
- different fixtures within buildings, e.g. air-conditioning units,
- change in internal fit out of buildings over the years or in different areas, e.g. more carpets and less linoleum or change in kitchen/bathroom cupboard material,
- external (yard) damages can vary greatly. For example in some areas vehicles can be readily moved whilst in other areas it is not possible,

- different approaches in assessing flood damages. Are the damages assessed on a "replacement" or a "repair and reinstate where possible" basis? Some surveys include structural damage within internal damage whilst others do not,
- varying warning times between communities means that the potential to actual damage ratio may change,
- variations in flood awareness of the community.

A2.1.2 Summary of Survey Data

Flood damages data from the following surveys are provided in Table A3:

- Inverell 1991 - Reference A1,
- Nyngan 1990 - Reference A2,
- Sydney (Georges River) 1986 - Reference A3.

References A1 and A2 were undertaken by Water Studies Pty Ltd and Reference A3 by the Centre for Resource and Environmental Studies (CRES) at the Australian National University, Canberra.

Table A3: Summary of Post Flood Damage Surveys
(Note: Costs quoted at the time of the flood)

	Nyngan	Inverell	Georges River
TOTAL FLOOD DAMAGES	$47 Million	$20.6 Million	$17 Million
Year	**1990**	**1991**	**1986**
Flooded Premises and Total Cost per section in $M (in brackets):			
Residences Commercial/Industrial Premises Public Authorities/Utilities	717 ($18.9) 98 ($11.3) 42 ($17.0)	126 ($2.3) 264 ($14.9) 36 ($3.4)	1000 215 Not Known
Total	857	426	
Damage ($M) per Category and % of Total Flood Damages (in brackets):			
Direct Indirect	28.6 (60%) 18.7 (40%)	10.7 (52%) 9.8 (48%)	16.9 (89%) 2.1(11%)
Average Damages per Premise and % of Total Flood Damages (in brackets):			
Average Residential Average Commercial/Industrial Average Public	$26 400(40%) $117 000(24%) $400 000(36%)	$18 000(11%) $54 000(72%) $93 000(17%)	$8 000(48%) $40 000(52%) Not Known
Average Residential Damages by Category and % of Total Residential Damages (in brackets):			
Direct - Internal Direct - External Direct - Structural Indirect - Financial Indirect - Clean Up Average depth of inundation above floor	$8 900(34%) $4 500(19%) $5 200(20%) $4 800(20%) $2 200(7%) 0.8m	$8 100(42%) $2 500(19%) $5 000(27%) $300(1%) $2 100(11%) 0.6m	Not Known $3 500 (44%) Not Known Assumed as 15% of Direct Not Known
Average Commercial Damages by Category and % of Total Commercial Damages (in brackets):			
Direct - Internal Direct - External Direct - Structural Indirect - Financial Indirect - Clean Up	$28 600 (25%) $1 100 (1%) $3 000(3%) $79 500 (70%) $2 000 (1%)	$17 100 (33%) $5 500 (12%) $750 (1%) $23 000 (45%) $4 900 (9%)	Not Known Not Known Not Known Assumed as 55% of Direct
Average Annual Damage	$0.63M	Unknown	$14.4M

NOTES:
1. 93% of all properties in Nyngan were flooded above floor level.
2. The AAD figure for Sydney (Georges River) is $0.88M for residential and $13.5M for commercial/industrial.

A2.2 Tangible Damages - Residential Properties

Tangible direct damages are generally calculated under the following components:

- Internal,
- Structural,
- External.

Tangible indirect damages can be subdivided into the following groups:

- accommodation and living expenses,
- loss of income,
- clean up activities.

Damages may be calculated as either estimated actual damages or estimated potential damages. If potential damages are calculated an Actual/Potential (A/P) ratio is estimated based upon (as well as other factors) the likely flood awareness of the community and the available warning time.

The flood awareness of the community is likely to be high with the available flood warning time medium. For these reasons the A/P ratio will be relatively high (say 80%). At Nyngan (February 1990) the A/P ratio for average residential damages was 77%. It should be remembered that not all items can necessarily be saved (kitchen cupboards, carpets) and that many residents may be away. Based upon the available data it is considered that the A/P ratio for the study area will be similar to that at Nyngan or Inverell.

A2.2.1 Direct Internal Damages

Water Studies

In the Water Studies approach internal damages are based upon the following formulae provided in Reference A1.

$$\frac{D}{D_2} = 0.06 + 1.42H - 0.61H^2 \qquad \text{for } H < 1.0\text{m}$$

$$\frac{D}{D_2} = 0.75 + 0.12H \qquad \text{for } H > 1.0\text{m}$$

where,

H = height of flooding above floor level (m)
D = damage at height (H) above floor level
D_2 = damage at height of 2m above floor level

At Nyngan and Inverell D_2 was $12 500 for small houses and $14 500 for medium/large houses. These values are in $1991's. The reference states that *"Damages to individual properties scatter widely around the relationship, which can only be used to reliably estimate the aggregated damage to a collection of flood prone dwellings and not the damage to a single dwelling."*. Structural damages are not included in the above figures.

CRES

In the CRES approach (Reference A3) internal and structural damages are combined. Data are provided for three groups of buildings, namely Poor, Medium and Good. The data are shown in $1986's in Table A4.

Table A4: Residential Stage-Damage for Actual Direct Damage to Structure and Contents ($1986's)
(Taken from the Georges River Study: Reference A3 - Table A2.2.7)

Over floor Depth	Poor	Medium	Good	Average
0.0 m	370	1045	2400	1270
0.1 m	740	2090	4799	2540
0.6 m	3012	5713	10360	6360
1.5 m	7102	7595	13190	9300
1.8 m	7210	7711	13391	9440

A2.2.2 Direct Structural Damages

In the CRES approach internal and structural damages are combined. In the Water Studies approach structural damage was adopted as approximately $5 000 at both Nyngan and Inverell.

A2.2.3 Direct External Damages

The majority of external damages is attributable to vehicles. However there is a high likelihood that a significant percentage of the vehicles can be moved to high ground even with minimal flood warning.

At Nyngan external damages were estimated as $4 500, mostly for vehicles, and at Inverell at $2 500 of which $1 500 was for vehicles. In the Sydney 1986 data obtained by CRES an external damages figure of $600 was adopted per property experiencing over ground flooding. In addition a sum of $2 000 per property experiencing over ground flooding in excess of 0.6m was included.

A2.2.4 Indirect Damages

In the Inverell study the indirect damages were taken as $200 for accommodation, $100 for loss of income and $2 100 for clean up activities. The total indirect damages ($2 400) therefore, represented approximately 20% of the direct damages. At Nyngan indirect damages were high due to the extended period residents were away from their homes and were estimated at $7 700 per dwelling flooded above floor level. In this case the indirect damages amounted to approximately 40% of the direct damages. CRES adopted a figure for indirect damages of 15% of the direct damages (Georges River Study).

A2.3 Adopted Tangible Damages - Residential Properties

Appropriate depth/damage values for the various component items were established with due consideration of the above historical data and information. The following sections document the component items and the resulting damage curve values (depth v damage) adopted for use in this study are summarised in Table A5.

Table A5: Adopted Residential Depth/Damage Data ($2001)

Depth over Floor/Yard (m)	Total	Direct Internal Damages	External Damages	Indirect and Structural Damages
0.1	**6118**	3918	200	2200
0.3	**15222**	8622	767	6600
0.5	**23350**	12350	1500	11000
1.0	**28400**	17400	1500	11000
1.5	**29600**	18600	1500	11000
2.0	**30800**	19800	1500	11000

A2.3.1 Direct Internal Damages

The Water Studies approach to the determination of internal damages was adopted for use in this study. As noted previously the A/P ratio for Nyngan is likely to be similar to that for the study area. A single D_2 value of $20 000 at 2.0 m depth was adopted for all residential buildings regardless of the type of the building.

A2.3.2 Direct Structural Damages

Structural damages were assumed to be a linear relationship from $0 at 0 m to $8 000 at 0.5 m. Above this value it was considered that there would be no additional structural damages.

In floods larger than a 1% AEP event there is the possibility that some buildings may collapse or have to be destroyed. The cost of these damages have not been included in the analysis.

A2.3.3 Direct External Damages

External damages (laundry/garage/yard/vehicle) were assumed to be a linear relationship from $0 at 0 m above ground level to $1 500 at 0.5 m.

A2.3.4 Indirect Damages

Indirect damages were assumed to be a linear relationship from $0 at 0 m above floor level to a maximum of $3 000 at 0.5 m.

A2.4 Tangible Damages - Public Utilities

The damages to public utilities include:

- water and sewerage supply,
- telecommunications,
- road/rail transport,
- other public assets.

Little data are available for establishing costs to public utilities, and the data from Nyngan and Inverell show that it can vary from 17% to 36% of the total damages bill.

The following is a summary of the likely damages to public property. Actual damages for all public utilities were not specifically estimated in this study as they are dependent on a number of factors which are often difficult to quantify. Additionally the values can sometimes represent only a small percentage of the total relative to other contributing factors.

Sewerage

The are about 19 sewage pumping stations within the St Georges Basin Floodplain. The survey undertaken as part of this study revealed that the ground surrounding all the pumping stations is generally flood affected for the 1 in 10 year ARI event and greater. Some properties within the floodplain still have septic systems which can result in the possible release of sewerage when they are inundated.

The damages are therefore largely intangible through the loss of supply of the system, such as inconvenience, disruption and health risk due to the present of raw sewage. The tangible damages to the infrastructure systems are typically only of a nominal value if the pumps and associated structure are damaged during the flood. For the purposes of this study the costs associated with repairs and maintenance of a sewage pumping stations are assumed to vary linearly from $0 at 0 m above the concrete plinth, to $2800 at 0.5 m depth.

Recreational Facilities/Roads

There will be some direct tangible damages in terms of cleanup and/or repairs but the major factors are intangible damages to the community through the loss of use of the facilities.

Telephone, Electricity, Water Supply

These facilities should experience only minor (if any) direct flood related damages. Telephone and electricity supplies may however, be severed at the time of the flood for other reasons (lightning, wind or ground saturation).

Evacuation and Clean-Up Costs

It is estimated that the evacuation and clean-up costs to Council for each event is $40 000.

A2.5 Caravan Parks

There are a significant number of caravan parks located within the floodplain study area, and within each caravan park there are numerous individual van sites often with elaborate annexes attached. The potential damages from such parks are likely to be significant and it was therefore considered appropriate to include some allowance within the overall damages estimate. Damages to amenities buildings were assumed to be similar to external yard damages varying from $0 at 0 m to a maximum of $3000 at 0.5 m. Caravan damages were assumed to vary linearly from $0 at 0.5 m (depth above average ground level for park) to a maximum of $3500 at 2.0 m depth. A value of 0.5 m was adopted (instead of 0 m) as an average depth for commencing caravan damages to account for variation in ground/caravan levels across a site (typically incorporating between 30 to 100 caravans) and to make some allowance for the lower relative value of items which may be stored at ground level or in an annex. Additionally, these items would often be raised or removed first if flooding was imminent and the greatest damage value is usually incurred when floodwaters inundate the caravan itself (floor typically 0.5 m above ground).

Because of the total number of sites which exist in the 16 caravan parks, initial calculations produced significant damages results for only shallow depths of inundation. The revised depth approach was therefore considered to provide a more reasonable weighting of possible damages.

A2.6 Annual Average Damages

It should be emphasised that these **figures include only tangible (direct or indirect) damages to buildings and residents, the cost of intangible damages has not been evaluated**. Available literature suggests that the extent of **intangible damages may equal or exceed the tangible damages. Damages to the public sector have not been accurately assessed in this study**. Recent studies show that **damages to public property can vary significantly but may comprise 50% of the private tangible flood damages**.

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A3. REFERENCES

A1. NSW Department of Water Resources
Inverell Flood Damage Survey February 1991 Flood
Water Studies Pty Ltd - November 1991.

A2. NSW Department of Water Resources
Nyngan 1990 Flood Investigation - Chapter 9
October 1990.

A3. Public Works, Department of Water Resources
Losses and Lessons from the Sydney Floods of August 1986 Vol. 1 and Vol. 2
Centre for Resource and Environmental Studies, Australian National University, and Environmental Management Pty Ltd Sydney - September 1990.

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APPENDIX B: PUBLIC CONSULTATION PROGRAM

APPENDIX B: PUBLIC CONSULTATION PROGRAM

The following text which set out the proposed consultation program was provided to the Floodplain Management Committee at the start of the study.

Council has requested that the community be involved in the preparation of the Floodplain Management Study (FMS) and Floodplain Management Plan (FMP) for the St Georges Basin floodplain area to ensure that affected persons are aware of the study and to ensure that the consultants have considered and reported on suggestions raised by the community.

To meet the requirements of the consultant's study brief in this regard a public consultation program has been prepared for implementation during all stages of the study process.

B1. OBJECTIVES

The consultation program seeks to:

- increase community awareness of the findings of the Flood Study and of the ongoing process of preparing the FMS and FMP,
- encourage community participation in the FMS and FMP preparation,
- encourage feedback on the draft FMP document to assist Council in their consideration of the final outcomes.

B2. KEY CONSIDERATIONS

In developing the consultation program, the following considerations were regarded as important:

- The expected role of the community needs to be clearly established. This means that the ground rules for community involvement need to be clearly set out so that the community knows what is expected of them. In general a wide range of community views will be sought and discussed. Final decision making will rest with the Floodplain Management Committee (FMC) and Council.

- The program will focus on residents and property owners of the flood liable areas although advertisements in the local press will make the general community aware of the study.

- The consultation program closely follows the study work program and will be seen as an important element of that process. However it is not seen as an end in itself but rather as a means of ensuring that the final product has been prepared in full consideration of all issues raised by the community.

- The consultation program will be carried out by the consultants and thus will be seen to be somewhat independent of any vested interests in the area. An alternative is to engage an independent facilitator to conduct the meetings.

- Consultation methods will seek to provide an independent and impartial forum to ensure that the community fully understands the proposals being considered for inclusion in the study, and can exchange ideas and discuss the full implications of proposals with relevant technical experts in a friendly and non-intimidatory environment. It is not intended that the program be a forum for debate or argument, rather one for the exchange of ideas and the recording of community views.

B3. PROPOSED PROGRAM

The proposed consultation program has three distinct phases:

- **Phase 1** is a short inception period during which broad agreement to the details of the study are to be resolved including matters such as:
  - means of disseminating information,
  - determining the format of the newsletter, questionnaire and advertisements,
  - identifying the community to be consulted,
  - details of the dates and agendas and participants for public meetings.

- **Phase 2** includes the range of activities during the preparation of the FMS.

- **Phase 3** includes the range of activities associated with the exhibition of the draft FMP and the review of submissions.

The following main elements of the program are presented for consideration.

B3.1 Phase 1 - Inception

Means of Disseminating Information: It is proposed that the community be consulted initially via a Letter of Introduction and a Questionnaire which will be distributed by mail to the approximately 2070 homes and businesses which occupy or own land within the study area. If people wish to respond or provide comment they will be asked to write to a Reply Paid Number at Webb McKeown's office. Subsequently two A4 newsletters will be provided.

The above material will be mailed to any other interested party nominated by the Committee. Council will distribute material to members of the Floodplain Management Committee.

Council will display the various material in local libraries, Council Offices, community centres and any other appropriate locations.

Advertisements will be placed by Council in the local and national papers at the time of distribution of the newsletter. Council will also issue press releases to local radio, television, and newspapers. These will also announce the dates of the public meetings.

The exact format of the newsletter and advertisements will be the subject of discussion but the broad issues to be covered are set out under Phase 2.

Agenda: The following dates are to be determined:

- 1st Floodplain Management Committee Meeting, 24 August 2000
- Period of Investigation of Strategies by Consultant,
- Date of Distribution of 1st Newsletter,
- Date of 1st Public Meetings,
- Period for Preparation of Draft FMS and FMP by Consultant,
- Date of Distribution of 2nd Newsletter,
- Date of 2nd Public Meetings,
- Date of Draft FMP submitted to Council.

Other FMC meetings will occur at regular intervals.

Community to be Involved: Any residents occupying land (within the study area) which is below the estimated PMF level will be invited to be involved in the process. Material will be provided to resident owners, non-resident owners and tenants. The advertisements will capture residents who have involvement in the area but do not occupy low lying land. All government and local progress associations will be contacted by direct mail.

Identification of Stakeholders: Any body who has a significant interest in the study should be identified and included in the mailing list. Depending on the number of groups they could be asked to attend the FMC meetings, attend meetings with the project group, or be talked to individually by the consultant.

How Public Interest will be Generated: The success of the study can be measured by how the outcomes of the study are supported by the community. To achieve a high level of support the community needs to be involved in the decision making process. The proposed program aims to generate public interest in the following ways:

- advertisements in local newspapers and press releases provided to local radio, television and newspapers,
- distribution of the letter of introduction and two newsletters,
- two public meetings,
- displays at Council,
- local progress associations and/or representatives on the Floodplain Management Committee should advise their members.

B3.2 Phase 2 - Preparation of the FMS

Preparation and Release of Newsletter: The newsletter will seek to:

- advise the community of the study, its purpose, timetable and expected outcomes,
- summarise the findings of the Flood Study,
- provide concise representations of the strategies proposed in the FMS,
- outline the consultation program and inform the community on how to become involved in the process,
- invite a submission on the draft FMS,
- advise of the forthcoming public meetings to discuss the findings of the FMS.

Discussions with Stakeholder Groups: It is expected that representatives of these groups will attend the FMC meetings. Alternatively it may be possible to meet with these groups prior to or following the FMC meetings.

Public Meetings: Two meetings will be held with residents (one for northern foreshore residents and one for Sussex Inlet residents). Invitations to attend the meetings would be included in the newsletter and public advertisement. It is anticipated that both meetings will be held on the same day in Council facilities.

It is expected that the meetings would run for approximately 2 hours and be chaired by a Councillor. Each will be attended by appropriate representatives of the consultant. The meetings would address the following issues:

- a presentation of the study process,
- an outline of the flooding characteristics of the area,
- a presentation of the strategies,
- community response to those strategies,
- discussion of other strategies to be considered,
- where to from here?

The meeting will include display of graphical material including aerial photos, maps and the proposed strategies.

Technical Workshop: A technical workshop would be held with relevant officers of Council (from a range of relevant disciplines such as engineering, planning and recreation), and State Government departments with an interest in the outcome of the FMS. This workshop would discuss the strategies presented in the FMS and any others nominated by the group. This workshop may form part of a FMC meeting and should occur after the public meetings.

The results of the workshop, discussions and submissions will be reported to the Council and will be presented to the FMC for consideration and recommendation prior to proceeding with the completion of the draft FMP.

B3.3 Phase 3 - Preparation of the Draft FMP

Once a draft FMS has been prepared and approved for exhibition by the committee the activities outlined below will occur. During this time the Draft FMP will be prepared. When the Draft FMP has been approved for exhibition by the committee the activities outlined below for the Draft FMS will occur for the Draft FMP.

- An exhibition of the draft FMS and then draft FMP will be prepared by Council and exhibited at Council Chambers and major libraries. It is not expected that the exhibitions will be elaborate or space consuming. The consultants would provide maps, plans, etc.

- Advertisements will be placed in the state (SMH) and local newspapers advising of the availability of the draft FMS and then draft FMP for comment. The advertisements will advise on where the draft study is exhibited and how comments can be made. The consultants would prepare the advertisements which would be placed by Council. Local radio, television stations and newspapers would also be issued with a press release from Council.

- A second newsletter will be prepared and circulated in a similar manner to the first newsletter with the addition of those who expressed an interest during the study process.

- Public meeting(s) will be held to discuss the draft and to hear comments of the community.

- Council and the consultants will review submissions on the Draft Reports and report to the FMC.

B3.4 Role of the Consultants

Webb, McKeown & Associates: Representatives from Webb, McKeown & Associates would participate in the meetings and workshop as appropriate. Mr Withnall would provide technical support and present the findings of the study in a manner understandable by non-technical members of the public. WM would prepare the newsletters and format of the consultation program.

Nexus Environmental Planning: Nexus Environmental Planning would participate in the FMC meetings and provide planning input where appropriate.

ST GEORGES BASIN FLOODPLAIN MANAGEMENT STUDY & PLAN

COMMUNITY INFORMATION SHEET DECEMBER 2000

INTRODUCTION

This Community Information Sheet has been issued to inform you of the Floodplain Management Studies (FMS) being prepared for the St Georges Basin area.

Shoalhaven City Council has appointed Webb, McKeown & Associates Pty Ltd (Consulting Engineers) to develop a sustainable plan for floodplain management of this area.

An integral part of the study process is the implementation of a community consultation program and this newsletter constitutes part of this process.

Your questions and/or comments are welcome at any time during the course of the study. Details on how to contact the study team are provided on the back of this sheet.

FLOODPLAIN MANAGEMENT PROCESS

The implementation of sound floodplain management practice is an important process (Diagram 1) which can be used to optimise development potential, and to obtain social and economic benefits from the reduction in tangible and intangible flood damages.

Following the establishment of an FPM Committee, the **first step** in the process is preparation of a Flood Study to establish design flood levels. (Design flood levels are levels which have a known likelihood of occurrence.

For example the 1% annual exceedance probability event (AEP) has a 1% or 1 in 100 chance of being equalled or exceeded in any year.) The draft Flood Study report was exhibited in March 2000 and the final report is currently being printed.

The **second step** is preparation of this FMS which identifies a range of floodplain management measures to address the problems and areas of concern.

The **third stage** is preparation of a Plan which documents how the work and strategies identified in the FMS are to be implemented.

The **final stage** is the undertaking of the works.

OBJECTIVES OF THE STUDY

The objectives for this FMS are as follows:

- to manage flooding as an integral part of the planning and development process,
- to systematically identify and address flooding problems,
- to prepare a schedule of works or strategies to manage the existing flood problem and reduce future flood damages,
- to implement a unified approach,
- to ensure sustainable development principles are achieved,
- to maintain and enhance the quality of the St Georges Basin.

Diagram 2: St Georges Basin Study Area

THE STUDY AREA

The St Georges Basin (Diagram 2) has a catchment area of approximately 327 square kilometres. The area of the basin itself is approximately 37 square kilometres (10% of total). The catchment area of the basin incorporates a number of tributary creeks including Wandandian Creek, Cow Creek, Tullarwalla Creek, Tomerong/Cockrow Creek, Warrowing Creek and Pats and Home Creeks.

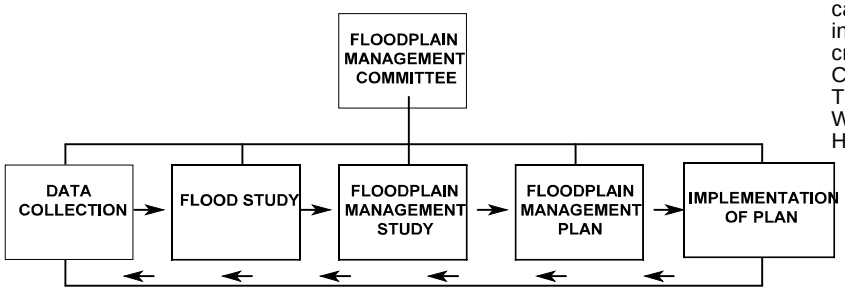

Diagram 1: The Floodplain Management Process

The Basin connects to the ocean through the Sussex Inlet Channel. Sussex Inlet is shallow, 6 kilometres long and varies in width between 50 and 300 metres.

The Basin has an open area up to 9 kilometres wide with relatively deep water (9m) surrounded by wide embayments and lagoons adjoining the Basin range from deep(7m) to shallow (3m).

The main settlements within the Basin catchment include Sussex Inlet, Sanctuary Point and Basin View.

THE FLOOD PROBLEM

Flooding of roads and residential areas within the catchment has occurred on a number of occasions in the last 20 to 30 years. Some nine minor storm events have been experienced (including February 1992, September 1993, April 1994 and more recently in August 1998 and October 1999) with significant events occurring in March 1959, October 1959, February 1971 and June 1991.

MANAGEMENT MEASURES

Possible floodplain management measures to address the various problems may be categorised under the following headings.

Flood Modification - structural works to modify flood behaviour.

Property Modification - modifies land use and development controls in accordance with flood risk/hazard.

Response Modification - planning, education and awareness measures which aim to modify the community's response to flood hazard.

Photo 1: Sussex Inlet in Flood (1991)

HOW DO I GET INVOLVED?

Community input to the FMS is essential and a range of consultation activities are planned to coincide with the various stages of the study. Activities will include:

- your direct feedback to the project team or Shoalhaven City Council,
- individual discussions with residents, businesses and other stakeholders,
- input from your local representatives on the Floodplain Management Committee,
- questionnaire,
- open shop days,
- public meeting,
- public exhibition of the draft FMS and Plan.

Submissions are welcome at any stage of the study process. Any interested party is also invited to join the "Contact Group" to receive updates throughout the study process.

Your local community representatives on the FPM Committee are:
Mr William Train
Ph 0412325475
Mrs Elaine Atkinson
Ph 44434493

WHO TO SPEAK TO?

The Project Manager is:
Mr Bruce Withnall
and
our full-time consultation "Listener" is
Ms Joanna Kuswadi

They can be contacted at:
Reply Paid 1752
Webb, McKeown & Associates
Level 2, 160 Clarence Street
SYDNEY NSW 2000
Telephone: (02) 9299 2855
Facsimile: (02) 9262 6208
Email:
StGeorges@webbmckeown.com.au

Up to date information on the Study is available on the website.
Internet:

www.webbmckeown.com.au/stgeorges

You may also wish to contact Mr Ajith Goonatilleke, Strategic Drainage Engineer, Shoalhaven City Council on (02) 44 293238 to discuss any aspects of the project.

Should you only wish to make a brief comment or seek clarification on any issue, or have any comments, please do not hesitate to contact us.

ST GEORGES BASIN FLOODPLAIN MANAGEMENT STUDY QUESTIONNAIRE

DECEMBER 2000

Your response to this questionnaire will help Council in its investigation of flooding issues for the St Georges Basin area. Please tick a G box where requested.

1. Please provide your name and address details below.

   Name: _____ Telephone: _____

   Address: _____

   Please indicate if you wish to be included as a member of the "Contact Group" mailing list to be directly updated or involved in the progress of the study.

   239 Yes G No

   If you are contactable by e-mail please provide your address:

   _____

2. How long have you been at this address? _____ Years

3. Type of development? **383** House **8** Commercial (specify) _____
   1 Residential Units **8** Agricultural/Rural

4. Your status with regard to this property?

   398 Owner/Occupier G Tenant **1** Other (please specify) _____

5. Do you think (or know) that your property may be flood liable? **269** Yes **135** No

6. Have you ever experienced any of the following at your current address?

   Please respond (tick) to each issue as appropriate.

	Yes	No	Not Applicable
Have floodwaters ever entered your yard?	**255**	**149**	G
Has flooding ever caused you to move your car?	**67**	**337**	G
Have floodwaters ever entered your house?	**36**	**368**	G
Has flooding ever caused you to leave your house?	**11**	**393**	G
Have you ever incurred a financial loss from flooding?	**37**	**367**	G
If YES please indicate an approximate amount (in $'s). _____			
Have you ever missed work during a flood?	**37**	**367**	G
Have you ever received a flood warning?	**20**	**384**	G
If YES was the warning useful?	**13**	**391**	G
Have you ever received assistance during a flood?	**29**	**375**	G
From whom - specify? _____			
Have you ever experienced any post flood problems or emotional trauma?	**33**	**371**	G
Do you have a flood action or emergency plan?	**62**	**342**	G
Do you think there is a risk to life in your area from flooding?	**51**	**353**	G
Do you think that you are flood aware?	**283**	**121**	G

7. If you have experienced flooding at your property, do you have any useful information to provide?
(If yes please attach or indicate the type of information available.) **79** Yes **325** No

8. To what extent do you think you may be affected by flooding in the following events?

	Evacuation Access	Yard Inundated	Buildings Inundated
In a small to medium flood which is more likely to actually be experienced (say once in every 20 years on average) (e.g 1991 Flood)	**33**	**236**	**36**
In a large flood which is less likely to occur (say once in every 100 years on average) (e.g 1971 Flood)	**33**	**171**	**92**
In the largest possible flood event imaginable	**40**	**112**	**156**

9. How much time do you think you would have in a major flood to undertake emergency measures?
105 no idea **70** 1 day **64** 12 hours **39** 6 hours **59** less than 6 hours

10. Is the issue of flooding in general (from severe rain and ocean conditions) of concern to you? **263** Yes **141** No

If Yes please indicate (tick) the various means by which you would like the problem to be addressed.

10 do nothing
127 better flood warning information
99 more information regarding damage minimisation or evacuation procedures
25 house raising
122 flood insurance
18 voluntary purchase of building/land
50 sealing (flood proofing) the entrances to the building
87 implement localised structural measures such as levees
225 dredge or enlarge the Sussex Inlet entrance channel

Other - specify: _____
_____

11. Please provide any further comments that you think appropriate.
_____**165** _____

After completing this questionnaire please check that you have answered every question. Please mail (no stamp required) the completed questionnaire within 7 days to:

REPLY PAID 1752
Webb, McKeown & Associates Pty Ltd
Level 2, 160 Clarence Street
SYDNEY NSW 2000
Attention: Ms Joanna Kuswadi

Alternatively, if you have access to the internet you may complete the questionnaire at the study website www.webbmckeown.com.au/stgeorges
OR
Fax: (02) 9262 6208

Thank you for your assistance

ST GEORGES BASIN

FLOODPLAIN MANAGEMENT STUDY & PLAN

COMMUNITY INFORMATION SHEET JUNE 2001

INTRODUCTION

This Community Information Sheet (No.2) has been issued to inform you of the progress of the Floodplain Management Study (FMS) being prepared for the St Georges Basin area.

Shoalhaven City Council has appointed Webb, McKeown & Associates Pty Ltd (Consulting Engineers) to develop a sustainable plan of management for the floodplain in this area.

An integral part of the study process is the implementation of a community consultation program and this newsletter constitutes part of this process.

Your questions and/or comments are welcome at any time during the course of the study. Details on how to contact the study team are provided on the back of this sheet.

FLOODPLAIN MANAGEMENT PROCESS

The implementation of sound floodplain management practice is an important process which can be used to optimise development potential, and to obtain social and economic benefits from the reduction in tangible and intangible flood damages without compromising the natural and built environments.

Following the establishment of an FPM Committee, the first step in the process is preparation of a Flood Study to establish design flood levels. Design flood levels are levels which have a known likelihood of occurrence. For example the 1% annual exceedance probability event (AEP) has a 1% or 1 in 100 chance of being equalled or exceeded in any year. The draft Flood Study report was exhibited in March 2000 and the final report is ready for printing and release pending formal adoption by Council.

The second step is the preparation of this FMS which identifies a range of floodplain management measures to address the problems and areas of concern. The third stage involves preparation of a Plan which documents how the proposal works and strategies identified in the FMS are to be implemented in terms of resourcing and timing. The final stage of the process is the undertaking of the works.

OBJECTIVES OF THE STUDY

The objectives for this FMS are as follows:

- to manage flooding as an integral part of the planning and development process,
- to systematically identify and address flooding problems,
- to prepare a schedule of works or strategies which will manage the existing flood problem and reduce future flood damages over a full range of flood events,
- to implement a unified approach,
- to ensure sustainable development principles are achieved,
- to maintain and enhance the quality of the St Georges Basin area,
- to gain community participation in the decision making process and thus assist community understanding and acceptance of the Management Study findings and the subsequent Plan.

THE STUDY AREA

The St Georges Basin (Diagram 1) has a catchment area of approximately 327 square kilometres. The area of the basin itself is approximately 37 square kilometres (10% of total). The catchment area of the basin incorporates a number of tributary creeks including Wandandian Creek, Cow Creek, Tullarwalla Creek, Tomerong/Cockrow Creek, Worrowing Creek , Pats and Home Creeks.

The Basin connects with the ocean through the Sussex Inlet channel. This channel is relatively shallow, 6 kilometres long and varies in width between 50 and 300 metres.

The Basin has an open area up to 9 kilometres wide with relatively deep water (9 m) surrounded by wide embayments and lagoons adjoining the Basin which range from deep (7 m) to shallow (3 m).

The main settlements within the Study Area include Sussex Inlet, Sanctuary Point and Basin View.

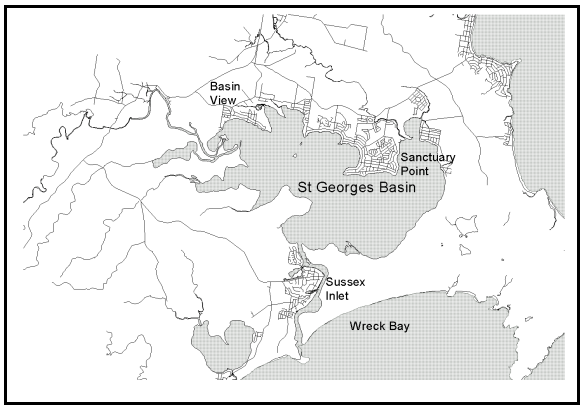

Diagram 1: St Georges Basin Study Area

THE FLOOD PROBLEM

Wave Set-up

The potential influence of wind wave effects on design flood levels around the St Georges Basin foreshore have been investigated and can be significant depending on the conditions prevailing for a particular location. The results suggest an added height of between 0.1m and 0.6m should be added to the design flood level in the Basin depending on the extent of exposure at various locations.

As part of the second step of the floodplain management process a survey of most residential and commercial properties within the floodplain was conducted in the early part of this year. The ground and building floor level information obtained was then compared against the design flood levels established by the Flood Study in the first step. A summary of the estimated number of buildings inundated for a range of design flood events is included in the table below.

Event	Number of Buildings Inundated above floor
10%	87
5%	136
2%	244
1%	392
Extreme	1022

Flood Damages

Based on the floor level and flood affectation information, the estimated damages which could be incurred for a range of flood events are indicated in the table below.

Frequency	Existing Damages ($ million)
Extreme	34.4
1% AEP	7.1
2% AEP	4.0
5% AEP	1.8
10% AEP	0.9
Average Annual Damages	**0.59**

Given the above values, the average annual damages cost to the community is estimated to be of the order of $0.59M over a 50 year timeframe.

Hydraulic/Hazard Mapping

The second step of the process also involves areas of the floodplain being defined in terms of their potential flood hazard exposure (high or low) and their hydraulic characteristics (floodway, flood storage and flood fringe).

Flood hazard is a measure of the overall adverse affects of flooding. It is typically based on the depth and velocity of floodwaters but also incorporates potential threat to life, danger and difficulty in evacuating people and possessions, as well as potential for damage and social disruption. Areas are classified as either low or high hazard depending on these risks over a range of flood events.

The hydraulic classifications applied to areas of the floodplain are as follows:

- **Floodways** - those areas where a significant volume of water flows during floods.
- **Flood Storage** - those areas of the floodplain that are important for temporary storage of floodwaters during the passage of a flood.
- **Flood Fringe** - the remaining area of land affected by flooding after the above two have been defined.

DECEMBER 2000 QUESTIONNAIRE

The response from the December 2000 Questionnaire was overwhelming and highlighted the community's concerns for flooding issues. Some 404 (20%) of the questionnaires were returned with 65% of respondents concerned about flooding and 67% believing they were flood liable. Approximately 20% of responses returned indicated they had useful information available and 41% of responses contained additional comments or discussion. A large number (25%) of responses were identified as requiring some form of feedback.

Other issues for consideration and useful information were also included in the responses and this highlights the community's awareness of their local environment.

The additional concerns raised by the community include:

- siltation of St Georges Basin,
- overgrown creeks - Tomerong/Cockrow, Worrowing and Erowal,
- infilling and development of land around the Basin and at Sussex Inlet,
- evacuation of Sussex Inlet,
- flood warning for St Georges Basin.

Stormwater drainage problems were a common issue but unfortunately these are not within the scope of the present study. Details of these concerns will be forwarded to Council. Other issues we hope to resolve through the issue of this newsletter.

The management options discussed below were developed based on these community and government concerns with regard to the entire floodplain. More specific and localised concerns are important and will be considered during the implementation stage of the process.

A survey of community views on management measures worthy of detailed consideration was also undertaken and the results are summarised in Diagram 2.

MANAGEMENT MEASURES

The possible floodplain management measures to address the various problems may be categorised under the following headings.

Flood Modification - structural works to modify flood behaviour.

Property Modification - modifies buildings and land uses

Response Modification - planning, education and awareness measures which aim to modify the community's response to flood hazard.

Planning and Future Development Control Measures - review and improve existing plans, operating procedures and development controls.

The Floodplain Management Committee together with Council representatives (including Councillors and Council officers from various departments) discussed possible flood mitigation measures for the St Georges Basin Floodplain at a recent workshop. The possible management measures were based on information obtained from the Flood Study and questionnaire and other investigations relating to the Basin. The workshop then discussed the priority and implementation of these measures.

Possible flood mitigation measures under consideration for the St Georges Basin Floodplain are included in the table below.

Action	Management Option
Flood Modification	
F1	Improve Hydraulic Efficiency of Sussex Inlet Channel
F2	Local drainage
Property Modification	
P1	Voluntary purchase
P2	House raising
P3	Flood proofing
Response Modification	
R1	Develop a flood warning system which links rainfall to basin and creek conditions
R2	Update SES Flood Plan to incorporate findings of FPM Study
R3	Undertake a workshop to update the SES, Police and other authorities.
R4	Develop a flood evacuation/damage minimisation strategy for caravan parks identified as medium to high hazard.
R5	Update the flood readiness program and implement to educate the community about flooding.
R6	Formalise a during and post flood evaluation program to ensure future events are well documented.
R7	Issue advice or notification to flood liable properties informing them of their particular circumstances.
Planning and Future Development Control Measures	
PL1	Review and formalise the current Flood Policy
PL2	Review and update Section 149 Certificates
PL3	Council to obtain advice on Greenhouse effect and re-assess the Flood Policy
PL4	Review and update LEP and DCP's in line with current information, FPM Manual and Coastal Management Manual.
PL5	Council to Monitor the extent and location of fill to ensure that local drainage is not adversely affected.

Wool Road Bypass

The Sanctuary Point Floodplain Management Study (Oct 93) identified the need to provide flood protection for houses in the vicinity of the Wool Road. The St Georges Basin By-Pass road involved raising the Wool Road, cross Tomerong/Cockrow Creek via a bridge and join Sanctuary Point Rd.

Recent investigations stated the provision of a levee (raised Wool Rd) would reduce mainstream flooding in the area but local drainage issues and bridge alignment need to be investigated further. This is being carried out by Council as part of the road and bridge design process.

HOW DO I GET INVOLVED?

Community input to the FMS is essential and a range of consultation activities are planned to coincide with the various stages of the study. Your next opportunity to participate will be at the Open Shop Day and Public Meeting. The locations, dates and times for these are listed below.

Any interested party is invited to attend the upcoming Open Shop Day, where a representative from the consultant will be on hand. Interested parties are also invited to the Public Meeting at which the consultant will present the findings of the study so far and the flood mitigation options available for the St Georges Basin floodplain.

Location	Date	Time
OPEN SHOP DAY		
St Georges Basin Community Centre - Meriton Street	27th June 2001	9:00 am - 12:00 noon
Sussex Inlet Community Centre - Thomson Street	27th June 2001	2:00 -5:00pm
PUBLIC MEETING		
Sussex Inlet Community Centre - Thomson Street	27th June 2001	7:00pm onwards

Submissions and enquires are welcome at any stage of the study process. Any interested party is also invited to join the "Contact Group" to receive updates throughout the study process.

Your local community representatives on the FPM Committee are:
Mr William Train Ph: 0412 325 475
Mrs Elaine Atkinson Ph: 4443 4493

WHO TO SPEAK TO?

The Project Manager is:
Mr Bruce Withnall
and our full-time consultation "Listener" is
Ms Karen Lancaster

They can be contacted at:
Webb, McKeown & Associates
Level 2, 160 Clarence Street
SYDNEY NSW 2000
Telephone: (02) 9299 2855
Facsimile: (02) 9262 6208
Email: StGeorges@webbmckeown.com.au

Information pertaining to the Study is also available on the website: www.webbmckeown.com.au/stgeorges
You may also wish to contact Mr Ajith Goonatilleke, Strategic Drainage Engineer, Shoalhaven City Council on (02) 4429 3238 to discuss any aspects of the project.

Should you only wish to make a brief comment, seek clarification on any issue, or have any comments, please do not hesitate to contact us.

St Georges Basin Floodplain Management Study Public Meeting at Sussex Inlet - 7:00pm - 9:00pm 27/6/01 Summary of Issues Raised

The Public Meeting at Sussex Inlet Community Centre was attended by approximately 20 people including Councillors, Council staff and interested members of the community. The general discussion which followed on from the presentation by the consultants included several issues as described below.

INLET

- Will dredging of Sussex Inlet ever happen?
- Wollongong University are yet to present their findings of their study on sedimentation of the Inlet.
- What effect will dredging have on the channel and how much needs to be dredged for their to be any affect?
- The sand blocking the entrance of the Inlet is from the beaches in Wreck Bay which tends to exacerbate flooding.
- Council does not plan to dredge the Inlet.

PROPERTY AFFECTATION

- Will properties now considered flood liable be notified individually?
- Council does not plan to notify properties on an individual basis, the S149 Certificates will be amended and there may be a public notification. This issue is to be investigated and considered further.
- More data and better modelling techniques have resulted in revised design flood levels and hence more properties have been identified as being affected in the flood standard event.

EVACUATION

- Will there be a public presentation of the SES evacuation plan?
- The SES are waiting on the findings of this study and how the community would like to be evacuated, i.e. lift furniture first then evacuate later.
- The SES are hoping to include the community for development of the plan.

WARNING

- Flood warning is critical as cars must be moved first as floodwaters are becoming increasingly saline and hence can cause more damage to cars.
- Are there any non-flood prone roads in Sussex Inlet?
- There are presently few rainfall or water level gauges in the St Georges Basin, with the gathering and availability of more data better predictions can hopefully be made in the future.
- Some form of warning system for the Basin is a priority.
- Many variables (including wind wave set-up) which affect the flood levels in the basin make it difficult for accurate prediction.

STORMWATER

- Is there any plan to clear the creeks of siltation and/or debris?
- For environmental and hydraulic reasons it is difficult to get approval to carry out works and so the creeks are unlikely to be cleared. The build up of debris acts as a habitat for wildlife and slows /dams the creeks to reduce scouring velocities.
- Stormwater problems are not considered as a major issue during widespread flood events.

OTHER

- The Sussex Inlet pumping station is inundated early in a flood event, should the pumps be raised above the new design flood levels.
- Are there any significant areas for development and how long is “no new” development applicable?
- The State Government now constrains development.

SUSSEX INLET ENTRANCE

- The peak tide level from the entrance to the basin can occur up to 4 hours later.
- Some tides do not reach the basin.
- The wind direction can affect the flow of water out of the Inlet entrance at the ocean.
- Particular wind directions can raise the water levels around the basin foreshore.

St Georges Basin Floodplain Management Study Public Meeting at St Georges Basin - 7:00pm - 9:00pm 16/8/01 Summary of Issues Raised

The Public Meeting at St Georges Basin Community Centre was attended by some 20 or more people including Councillors, Council staff and interested members of the community. The general discussion on conclusion of the presentation included the following issues:

- Siltation of the basin and the Sussex Inlet Channel,
- debris and siltation of the local creeks,
- local overland flooding,
- construction and maintenance of stormwater drains,
- zoning of land.

Some of the issues mentioned above do not fall completely within the scope of the Floodplain Risk Management Process and the community was informed that these issues are addressed by the Estuary Management Process and the Healthy Rivers Commission's Coastal Lakes Study but would be noted/referenced within this report.

The zoning of land issue involved considerable discussion because the community perceive that property values would decrease when land previously not coded as being affected is identified as flood liable and hence reducing their return on investment. It was also noted that the actual sale of affected properties is made difficult because banks are less likely to approve loans for those which are classified as flood liable.

One detailed submission was tabled by a concerned member of the community. The issues raised in the submission included:

- river flows,
- debris and siltation of the creeks,
- erosion and bank stability of the major creeks,
- pollution of the creeks,
- waterway traffic.

Open Shop Days - St Georges Basin - 16/8/01
Summary of Additional Comments Sheets

Open Shop	Suburb	Comments
Sussex Inlet	Sussex Inlet	Stormwater drainage - "unfortunately not within the scope of the study". I would question whether it is possible to ignore the problems of stormwater drainage if one of the objectives is to manage flooding. Our property at River Rd, Sussex Inlet has in the past been affected by flooding. We would appreciate the results of the recent surveys (ground and floor level information) being made available to us - in view of possible inundation our home and consequent insurance problems i.e. flood classification of our land.
Sussex Inlet	St Georges Basin	Interested in knowing flood affection on property in Island Point Road.
Sussex Inlet	Sussex Inlet	Fairview Crescent floods could be alleviated by constructing a levee bank with appropriate protection for one way flow of drainage water. Damage to my residence was caused by debris build up in the stand of trees opposite to residence. The council does not keep the low growth clear of the trees hence in the flood times debris builds up forcing water into Fairview Cres and onto the residential blocks Blow up the entrance and all the water will flow out to sea.
Sussex Inlet	Sussex Inlet	Make a harbour at the entrance to Sussex Inlet by sealing off the ocean break between Farnam Headland and the rocky island to the north-east. This would create a beautiful natural safe harbour for anchoring and eliminate the dangerous sand bar at the entrance to the inlet. This would eliminate the surge in the river created by southerly or south west gales which backs up the floodwaters from St Georges.
Sussex Inlet	Sussex Inlet	Query on situation at Jacobs Dr Bridge
Sanctuary Point	Sanctuary Point	Flood levels.

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APPENDIX C: BANK EROSION AND FAILURE

APPENDIX C: BANK EROSION AND FAILURE

C1. GENERAL

The terms bank erosion and bank failure are often used interchangeably. However, the two terms have different specific meanings. *Erosion* occurs when individual soil particles of the bank's surface material are removed. *Failure* occurs when a relatively large section of the bank fails and slides into the channel.

The major factors contributing to river bank erosion are:

- altered flow patterns, tidal currents and/or velocities,
- wave attack (from boats and wind),
- rainfall,
- seepage,
- overbank drainage,
- changes in land use (e.g. removal of native vegetation, introduction of livestock).

The major causes of river bank failure can generally be categorised as either an increase in the shear stresses in the bank or a decrease in the shear strength of the soil. These causes, which can individually or in combination lead to bank failure are:

- increase in shear stress within the bank,
- changes in channel shape due to bed scour or erosion of the bank face,
- increase of load on top of the bank,
- rapid drawdown of water against the bank face,
- decrease in shear strength of soil,
- swelling of clays due to absorption of water,
- pressure of groundwater from within the bank,
- creep, or minor movements of the soil,
- removal of vegetation from banks.

C2. BANK EROSION

Soil particles carried away from a bank by flowing water are removed by a tractive force which tends to pull particles along with the flow. An *alteration in flow patterns, tidal currents and/or velocities*, whether natural (e.g. flooding) or caused by man (e.g. excavation) can increase the tractive force. The potential for erosion depends on the bank particle's resistance, which is based on its size and cohesive properties. Larger particles weigh more and are harder to move, thus gravel is more resistant to erosion than sand. Highly cohesive particles such as clay particles are more resistant than less cohesive particles such as silt particles.

Flow patterns vary across the width of a river, particularly at bends. The velocity (and correspondingly the tractive force) significantly increases towards the outside of the bend, causing a greater erosion potential on the outside bank. On the inside of the bend the velocity decreases allowing suspended sediments to deposit and build a point bar.

Local scour around obstacles in the bed or banks of the channel is caused by the turbulence of eddies and velocity concentrations in the flow generated by the obstacle. The extent of scour is related to the size and streamlining of the obstacle. Typical obstacles which cause scour are irregular bank lines, bridge piers, weirs, boat docks, rubble, and trees.

When *waves* set up by passing boats or wind reach the river bank, the repeated agitation can dislodge soil particles. Waves will alter the exposed bank wherever the energy cannot be dissipated in non-destructive hydrodynamic turbulence, such as progressive breaking on a stable beach, movement through the interstitial spaces of a rip rap slope, or diffraction and transfer of momentum through vegetation or other fixed or floating bodies. Additional damage can be caused by boats which moor.

Raindrops striking an exposed river bank tend to loosen soil particles and reduce the infiltration capacity of the soil. With the infiltration capacity reduced, more and more of the rainfall will run down the bank, increasing the tractive force of the runoff and thereby increasing the potential for erosion.

Seepage effects can be either steady or unsteady. Steady effects relate to discharge from, and recharge to, the regional groundwater regime through the channel bank. Pressure from groundwater movement inside the bank forces water on to the face of the bank, loosening soil particles at the bank's surface. The resulting downslope movement of seepage water and loosened soil particles can further erode the bank. Groundwater seepage can be observed as a wet bank face or as piping flow from small holes on the slope.

Unsteady seepage effects relate to changes in pore water pressure in the bank due to fluctuations in the water level in the channel, and are independent of the steady seepage into or out of the bank. These result from long-period changes such as flooding and tidal activity, or short-period changes such as water level drawdown due to boat and surface waves. The flow of pore water within the soil depends on the rate of change of the water level in the channel, the permeability, and the drawdown or wave height. Silty and sandy soils are most at risk as they cannot respond quickly enough to avoid relatively high pressure gradients, yet the seepage velocity may be significant.

Overbank drainage is closely related to the problem of river bank surface erosion due to rainfall and seepage, and can be responsible for severe sheet and rill erosion. Whilst erosion due to overbank drainage can occur naturally, it is more likely to occur when the land near the top of the bank has been disturbed by clearing and ploughing and no provisions have been made for surface drainage control.

Changes in land use which influence river flow past the bank and the amount of sediment in the flow can cause an otherwise erosion-free bank to suffer severe erosion. Three major changes in land use which can increase the potential for erosion are vegetation clearing (e.g. for agricultural purposes), allowing livestock to trample banks, and urbanisation. The inevitable results of removing vegetative cover, disturbing surface soils, and decreasing the area available for rainfall infiltration are downstream flooding and increased sediment loads. In addition to higher tractive forces during the flood, the sediment load deposited by the flood reduces the channel's flood-carrying capacity so that the river may attempt to widen itself to carry the flow, thus further eroding the banks.

C3. BANK FAILURE

Bank failure due to *changes in channel shape* such as toe scour is perhaps the most dramatic and serious cause of bank recession, resulting in sudden loss of the bank and its vegetation. Scour typically tends to occur at the toe of the bank, over steepening the slope and instigating collapse of the bank through slip circle failure or slumping. Resultant talus which normally stabilises the toe is subsequently removed through sediment transport under strong river and/or tidal flows and the recession process is repeated.

An *increase in the load on top of the bank* causes an increase in shear stress within the bank, thereby increasing the potential for bank failure. Loads can be increased by man-made structures such as roads, bridges, buildings, etc., as well as by living things such as livestock.

Bank failure due to *rapid drawdown* (or a rapid drop in water surface elevation) is most likely to occur as floodwaters recede, or when the bank is subject to fluctuations in water surface elevations. During periods of high water, banks can become saturated by inflow from the river. When the bank face is covered by water, a pressure balance exists between the water in the channel and the weight of the saturated bank, helping to keep the bank in place. If the water elevation of the river is suddenly lowered and the soil cannot drain quickly, a pressure imbalance will exist (A pressure imbalance can also be caused by infiltration due to rainfall or runoff, or by groundwater sources deep within the bank). If the bank has insufficient shear strength to resist, the imbalance may cause bank failure.

The *swelling of clay materials* within banks due to the absorption of water can cause erosion by decreasing the shear strength of the bank. When the exposed wet clay and silt dry out, shrinkage and cracking can occur near the bank's surface, forming a layer of soil that can be easily eroded. The next time that water moves over the bank face, all or part of the layer may be removed. As the newly exposed material dries out, the cycle can repeat itself.

High *pore water pressure* in the bank material due to seepage or rapid lowering of the water level in the channel, will reduce the shear strength of the soil and can trigger a deep-seated rotational failure.

Soil creep can be observed as the development of bank cracks running generally parallel to a river. Wetting and drying cycles can cause swelling and shrinking of soils which contain clay. This encourages the generation of vertical fissures and the formation of soil blocks with desiccation cracks. This in turn encourages soil creep which can be responsible for bank failure.

The *root mat from vegetated banks* (mangroves have a particularly effective root mat) can modify the geotechnical properties of the soil, such that the shear strength of the bank can be increased and some tensile strength provided. Vegetation can therefore help to maintain the stability of river banks by helping prevent tension crack formation. Removal of the vegetation can cause the river bank to suffer mass failure.

APPENDIX D: FLOOR LEVEL DATABASE

APPENDIX D: FLOOR LEVEL DATABASE

D1. DESCRIPTION OF DATABASE

The floor levels of properties believed to lie within the floodplain were surveyed during January and February 2001. The floor levels were then linked with Council's property database using a Geographic Information System (GIS).

The database provided a GIS tag, street address, habitable floor level in mAHD and type of floor/building construction. The following assumptions were made in the analysis:

- floor level data were generally only obtained for habitable buildings. Thus garden sheds, garages, oyster cleaning sheds and other non-habitable buildings were not included,
- all buildings were primarily used for residential purposes,
- no allowance was made whether the building was permanently or temporarily occupied (data unavailable),
- critical levels for important infrastructure such as sewage pumping stations were also obtained,
- only details of office administration and amenities buildings were included in the survey for caravan parks.

Table D1: Property Database

LEGEND:

Material: B - brick; W/B - weatherboard; F - fibro; CONC - concrete; AL - aluminium

Zone Location: BF - Basin Foreshore; SP - Sanctuary Point; SI - Sussex Inlet

Type: D - dwelling; U - units; C - commercial

Size: S - small; M - medium; L - large

ZONE LOCATION	ST No.	STREET NAME	RELEVANT GRIDPOINT IN HYDRAULIC MODEL	GIS UPN	TYPE	STOREYS	MATERIAL	SIZE	GROUND RL	FLOOR RL	REMARKS
BF	14	BROMPTON RD	GDUMWU	85356	D	1	B	M	4.03	5.46	
BF	22	CLARENDON CRES	GDUMWU	71906	D	1	F	M	3.69	5.63	
BF	7	COLLETT PL	GDUMWU	6302	D	1	B	M	3.05	3.48	
BF	8	COLLETT PL	GDUMWU	6303	D	1	B	M	2.56	3.09	
BF	10	COLLETT PL	GDUMWU	6304	D	1	B	M	2.22	3.53	
BF	5	FISHERMAN RD	GHOM3	6333	D	1	B	M	4.87	7.95	
BF	7	FISHERMAN RD	GHOM3	6332	D	2	B	M	6.42	7.73	
BF	9	FISHERMAN RD	GHOM3	6335	D	1	W/B	M	3.03	3.57	
BF	20	FISHERMAN RD	GHOM2	6350	D	1	F	M	5.50	6.70	
BF	22	FISHERMAN RD	GHOM2	6349	D	1	B	M	2.61	4.88	
BF	24	FISHERMAN RD	GHOM2	6348	D	2	W/B	M	2.76	3.96	
BF	2	FREDERICK ST	GDUMWU	7960	D	1	B	M	2.44	3.50	
BF	1	FREDERICK ST	GDUMWU	7959	D	1	F	M	3.17	3.62	
BF	17	GRAHAM AVE	GDUMWU	6363	D	1	F	M	2.67	3.92	
BF	19	GRAHAM AVE	GDUMWU	6364	D	E	F	M	2.24	5.13	
BF	21	GRAHAM AVE	GDUMWU	6365	D	2	B/F	M	2.26	2.95	
BF	23	GRAHAM AVE	GDUMWU	6366	D	2	B/F	M	1.80	2.16	
BF	4	ISLAND POINT RD	GDUMWU	38501	C	2	B	L	1.60	2.46	
BF	5	ISLAND POINT RD	GDUMWU	38505	D	2	B/F	M	4.15	4.21	
BF	6	ISLAND POINT RD	GDUMWU	38500	D	1	F	S	1.70	2.32	
BF	7	ISLAND POINT RD	GDUMWU	38506	D	2	B/F	L	4.18	4.22	
BF	10	ISLAND POINT RD	GDUMWU	38498	D	1	F	M	1.64	2.43	
BF	12	ISLAND POINT RD	GDUMWU	38497	D	1	F	M	1.53	2.21	
BF	14	ISLAND POINT RD	GDUMWU	38496	D	1	F	S	1.81	3.66	
BF	16	ISLAND POINT RD	GDUMWU	38495	D	1	F	M	2.39	4.29	
BF	16A	ISLAND POINT RD	GDUMWU	38494	D	1	B	M	2.84	4.33	
BF	18	ISLAND POINT RD	GDUMWU	38493	D	1	B	M	3.33	4.59	
BF	8	ISLAND POINT RD	GDUMWU	38499	D	1	B	M	1.97	2.37	
BF	9	ISLAND POINT RD	GDUMWU	38507	D	2	B	L	4.52	4.18	
BF	6	KEVIN CRES	GDUMWU	6647	B	1	B	M	3.40	5.68	
BF	8	KEVIN CRES	GDUMWU	6648	D	1	B	M	2.84	4.38	
BF	15	LACHLAN CRES	GDUMWU	6656	D	1	B/WB	M	2.50	3.77	
BF	2	LORALYN AVE	GDUMWU	6768	D	2	B/F	M	3.09	4.09	
BF	4	LORALYN AVE	GDUMWU	6769	D	2	B/F	M	3.21	3.85	
BF	10	LORALYN AVE	GDUMWU	6765	D	1	B	M	2.14	3.61	
BF	100	LORALYN AVE	GDUMWU	6721	Development out of Range				2.90		
BF	102	LORALYN AVE	GDUMWU	6720	D	1	F	M	3.00	6.01	
BF	104	LORALYN AVE	GDUMWU	6719	Development out of Range				3.00		
BF	106	LORALYN AVE	GDUMWU	6718	D	2	B	L	2.90	3.99	
BF	108	LORALYN AVE	GDUMWU	6717	D	1	B	M	2.50	4.24	
BF	110	LORALYN AVE	GDUMWU	6716	D	1	F	M	2.00	3.02	
BF	112	LORALYN AVE	GDUMWU	6715	D	2	B	L	1.80	2.67	
BF	114	LORALYN AVE	GDUMWU	6714	D	1	B	M	1.80	3.81	
BF	116	LORALYN AVE	GDUMWU	6713	D	2	B	L	2.20	2.94	
BF	118	LORALYN AVE	GDUMWU	6712	D	2	B	M	2.20	2.53	
BF	12	LORALYN AVE	GDUMWU	6764	D	1	F	S	2.73	3.54	
BF	120	LORALYN AVE	GDUMWU	6711	VACANT				1.80		
BF	122	LORALYN AVE	GDUMWU	6710	D	1	B	M	1.60	4.10	
BF	124	LORALYN AVE	GDUMWU	6709	D	1	F	M	1.20	3.80	
BF	126	LORALYN AVE	GDUMWU	6705	D	SPLIT	B F	M	1.40	4.10	
BF	127	LORALYN AVE	GDUMWU	55618	D	1	B	M	2.47	3.01	
BF	128	LORALYN AVE	GDUMWU	6703	D	2	B	L	1.40	2.90	
BF	129	LORALYN AVE	GDUMWU	79017	D	2	B	M	1.96	2.85	
BF	130	LORALYN AVE	GDUMWU	6702	D	E	B W/B	L	1.20	5.20	
BF	14	LORALYN AVE	GDUMWU	6763	D	2	B	M	2.60	2.73	
BF	16	LORALYN AVE	GDUMWU	6762	D	1	W/B	M	2.54	3.59	
BF	166	LORALYN AVE	GDUMWU	8787	D	1	F	S	2.60	5.31	
BF	168	LORALYN AVE	GDUMWU	8786	D	1	F	S	2.60	5.56	
BF	170	LORALYN AVE	GDUMWU	8785	D	1	B	M	2.70	3.96	
BF	172	LORALYN AVE	GDUMWU	8784	D	2	CONC	L	2.80	2.30	
BF	174	LORALYN AVE	GDUMWU	8783	D	2	CONC	L	2.70	2.30	
BF	176	LORALYN AVE	GDUMWU	8782	D	1	B	M	2.70	2.71	
BF	178	LORALYN AVE	GDUMWU	8781	D	1	W/B	M	2.60	3.19	
BF	18	LORALYN AVE	GDUMWU	6761	D	1	W/B	S	2.55	3.60	
BF	180	LORALYN AVE	GDUMWU	8780	D	1	F	S	2.60	3.29	
BF	184	LORALYN AVE	GDUMWU	8778	D	1	B	M	2.50	3.00	
BF	186	LORALYN AVE	GDUMWU	8777	D	1	B	M	2.40	3.14	
BF	187	LORALYN AVE	GDUMWU	8737	D	1	F	M	3.22	3.89	
BF	188	LORALYN AVE	GDUMWU	8776	D	1	B	M	2.60	3.25	
BF	190	LORALYN AVE	GDUMWU	8775	D	1	B	M	2.75	3.40	
BF	192	LORALYN AVE	GDUMWU	8774	D	1	F	M	2.70	3.71	
BF	194	LORALYN AVE	GDUMWU	8773	D	1	F	M	2.60	3.87	
BF	196	LORALYN AVE	GDUMWU	8772	D	1	F	M	2.50	3.83	

LEGEND:

Material: B - brick; W/B - weatherboard; F - fibro; CONC - concrete; AL - aluminium

Zone Location: BF - Basin Foreshore; SP - Sanctuary Point; SI - Sussex Inlet

Type: D - dwelling; U - units; C - commercial

Size: S - small; M - medium; L - large

ZONE LOCATION	ST No.	STREET NAME	RELEVANT GRIDPOINT IN HYDRAULIC MODEL	GIS UPN	TYPE	STOREYS	MATERIAL	SIZE	GROUND RL	FLOOR RL	REMARKS
BF	198	LORALYN AVE	GDUMWU	8771	D	1	B	M	2.40	3.88	
BF	20	LORALYN AVE	GDUMWU	6760	D	1	F	M	2.68	3.83	
BF	200	LORALYN AVE	GDUMWU	8770	D	1	F	M	2.30	3.82	
BF	202	LORALYN AVE	GDUMWU	8769	D	2	B	M	2.00	3.07	
BF	204	LORALYN AVE	GDUMWU	8768	D	1	B	M	1.50	5.46	
BF	206	LORALYN AVE	GDUMWU	8767	D	2	B/AL/CLAD WB	M	1.80	4.04	
BF	208	LORALYN AVE	GDUMWU	8766	D	1	W/B	M	2.00	4.49	
BF	22	LORALYN AVE	GDUMWU	6759	D	2	B	L	2.56	3.30	
BF	24	LORALYN AVE	GDUMWU	6758	D	1	B	M	2.70	3.40	
BF	26	LORALYN AVE	GDUMWU	6757	D	2	B	M	2.66	3.25	
BF	28	LORALYN AVE	GDUMWU	6756	D	1	F	S	2.73	3.37	
BF	30	LORALYN AVE	GDUMWU	6755	D	E	B/F	M	3.10	5.71	
BF	32	LORALYN AVE	GDUMWU	6754	D	2	B	M	2.54	3.67	
BF	34	LORALYN AVE	GDUMWU	6753	D	1	W/B	M	2.55	3.01	
BF	36	LORALYN AVE	GDUMWU	6752	D	1	B/F	M	2.77	3.70	
BF	38	LORALYN AVE	GDUMWU	6751	D	1	B	M	2.66	3.86	
BF	44	LORALYN AVE	GDUMWU	6748	D	1	B	M	2.85	3.86	
BF	46	LORALYN AVE	GDUMWU	6746	D	1	B/F	S	2.48	3.56	
BF	48	LORALYN AVE	GDUMWU	6747	D	1	B	M	2.46	3.57	
BF	50	LORALYN AVE	GDUMWU	6745	D	1	F	M	2.32	3.03	
BF	52	LORALYN AVE	GDUMWU	6744	D	1	B	M	1.20	2.06	
BF	54	LORALYN AVE	GDUMWU	6743	D	1	F	S	1.53	2.68	
BF	56	LORALYN AVE	GDUMWU	6742	D	1	B/WB	M	1.79	3.30	
BF	58	LORALYN AVE	GDUMWU	6741	D	1	B	M	1.85	3.38	
BF	60	LORALYN AVE	GDUMWU	6740	D	1	F	M	2.04	3.97	
BF	62	LORALYN AVE	GDUMWU	6739	D	1	F	M	2.11	4.56	
BF	8	LORALYN AVE	GDUMWU	6766	D	1	B	L	2.34	3.90	
BF	159	MACLEANS POINT RD	GDUMWU	8944	D	1	B	M	3.25	4.42	
BF	161	MACLEANS POINT RD	GDUMWU	8943	D	1	B	M	2.85	3.85	
BF	163	MACLEANS POINT RD	GDUMWU	8942	D	1	F	M	2.75	3.99	
BF	165	MACLEANS POINT RD	GDUMWU	8941	D	1	F	M	2.55	3.55	
BF	167	MACLEANS POINT RD	GDUMWU	8940	D	1	AL/WB	M	2.45	3.07	
BF	**169**	MACLEANS POINT RD	GDUMWU	8939	D	2	B	M	2.65	2.98	
BF	171	MACLEANS POINT RD	GDUMWU	8938	VACANT				2.60		
BF	172	MACLEANS POINT RD	GDUMWU	8882	D	2	B/F	M	3.30	3.52	
BF	173	MACLEANS POINT RD	GDUMWU	8936	D	1	F	M	2.70	3.78	
BF	174	MACLEANS POINT RD	GDUMWU	8883	U	1	B	M	3.50	3.87	
BF	175	MACLEANS POINT RD	GDUMWU	8937	D	1	F	M	2.85	3.77	
BF	177	MACLEANS POINT RD	GDUMWU	8935	D	2	BF	M	2.90	3.36	
BF	179	MACLEANS POINT RD	GDUMWU	8934	D	1	F	S	2.75	3.61	
BF	18	MATHIE ST	GDUMWU	17090	D	1	B	M	4.26	5.97	
BF	19	MATHIE ST	GDUMWU	84578	D	1	B	M	1.20	4.62	
BF	33	RESERVE RD	GDUMWU	17111	D	1	B	M	3.14	6.65	
BF	41	RESERVE RD	GDUMWU	15342	D	1	B	M	3.70	5.98	
BF	25 A	RESERVE RD	GDUMWU	71923	D	2	B	M	3.31	7.03	
BF	33 a	RESERVE RD	GDUMWU	17110	D	1	W/B	M	2.78	6.57	
BF	41 a	RESERVE RD	GDUMWU	15341	D	1	B	M	3.92	6.49	
BF	24	RIVERSIDE ESP STH	GDUMWU	6131	D	2	B	M	3.59	3.75	
BF	27	RIVERSIDE ESP STH	GDUMWU	71903	D	1	B	M	3.91	4.69	
BF	100	SANCTUARY POINT RD	G99TOM6	20203	D	1	F	S	1.98	3.38	
BF	102	SANCTUARY POINT RD	G99TOM6	9549	D	1	B	M	2.85	2.95	
BF	104	SANCTUARY POINT RD	G99TOM6	9550	SHED		F	TINY	1.58		
BF	118	SANCTUARY POINT RD	GDUMWU	9551	D	1	B	M	1.99	2.89	
BF	120	SANCTUARY POINT RD	GDUMWU	9552	D	1	B	S	1.99	2.84	
BF	122	SANCTUARY POINT RD	GDUMWU	87930	D	1	F	M	2.54	3.29	
BF	122A	SANCTUARY POINT RD	GDUMWU	87929	D	1	B	M	1.94	2.62	
BF	124	SANCTUARY POINT RD	GDUMWU	9554	D	2	B/F	M	1.94	2.75	
BF	126	SANCTUARY POINT RD	GDUMWU	9555	D	1	B	S	2.29	3.95	
BF	128	SANCTUARY POINT RD	GDUMWU	9556	D				1.53	4.62	
BF	130	SANCTUARY POINT RD	GDUMWU	9557	D	1	F	M	2.55	3.78	
BF	164	SANCTUARY POINT RD	GDUMWU	9574	D	1	F	M	5.37	5.54	
BF	166	SANCTUARY POINT RD	GDUMWU	9575	D	2	B F	M	1.80	4.11	
BF	168	SANCTUARY POINT RD	GDUMWU	9576	VACANT				1.80		
BF	170	SANCTUARY POINT RD	GDUMWU	9577	D	2	B	L	1.69	3.42	
BF	172	SANCTUARY POINT RD	GDUMWU	9578	D	1	F	S	3.47	3.28	
BF	174	SANCTUARY POINT RD	GDUMWU	9579	D	1	MC WB	M	2.50	3.76	
BF	190	SANCTUARY POINT RD	GDUMWU	9581	D	1	B	M	2.67	3.08	
BF	192	SANCTUARY POINT RD	GDUMWU	9580	D	1	B	M	2.97	3.61	
BF	194	SANCTUARY POINT RD	GDUMWU	9582	D	2	B	M	1.73	3.52	
BF	181	THE WOOL RD	GHOM2	7095	D	1	W/B	M	4.16	4.63	
BF	183	THE WOOL RD	GHOM2	7096	D	1	B	M	3.01	3.64	
BF	218	THE WOOL RD	GDUMWU	7058	D	1	B	M	2.73	3.78	
BF	220	THE WOOL RD	GDUMWU	7103	D	1	W/B	M	4.32	5.34	
BF	222	THE WOOL RD	GDUMWU	19270	D	2	B	M	5.74	6.00	
BF	50	THE WOOL RD	GDUMWU	79163	D	1	W/B	M	2.97	3.97	
BF	54	THE WOOL RD	GDUMWU	79162	D	1	B	M	3.38	4.18	

LEGEND:

Material: B - brick; W/B - weatherboard; F - fibro; CONC - concrete; AL - aluminium

Zone Location: BF - Basin Foreshore; SP - Sanctuary Point; SI - Sussex Inlet

Type: D - dwelling; U - units; C - commercial

Size: S - small; M - medium; L - large

ZONE LOCATION	ST No.	STREET NAME	RELEVANT GRIDPOINT IN HYDRAULIC MODEL	GIS UPN	TYPE	STOREYS	MATERIAL	SIZE	GROUND RL	FLOOR RL	REMARKS
BF	60	THE WOOL RD	GDUMWU	85355	D	1	B	M	4.70	6.01	
BF	105	WALMER AVE	GDUMWU	10508	D	SPLIT	F	M	2.72	3.57	
BF	107	WALMER AVE	GDUMWU	10507	D	2	F	M	2.80	3.72	
BF	109	WALMER AVE	GDUMWU	10506	D	1	F	M	2.70	3.48	
BF	111	WALMER AVE	GDUMWU	10505	D	1	F	M	2.60	3.54	
BF	113	WALMER AVE	GDUMWU	10504	D	1	F	M	2.60	3.04	
BF	115	WALMER AVE	GDUMWU	10503	D	1	B	M	2.70	4.50	
BF	117	WALMER AVE	GDUMWU	10502	D	1	B	M	2.60	4.41	
BF	119	WALMER AVE	GDUMWU	10501	D	2	B	L	2.58	4.65	
BF	121	WALMER AVE	GDUMWU	10500	D	1	B	M	2.30	3.05	
BF	123	WALMER AVE	GDUMWU	10499	D	2	B	L	2.10	2.46	
BF	125	WALMER AVE	GDUMWU	10498	D	1	F	M	2.10	3.18	
BF	127	WALMER AVE	GDUMWU	10497	D	E	F	M	2.01	5.42	
BF	129	WALMER AVE	GDUMWU	10496	D	1	B	M	1.90	2.49	
BF	131	WALMER AVE	GDUMWU	10495	D	1	AL/WB	M	1.90	3.18	
BF	133	WALMER AVE	GDUMWU	10494	D	1	F	M	1.65	3.00	
BF	135	WALMER AVE	GDUMWU	10493	D	1	F	M	1.50	3.00	
BF	137	WALMER AVE	GDUMWU	10492	D	SPLIT	B	M	1.40	2.24	
BF	139	WALMER AVE	GDUMWU	10491	D	1	F	M	1.25	3.18	
BF	141	WALMER AVE	GDUMWU	10490	D	1	B	M	1.25	2.79	
BF	143	WALMER AVE	GDUMWU	10489	D	SPLIT	B	M	1.25	2.98	
BF	145	WALMER AVE	GDUMWU	10488	D	1	F	M	1.25	2.63	
BF	146	WALMER AVE	GDUMWU	10378	D	2	F	M	2.80	2.99	
BF	147	WALMER AVE	GDUMWU	10487	D	1	F	S	1.20	2.22	
BF	149	WALMER AVE	GDUMWU	10486	D	1	B/F	S	1.20	2.25	
BF	150	WALMER AVE	GDUMWU	10380	D	1	B	M	2.90	3.38	
BF	151	WALMER AVE	GDUMWU	10485	D	2	B/F	M	0.95	1.23	
BF	152	WALMER AVE	GDUMWU	10381	D	1	WB	M	2.85	3.22	
BF	153	WALMER AVE	GDUMWU	10484	D	E	F	M	0.91	1.46	
BF	154	WALMER AVE	GDUMWU	10382	D	2	B/F	M	2.60	2.48	
BF	156	WALMER AVE	GDUMWU	10383	D	1	AL/WB	M	2.60	3.11	
BF	158	WALMER AVE	GDUMWU	10384	D	1	F	M	2.68	2.90	
BF	159	WALMER AVE	GDUMWU	10481	D	1	WB	M	1.63	2.46	
BF	160	WALMER AVE	GDUMWU	10385	D	1	F	M	2.65	3.27	
BF	161	WALMER AVE	GDUMWU	10480	D	1	F	M	1.59	1.56	
BF	162	WALMER AVE	GDUMWU	10386	D	2	B/F	M	2.55	2.32	
BF	163	WALMER AVE	GDUMWU	10479	D	2	B/WB	M	1.75	2.64	
BF	164	WALMER AVE	GDUMWU	10387	VACANT				2.24		
BF	165	WALMER AVE	GDUMWU	10478	D	1	B	M	1.15	2.68	
BF	166	WALMER AVE	GDUMWU	10388	D	2	BWB	M	2.25	2.51	
BF	167	WALMER AVE	GDUMWU	10477	SHED		F	S	1.17	1.44	
BF	168	WALMER AVE	GDUMWU	10389	D	2	B	M	2.27	2.94	
BF	169	WALMER AVE	GDUMWU	10476	D	1	AL/WB	M	0.96	2.22	
BF	170	WALMER AVE	GDUMWU	10390	D	1	B	M	2.25	3.41	
BF	171	WALMER AVE	GDUMWU	10475	D	1	B	M		2.60	
BF	172	WALMER AVE	GDUMWU	10391	D	1	B	M	2.26	3.63	
BF	174	WALMER AVE	GDUMWU	10392	D	1	F	M	2.65	4.12	
BF	176	WALMER AVE	GDUMWU	10393	D	E	WB	M	3.24	6.80	
BF	178B	WALMER AVE	GDUMWU	7961	D	1	WB	M	3.20	3.99	
BF	180	WALMER AVE	GDUMWU	10395	D	1	B	M	3.07	3.45	
BF	182	WALMER AVE	GDUMWU	10396	D	2	B	M	2.88	3.05	
BF	184	WALMER AVE	GDUMWU	10397	D	1	B	M	2.85	3.31	
BF	185	WALMER AVE	GDUMWU	10468	D	1	B	M	1.10	2.94	
BF	186	WALMER AVE	GDUMWU	10398	D	1	B	M	2.97	3.20	
BF	187	WALMER AVE	GDUMWU	10467	DOUBLE METAL GARAGE ONLY				1.94	2.15	
BF	188	WALMER AVE	GDUMWU	10399	D	2	B	M	3.06	3.35	
BF	189	WALMER AVE	GDUMWU	10466	D	2	B	M	0.98	1.54	
BF	190	WALMER AVE	GDUMWU	10400	D	2	B	M	3.76	3.95	
BF	191	WALMER AVE	GDUMWU	10465	VACANT				0.98		
BF	193	WALMER AVE	GDUMWU	10464	D	2	B	M	1.23	1.44	
BF	195	WALMER AVE	GDUMWU	10463	D	2	B	M	0.88	1.59	
BF	197	WALMER AVE	GDUMWU	10462	D	1	B		1.20	6.04	
BF	199	WALMER AVE	GDUMWU	10461	D	S	B	M	1.30	5.51	
BF	203	WALMER AVE	GDUMWU	10460	VACANT				1.40		
BF	205	WALMER AVE	GDUMWU	10459	D	1	B	M	1.40	6.71	
BF	207	WALMER AVE	GDUMWU	10458	D	1	F	M	1.50	6.52	
SP	1	AZALEA AVE	G99TOM12	7283	D	1	WB	S	3.35	4.05	
SP	4	AZALEA AVE	G99TOM13	7281	D	1	F	S	3.78	4.70	
SP	5	AZALEA AVE	G99TOM12	7285	D	1	F	M	4.19	4.47	
SP	6	AZALEA AVE	G99TOM13	7280	D	1	B	M	4.60	4.91	
SP	8	AZALEA AVE	G99TOM13	7279	D	2	B	L	5.00	5.32	
SP	9	AZALEA AVE	G99TOM12	7287	D	1	B	M	4.77	5.06	
SP	2	BORONIA AVE	G99TOM14	7338	D	1	B	S	2.32	3.55	
SP	4	BORONIA AVE	G99TOM14	7337	D	1	F	S	2.46	3.58	
SP	6	BORONIA AVE	G99TOM14	7336	D	1	F	S	3.46	4.06	

LEGEND:

Material: B - brick; W/B - weatherboard; F - fibro; CONC - concrete; AL - aluminium

Zone Location: BF - Basin Foreshore; SP - Sanctuary Point; SI - Sussex Inlet

Type: D - dwelling; U - units; C - commercial

Size: S - small; M - medium; L - large

ZONE LOCATION	ST No.	STREET NAME	RELEVANT GRIDPOINT IN HYDRAULIC MODEL	GIS UPN	TYPE	STOREYS	MATERIAL	SIZE	GROUND RL	FLOOR RL	REMARKS
SP	8	BORONIA AVE	G99TOM13	7335	D	1	WB	S	4.05	4.81	
SP	10	BORONIA AVE	G99TOM13	7334	D	1	F	S	4.55	5.32	
SP	1	FAIRWAY DR	G99TOM14	7819	D	1	F	S	1.97	3.01	
SP	2	FAIRWAY DR	G99TOM13	7714	D	1	F	S	1.88	3.06	
SP	3	FAIRWAY DR	G99TOM14	7818	D	1	F	S	2.02	3.08	
SP	4	FAIRWAY DR	G99TOM13	7715	D	1	B	M	2.17	3.64	
SP	5	FAIRWAY DR	G99TOM13	7817	D	1	F	S	2.14	3.39	
SP	6	FAIRWAY DR	G99TOM13	7716	D	1	B	M	1.92	2.99	
SP	7	FAIRWAY DR	G99TOM13	7816	D	1	F	S	2.02	3.57	
SP	9	FAIRWAY DR	G99TOM13	7815	D	1	B	S	2.42	2.92	
SP	14	FAIRWAY DR	G99TOM13	7720	D	1	B	M	2.29	3.15	
SP	18	FAIRWAY DR	G99TOM13	7722	D	1	F	S	1.87	2.94	
SP	22	FAIRWAY DR	G99TOM12	7724	D	1	F	S	2.00	2.93	
SP	23	FAIRWAY DR	G99TOM12	7812	D	1	B	S	3.06	3.43	
SP	24	FAIRWAY DR	G99TOM12	7725	D	1	F	S	2.25	3.03	
SP	25	FAIRWAY DR	G99TOM12	7811	D	1	B	S	2.70	3.59	
SP	26	FAIRWAY DR	G99TOM12	7726	D	1	B	M	2.30	2.56	
SP	27	FAIRWAY DR	G99TOM12	7810	D	2	B	M	2.74	2.90	
SP	28	FAIRWAY DR	G99TOM12	7727	D	1	F	M	2.45	3.06	
SP	29	FAIRWAY DR	G99TOM12	7809	D	1	F	S	2.66	3.74	
SP	32	FAIRWAY DR	G99TOM12	7729	D	1	B	M	2.39	3.29	
SP	33	FAIRWAY DR	G99TOM12	7807	D	1	F	M	3.29	4.27	
SP	35	FAIRWAY DR	G99TOM12	7806	D	1	B	M	3.79	4.23	
SP	42	FAIRWAY DR	G99TOM11	7734	D	1	F	S	2.10	3.04	
SP	44	FAIRWAY DR	G99TOM11	7735	D	1	F	S	2.16	2.66	
SP	52	FAIRWAY DR	G99TOM11	7739	D	2	F	M	2.59	3.29	
SP	54	FAIRWAY DR	G99TOM11	7740	D	1	B	S	2.59	3.29	
SP	56	FAIRWAY DR	G99TOM11	7741	D	2	B	M	2.94	3.09	
SP	62	FAIRWAY DR	G99TOM11	7744	D	1	F	S	4.05	4.58	
SP	66	FAIRWAY DR	G99TOM11	7746	D	1	B	S	3.64	4.24	
SP	27	FIRST AVE	GERO2	21950	D	1	B	M	5.25	5.35	
SP	29	FIRST AVE	GERO2	21949	D	1	B	M	5.88	5.98	
SP	7	KALLAROO RD	GERO2	14210	D	1	F	S	3.73	4.63	
SP	9	KALLAROO RD	GERO2	14209	D	1	F	M	3.55	4.49	
SP	11	KALLAROO RD	GERO2	14208	D	1	B	M	2.90	4.03	
SP	16	KALLAROO RD	GERO2	14183	D	1	F	S	3.22	4.01	
SP	20	KALLAROO RD	GERO2	14185	D	1	F	M	3.10	3.43	
SP	26	KALLAROO RD	GERO2	14186	D	1	F	S	3.63	3.93	
SP	103	LARMER AVE	G99TOM11	9729	D	1	F	S	1.50	3.13	
SP	105	LARMER AVE	G99TOM11	9727	D	1	B	M	1.43	3.08	
SP	107	LARMER AVE	G99TOM11	9728	D	2	WB	M	1.46	4.07	
SP	109	LARMER AVE	G99TOM11	9726	D	1	F	M	1.57	3.05	
SP	111	LARMER AVE	G99TOM11	9725	D	2	B	M	1.55	1.65	
SP	113	LARMER AVE	G99TOM11	9724	D	2	F	M	1.62	1.93	
SP	115	LARMER AVE	G99TOM11	9723	D	2	B	M	1.54	1.99	
SP	143	LARMER AVE	G99TOM11	38003	D	1	B	M	2.36	2.47	
SP	145	LARMER AVE	G99TOM11	20208	D	1	B	M	2.36	2.47	
SP	149	LARMER AVE	G99TOM11	9721	D	1	B	M	2.41	2.59	
SP	151	LARMER AVE	G99TOM11	9720	D	1	F	M	2.58	3.43	
SP	153	LARMER AVE	G99TOM11	9719	D	1	F	M	2.58	3.43	
SP	155	LARMER AVE	G99TOM11	9718	D	1	B	M	3.43	3.78	
SP	157	LARMER AVE	G99TOM11	9717	D	1	F	M	3.74	4.31	
SP	2	MACGIBBON PDE	GWOR4	29626	D	1	B	M	7.66	7.92	
SP	4	MACGIBBON PDE	GWOR4	29627	D	1	WB	M	7.78	7.99	
SP	6	MACGIBBON PDE	GWOR4	14747	D	1	F	S	7.13	7.86	
SP	10	MACGIBBON PDE	GWOR4	14748	D	1	B	M	6.87	7.56	
SP	12	MACGIBBON PDE	GWOR4	14749	D	2	B	M	6.33	7.56	
SP	14	MACGIBBON PDE	GWOR4	14750	D	1	F	S	6.56	7.90	
SP	16	MACGIBBON PDE	GWOR4	14751	D	1	F	S	6.56	7.97	
SP	94	MACGIBBON PDE	GWOR3	14773	D	1	B	S	3.75	3.56	
SP	96	MACGIBBON PDE	GWOR3	14785	D	1	F	M	3.77	4.12	
SP	98	MACGIBBON PDE	GWOR3	14786	D	1	F	S	3.09	3.78	
SP	100	MACGIBBON PDE	GWOR3	14787	D	1	F	S	2.93	3.69	
SP	102	MACGIBBON PDE	GWOR3	14788	D	1	F	S	2.35	3.02	
SP	4	MCGOWEN ST	GWOR2	14846	D	2	F	M	1.53	1.59	
SP	8	MCGOWEN ST	GWOR2	14845	D	1	WB	M	2.02	2.54	
SP	10	MCGOWEN ST	GWOR2	14843	D	2	B/F	M	1.28	2.03	
SP	14	MCGOWEN ST	GWOR2	14841	D	2	F	M	2.44	5.10	
SP	16	MCGOWEN ST	GWOR2	14840	D	1	F	S	2.67	3.16	
SP	20	MCGOWEN ST	GWOR2	14838	D	1	WB	M	2.89	3.06	
SP	22	MCGOWEN ST	GWOR2	14837	D	1	B	M	2.65	2.76	
SP	24	MCGOWEN ST	GWOR2	14836	D	1	WB	M	2.72	3.11	
SP	26	MCGOWEN ST	GWOR2	14835	D	1	F	S	2.94	3.29	
SP	28	MCGOWEN ST	GWOR2	14834	D	1	F	S	2.59	3.60	
SP	34	MCGOWEN ST	GWOR2	14831	D	1	F	S	1.70	2.86	
SP	36	MCGOWEN ST	GWOR2	14830	D	2	B	M	2.52	3.00	
SP	38	MCGOWEN ST	GWOR2	14829	D	2	B	M	2.17	2.54	

LEGEND:

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Zone Location: BF - Basin Foreshore; SP - Sanctuary Point; SI - Sussex Inlet

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ZONE LOCATION	ST No.	STREET NAME	RELEVANT GRIDPOINT IN HYDRAULIC MODEL	GIS UPN	TYPE	STOREYS	MATERIAL	SIZE	GROUND RL	FLOOR RL	REMARKS
SP	40	MCGOWEN ST	GWOR2	14828	D	2	F	M	1.88	3.74	
SP	42	MCGOWEN ST	GWOR2	14827	D	1	WB	M	1.98	2.98	
SP	44	MCGOWEN ST	GWOR2	14826	D	2	WB	M	1.60	2.79	
SP	46	MCGOWEN ST	GWOR2	14825	D	2	B	M	1.92	4.93	
SP	48	MCGOWEN ST	GWOR2	14824	D	2	B	M	1.63	4.62	
SP	50	MCGOWEN ST	GWOR2	14823	D	1	F	M	1.62	2.18	
SP	52	MCGOWEN ST	GWOR2	14822	D	1	B	M	1.52	2.52	
SP	54	MCGOWEN ST	GWOR1	14821	D	1	F	S	1.31	1.65	
SP	56	MCGOWEN ST	GWOR1	29750	D	1	B	M	1.30	2.68	
SP	2	MOUNTAIN ST	G99TOM9U	9051	D	2	F	M	1.42	1.65	
SP	3	MOUNTAIN ST	G99TOM9U	9053	D	1	B	M	1.60	2.83	
SP	4	MOUNTAIN ST	G99TOM9U	9050	D	1	B	M	1.47	2.57	
SP	5	MOUNTAIN ST	G99TOM9U	9054	D	2	F	S	1.47	1.52	
SP	7	MOUNTAIN ST	G99TOM9U	9056	D	1	F	S	1.30	2.83	
SP	8	MOUNTAIN ST	G99TOM9U	9048	D	2	B	M	1.53	4.43	
SP	10	MOUNTAIN ST	G99TOM9U	9047	D	2	B	M	1.53	4.20	
SP	11	MOUNTAIN ST	G99TOM9U	9057	D	1	B	M	1.39	2.67	
SP	12	MOUNTAIN ST	G99TOM9U	9046	D	1	F	M	1.74	2.85	
SP	13	MOUNTAIN ST	G99TOM9U	9058	D	2	B	M	1.49	4.23	
SP	14	MOUNTAIN ST	G99TOM9U	9045	D	1	F	S	1.81	2.61	
SP	15	MOUNTAIN ST	G99TOM9U	9059	D	2	F	L	1.54	1.57	
SP	16	MOUNTAIN ST	G99TOM9U	9044	D	1	F	M	1.72	2.56	
SP	18	MOUNTAIN ST	G99TOM9U	9043	D	1	B	S	1.77	2.75	
SP	20	MOUNTAIN ST	G99TOM9U	9042	D	1	WB	M	1.75	2.59	
SP	21	MOUNTAIN ST	G99TOM9U	9062	D	2	F	M	1.81	2.00	
SP	22	MOUNTAIN ST	G99TOM9U	9041	D	1	B	M	1.75	2.58	
SP	23	MOUNTAIN ST	G99TOM7	9063	D	1	B	M	1.83	2.59	
SP	24	MOUNTAIN ST	G99TOM9U	9040	D	2	WB	M	1.79	1.81	
SP	25	MOUNTAIN ST	G99TOM7	9064	D	1	B	M	1.80	2.97	
SP	26	MOUNTAIN ST	G99TOM7	9039	D	1	WB	S	1.71	2.95	
SP	27	MOUNTAIN ST	G99TOM7	9065	D	1	F	S	1.66	2.58	
SP	29	MOUNTAIN ST	G99TOM7	9066	D	1	WB	M	1.76	2.43	
SP	31	MOUNTAIN ST	G99TOM7	9067	D	1	F	M	1.77	2.33	
SP	32	MOUNTAIN ST	G99TOM7	9036	D	1	F	M	1.75	2.70	
SP	34	MOUNTAIN ST	G99TOM7	20188	D	2	B	L	1.56	1.77	
SP	35	MOUNTAIN ST	G99TOM7	9069	D	1	B	S	1.72	2.45	
SP	36	MOUNTAIN ST	G99TOM7	20187	D	2	B	L	1.39	1.61	
SP	16	NAVAL PDE	GERO1	14511	D	1	WB	M	3.51	4.11	
SP	21	NAVAL PDE	GERO1	14520	D	1	F	M	3.10	3.97	
SP	2	PAGE ST	GWOR1	14868	D	1	F	S	1.30	1.93	
SP	8	PAGE ST	GWOR1	14871	D	1	F	S	1.54	2.58	
SP	10	PAGE ST	GWOR1	14872	D	2	WB	M	1.79	2.90	
SP	12	PAGE ST	GWOR1	14873	D	2	WB	S	2.24	4.78	
SP	14	PAGE ST	GWOR1	14874	D	1	F	S	2.50	5.50	
SP	14	PRENTICE AVE	GWOR1	14911	D	1	B/WB	M	0.94	0.94	
SP	16	PRENTICE AVE	GWOR1	14914	D	E	B/F	M	0.57	2.89	
SP	22	PRENTICE AVE	GWOR1	14915	D	1	F	M	0.92	1.38	
SP	24	PRENTICE AVE	GWOR1	14916	D	1	F	M	1.38	2.06	
SP	28	PRENTICE AVE	GWOR1	14918	D	1	B	M	2.17	5.43	
SP	30	PRENTICE AVE	GWOR1	14919	D	1	F	S	1.18	1.99	
SP	1	ROSE AVE	G99TOM13	9442	D	1	B	M	3.22	3.73	
SP	3	ROSE AVE	G99TOM13	9443	D	1	B	S	4.12	4.43	
SP	4	ROSE AVE	G99TOM13	9441	D	1	F	S	4.74	5.36	
SP	17	ROULSTONE CRES	G99TOM16	9453	D	1	B	M	5.37	6.17	
SP	19	ROULSTONE CRES	G99TOM16	9454	D	1	F	M	5.07	5.09	
SP	21	ROULSTONE CRES	G99TOM16	9455	D	1	B	M	4.54	4.77	
SP	25	ROULSTONE CRES	G99TOM16	9457	D	1	F	M	3.27	3.78	
SP	29	ROULSTONE CRES	G99TOM15	9459	D	2	B/WB	M	3.21	3.07	
SP	35	ROULSTONE CRES	G99TOM15	9461	D	E	B/WB	S	2.25	5.29	
SP	37	ROULSTONE CRES	G99TOM15	9462	D	2	B/WB	M	3.15	2.92	
SP	41	ROULSTONE CRES	G99TOM15	9464	D	2	F/WB	M	2.20	2.13	
SP	2	SALINAS ST	G99TOM19	9509	D	1	B	S	5.16	5.45	
SP	4	SALINAS ST	G99TOM19	9508	D	1	B	M	5.04	5.21	
SP	6	SALINAS ST	G99TOM19	9507	D	1	F	M	5.11	5.42	
SP	7	SALINAS ST	G99TOM19	9501	D	1	F	S	5.48	6.31	
SP	8	SALINAS ST	G99TOM19	9506	D	1	B	M	4.58	4.64	
SP	9	SALINAS ST	G99TOM19	9502	D	1	B	S	5.23	5.69	
SP	11	SALINAS ST	G99TOM19	9503	D	1	B	S	4.90	5.52	
SP	11	SANCTUARY PT. RD	G99TOM9U	9706	D	1	B	M	3.19	3.42	
SP	12	SANCTUARY PT. RD	G99TOM9U	9512	D	1	F	M	3.08	3.85	
SP	16	SANCTUARY PT. RD	G99TOM9U	76435	D	1	B	L	1.92	1.96	
SP	27	SANCTUARY PT. RD	G99TOM7	9703	D	1	B	M	3.56	4.13	
SP	28	SANCTUARY PT. RD	G99TOM7	9517	D	1	B	M	2.41	2.53	
SP	30	SANCTUARY PT. RD	G99TOM7	9516	Telstra	1	F	S	2.50	2.92	
SP	38	SANCTUARY PT. RD	G99TOM6	9521	D	1	B	M	3.93	4.35	
SP	40	SANCTUARY PT. RD	G99TOM6	9520	D	1	B	M	4.28	4.58	
SP	2	SHOREVILLE PL	G99TOM18	9732	D	1	B	M	5.43	5.57	

LEGEND:

Material: B - brick; W/B - weatherboard; F - fibro; CONC - concrete; AL - aluminium

Zone Location: BF - Basin Foreshore; SP - Sanctuary Point; SI - Sussex Inlet

Type: D - dwelling; U - units; C - commercial

Size: S - small; M - medium; L - large

ZONE LOCATION	ST No.	STREET NAME	RELEVANT GRIDPOINT IN HYDRAULIC MODEL	GIS UPN	TYPE	STOREYS	MATERIAL	SIZE	GROUND RL	FLOOR RL	REMARKS
SP	3	SHOREVILLE PL	G99TOM18	9731	D	1	B	M	5.02	5.24	
SP	4	SHOREVILLE PL	G99TOM18	9730	D	1	F	M	4.97	5.22	
SP	5	SHOREVILLE PL	G99TOM18	10271	D	1	F	M	6.02	6.36	
SP	215	THE PARK DR	G99TOM15	9859	D	1	F	S	4.62	5.17	
SP	217	THE PARK DR	G99TOM15	34444	D	1	F	S	4.06	4.61	
SP	221	THE PARK DR	G99TOM15	34442	D	1	B	L	2.53	3.30	
SP	223	THE PARK DR	G99TOM14	9858	D	1	B	S	2.38	3.29	
SP	229	THE PARK DR	G99TOM14	9856	D	1	F	S	2.09	3.62	
SP	233	THE PARK DR	G99TOM14	9854	D	1	F	S	1.85	2.92	
SP	237	THE PARK DR	G99TOM14	9852	D	2	B	L	1.88	3.70	
SP	239	THE PARK DR	G99TOM14	9851	D	1	F	S	1.70	3.62	
SP	240	THE PARK DR	G99TOM13	10087	D	1	F	S	1.87	3.03	
SP	241	THE PARK DR	G99TOM14	9850	D	2	F	M	1.63	4.80	
SP	242	THE PARK DR	G99TOM13	10088	D	1	F	S	1.83	2.82	
SP	245	THE PARK DR	G99TOM13	9848	D	1	B	M	1.93	3.03	
SP	246	THE PARK DR	G99TOM13	10089	D	1	B	S	1.90	3.16	
SP	247	THE PARK DR	G99TOM13	9847	D	1	F	S	1.91	3.03	
SP	248	THE PARK DR	G99TOM13	10091	D	1	F	S	1.86	3.31	
SP	249	THE PARK DR	G99TOM13	9846	D	1	F	S	1.70	3.09	
SP	250	THE PARK DR	G99TOM13	10092	GARAGE	1	F	S	1.70	2.35	
SP	251	THE PARK DR	G99TOM13	9845	D	1	WB	S	1.80	3.03	
SP	252	THE PARK DR	G99TOM13	10093	D	1	F	S	1.45	3.20	
SP	253	THE PARK DR	G99TOM13	9844	D	1	F	S	1.93	3.56	
SP	254	THE PARK DR	G99TOM13	10094	D	2	B	M	1.60	2.30	
SP	255	THE PARK DR	G99TOM13	9843	D	2	B	M	1.90	2.07	
SP	256	THE PARK DR	G99TOM13	10095	D	2	B	M	1.81	4.48	
SP	257	THE PARK DR	G99TOM13	9842	D	1	F	S	2.29	3.24	
SP	258	THE PARK DR	G99TOM13	10096	D	1	B	M	1.63	2.58	
SP	259	THE PARK DR	G99TOM13	53288	D	2	F	S	1.64	3.24	
SP	260	THE PARK DR	G99TOM13	10098	D	1	B	M	1.65	3.05	
SP	262	THE PARK DR	G99TOM13	10097	D	1	F	S	2.08	3.05	
SP	265	THE PARK DR	G99TOM13	9838	D	1	B	M	1.48	3.03	
SP	266	THE PARK DR	G99TOM13	10101	D	1	B	M	1.71	3.24	
SP	267	THE PARK DR	G99TOM13	9837	D	2	B	M	1.25	1.53	
SP	268	THE PARK DR	G99TOM13	10100	D	1	B	M	1.60	3.07	
SP	269	THE PARK DR	G99TOM13	9836	D	1	B	S	1.40	3.25	
SP	270	THE PARK DR	G99TOM12	10102	D	1	B	S	1.60	3.16	
SP	271	THE PARK DR	G99TOM13	74756	D	1	F	S	1.43	1.89	
SP	272	THE PARK DR	G99TOM12	10103	D	2	B	L	2.05	4.68	
SP	273	THE PARK DR	G99TOM12	74754	D	2	WB	M	1.35	3.39	
SP	274	THE PARK DR	G99TOM12	10104	D	2	F	L	1.98	2.01	
SP	275	THE PARK DR	G99TOM12	9832	D	2	WB	M	1.42	3.69	
SP	276	THE PARK DR	G99TOM12	10105	D	1	F	S	2.01	2.96	
SP	277	THE PARK DR	G99TOM12	9831	D	1	B	M	1.30	3.31	
SP	278	THE PARK DR	G99TOM12	10106	D	1	B	S	2.01	3.03	
SP	280	THE PARK DR	G99TOM12	10107	D	2	B	M	1.80	1.86	
SP	281	THE PARK DR	G99TOM12	9829	D	2	B	M	1.50	4.22	
SP	282	THE PARK DR	G99TOM11	10108	D	2	B	M	2.00	2.05	
SP	284	THE PARK DR	G99TOM11	10109	D	2	B	M	1.94	4.51	
SP	285	THE PARK DR	G99TOM11	9827	D	1	B	S	1.56	3.28	
SP	287	THE PARK DR	G99TOM11	9826	D	2	B	M	1.63	4.26	
SP	288	THE PARK DR	G99TOM11	10111	D	1	B	S	1.70	3.02	
SP	290	THE PARK DR	G99TOM11	10112	D	1	WB	S	1.44	2.46	
SP	291	THE PARK DR	G99TOM11	9824	D	2	B	M	1.34	3.55	
SP	292	THE PARK DR	G99TOM11	10114	D	2	B	M	1.34	1.57	
SP	293	THE PARK DR	G99TOM11	9823	D	2	B	M	1.40	1.44	
SP	294	THE PARK DR	G99TOM11	10113	D	1	B	M	1.65	1.70	
SP	296	THE PARK DR	G99TOM9U	10115	D	1	F	S	1.66	2.94	
SP	298	THE PARK DR	G99TOM9U	10116	D	1	WB	S	1.59	2.90	
SP	302	THE PARK DR	G99TOM9U	10118	D	1	B	M	1.75	2.52	
SP	303	THE PARK DR	G99TOM9U	9818	D	1	B	M	1.93	2.54	
SP	307	THE PARK DR	G99TOM9U	9816	D	1	B	L	1.93	2.61	
SP	308	THE PARK DR	G99TOM9U	10121	D	1	B	M	1.79	1.89	
SP	309	THE PARK DR	G99TOM9U	9815	D	1	F	S	1.97	2.58	
SP	310	THE PARK DR	G99TOM9U	10122	D	2	F	S	1.63	4.55	
SP	311	THE PARK DR	G99TOM9U	9814	D	1	F	M	1.84	2.72	
SP	313	THE PARK DR	G99TOM9U	9813	D	2	B	M	1.96	2.04	
SP	314	THE PARK DR	G99TOM9U	10124	D	2	B	L	1.66	2.60	
SP	318	THE PARK DR	G99TOM9U	10126	D	1	B	M	1.87	3.07	
SP	319	THE PARK DR	G99TOM9U	9810	D	1	WB	M	1.82	2.89	
SP	320	THE PARK DR	G99TOM7	10127	D	2	F	S	1.77	4.33	
SP	321	THE PARK DR	G99TOM9U	9809	D	1	F	M	1.82	2.67	
SP	322	THE PARK DR	G99TOM7	10128	D	2	B	M	1.61	1.84	
SP	323	THE PARK DR	G99TOM7	9808	D	2	F	S	1.50	1.73	
SP	324	THE PARK DR	G99TOM7	10129	D	2	B	M	1.52	1.72	
SP	325	THE PARK DR	G99TOM7	9807	D	1	B	M	1.47	2.78	
SP	327	THE PARK DR	G99TOM7	9806	D	2	F	M	1.50	1.59	

LEGEND:

Material: B - brick; W/B - weatherboard; F - fibro; CONC - concrete; AL - aluminium

Zone Location: BF - Basin Foreshore; SP - Sanctuary Point; SI - Sussex Inlet

Type: D - dwelling; U - units; C - commercial

Size: S - small; M - medium; L - large

ZONE LOCATION	ST No.	STREET NAME	RELEVANT GRIDPOINT IN HYDRAULIC MODEL	GIS UPN	TYPE	STOREYS	MATERIAL	SIZE	GROUND RL	FLOOR RL	REMARKS
SP	328	THE PARK DR	G99TOM7	10131	D	1	F	S	1.47	1.94	
SP	330	THE PARK DR	G99TOM7	10132	D	1	F	S	1.30	2.42	
SP	332	THE PARK DR	G99TOM6	10133	D	1	B	S	1.40	2.46	
SP	333	THE PARK DR	G99TOM7	9804	D	2	B	S	1.17	1.25	
SP	334	THE PARK DR	G99TOM6	10134	D	2	B	M	1.45	1.64	
SP	335	THE PARK DR	G99TOM7	9803	D	2	B	M	1.13	2.20	
SP	336	THE PARK DR	G99TOM6	10135	D	2	B	L	1.10	1.39	
SP	337	THE PARK DR	G99TOM7	9802	D	2	B	S	1.08	1.12	
SP	338	THE PARK DR	G99TOM6	10136	D	1	B	M	0.98	1.09	
SP	339	THE PARK DR	G99TOM6	9801	D	1	F	S	1.38	2.52	
SP	340	THE PARK DR	G99TOM6	10137	D	1	F	S	1.11	2.35	
SP	341	THE PARK DR	G99TOM6	9800	D	2	B	M	1.08	1.25	
SP	343	THE PARK DR	G99TOM6	9798	D	1	B	M	1.32	1.32	
SP	344	THE PARK DR	G99TOM6	10139	D	1	F	M	1.30	2.77	
SP	345	THE PARK DR	G99TOM6	9799	D	1	F	S	1.12	2.62	
SP	346	THE PARK DR	G99TOM6	10140	D	2	B	M	1.05	1.37	
SP	347	THE PARK DR	G99TOM6	9797	D	1	B	M	1.07	1.21	
SP	348	THE PARK DR	G99TOM6	10141	D	1	F	M	1.36	2.55	
SP	350	THE PARK DR	G99TOM6	10142	D	2	F	M	1.36	4.52	
SP	352	THE PARK DR	G99TOM6	10143	D	2	B	M	1.48	2.54	
SP	353	THE PARK DR	G99TOM6	9795	D	2	B	M	1.10	1.41	
SP	354	THE PARK DR	G99TOM6	10144	D	2	B	M	1.41	1.57	
SP	355	THE PARK DR	G99TOM6	9794	D	2	B	L	1.08	1.20	
SP	359	THE PARK DR	G99TOM6	9792	D	2	B	M	1.05	1.08	
SP	363	THE PARK DR	G99TOM6	9790	D	2	B	M	1.21	1.26	
SP	365	THE PARK DR	G99TOM6	9789	D	2	B	M	1.26	1.41	
SP	369	THE PARK DR	G99TOM6	9788	D	2	B	M	1.31	1.57	
SP	371	THE PARK DR	G99TOM6	9787	D	1	B	M	1.25	2.31	
SP	122	THE WOOL RD	G99TOM18	10154	D	1	F	M	3.79	4.80	
SP	124	THE WOOL RD	G99TOM18	10153	D	1	B	M	3.81	4.07	
SP	126	THE WOOL RD	G99TOM18	10152	D	2	B	M	3.71	3.92	
SP	128	THE WOOL RD	G99TOM18	10151	D	1	F	S	3.45	4.13	
SP	130	THE WOOL RD	G99TOM18	10150	D	1	B	S	3.58	3.76	
SP	3	VOST DR	G99TOM18	10275	D	1	F	M	4.82	5.60	
SP	5	VOST DR	G99TOM18	10274	D	1	B	M	5.77	5.96	
SP	7	VOST DR	G99TOM18	10273	D	1	B	M	6.17	6.29	
SP	13	VOST DR	G99TOM18	10270	D	1	B	M	5.71	6.86	
SP	15	VOST DR	G99TOM18	10269	D	1	B	M	5.56	5.74	
SP	17	VOST DR	G99TOM18	10268	D	1	B	M	4.96	5.45	
SI		JACOBS DR	GBAD4	6410	D	1	B/F	L	1.71	2.35	TOWN HOUSES
SI		JACOBS DR	GBAD4	87019	D	1	B	M	2.35	2.87	
SI		JACOBS DR	GBAD4	87019	D	2	B	M	2.72	2.91	TOWN HOUSES
SI		JACOBS DR	GBAD4	87019	D	2	B	M	2.72	2.91	TOWN HOUSES
SI		JACOBS DR	GBAD4	87019	D	2	B	M	2.72	2.91	TOWN HOUSES
SI		JACOBS DR	GBAD4	87019	D	2	B	M	2.72	2.91	TOWN HOUSES
SI		JACOBS DR	GBAD4	87019	D	2	B	M	2.72	2.91	TOWN HOUSES
SI		JACOBS DR	GBAD4	87019	D	2	B	M	2.72	2.91	TOWN HOUSES
SI		JACOBS DR	GBAD4	87019	D	2	B	M	2.72	2.91	TOWN HOUSES
SI		RIVER RD	GBAD4	79989	D	2	B	M	1.64	2.18	8 TOWN HOUSES
SI	4	BANKSIA ST	GSECT25	10888	D	1	F	M	1.17	2.13	
SI	6	BANKSIA ST	GSECT25	10887	D	1	B	S	1.10	2.02	
SI	8	BANKSIA ST	GSECT25	10886	D	1	F	M	1.07	1.69	
SI	9	BANKSIA ST	GSECT25	10872	D	2	B/F	M	1.08	1.37	
SI	1/23	BANKSIA ST	GSECT25	88729	U	1	B	M	1.38	2.33	
SI	10	BANKSIA ST	GSECT25	10885	D	1	F	S	1.15	2.38	
SI	11	BANKSIA ST	GSECT25	10873	D	1	F	S	1.08	1.48	
SI	12	BANKSIA ST	GSECT25	10884	D	1	F	S	1.29	1.88	
SI	13	BANKSIA ST	GSECT25	10874	D	2	B/F	M	1.37	1.45	
SI	14	BANKSIA ST	GSECT25	10883	D	1	F	S	1.20	1.76	
SI	15	BANKSIA ST	GSECT25	10875	D	1	F	S	1.32	1.71	
SI	16	BANKSIA ST	GSECT25	20714	D	1	F	S	1.41	1.80	
SI	17	BANKSIA ST	GSECT25	10876	D	1	B	M,	1.33	2.31	
SI	18	BANKSIA ST	GSECT25	20715	D	1	F	S	1.36	1.65	
SI	2/23	BANKSIA ST	GSECT25	88730	U	1	B	M	1.38	2.33	
SI	20	BANKSIA ST	GSECT25	20484	C	1	B/F	L	1.47	2.19	CHURCH
SI	21	BANKSIA ST	GSECT25	10878	D	1	F	S	1.31	1.83	
SI	22	BANKSIA ST	GSECT25	20485	C	1	B/F	L	1.47	2.19	CHURCH
SI	24	BANKSIA ST	GSECT25	10882	D	1	F	M	1.64	2.20	
SI	25	BANKSIA ST	GSECT25	10880	D	1	B	M	1.55	2.33	
SI	26	BANKSIA ST	GSECT25	10881	D	1	F	M	1.62	2.19	
SI	27	BANKSIA ST	GSECT25	20479	C	1	B	M	1.64	2.36	POLICE
SI	1	BEACHCOMBER AVE	GSECT11	10898	D	1	B	S	4.13	4.40	
SI	2	BEACHCOMBER AVE	GSECT11	10889	D	2	WB	M	4.01	4.20	
SI	3	BEACHCOMBER AVE	GSECT11	10897	D	1	B	M	3.90	4.29	
SI	4	BEACHCOMBER AVE	GSECT11	10890	D	1	WB	M	3.92	4.35	

LEGEND:

Material: B - brick; W/B - weatherboard; F - fibro; CONC - concrete; AL - aluminium

Zone Location: BF - Basin Foreshore; SP - Sanctuary Point; SI - Sussex Inlet

Type: D - dwelling; U - units; C - commercial

Size: S - small; M - medium; L - large

ZONE LOCATION	ST No.	STREET NAME	RELEVANT GRIDPOINT IN HYDRAULIC MODEL	GIS UPN	TYPE	STOREYS	MATERIAL	SIZE	GROUND RL	FLOOR RL	REMARKS
SI	5	BEACHCOMBER AVE	GSECT11	10896	D	1	B	M	3.87	4.16	
SI	6	BEACHCOMBER AVE	GSECT11	10891	D	1	B	M	3.65	4.30	
SI	8	BEACHCOMBER AVE	GSECT11	10892	D	2	B/WB	M	3.33	3.36	
SI	9	BEACHCOMBER AVE	GSECT11	10894	D	1	F	M	3.49	3.94	
SI	10	BEACHCOMBER AVE	GSECT11	10893	D	1	WB	M	3.17	3.75	
SI	3	BOATHARBOUR DR	GSECT11	10931	D	2	B/F	M	2.85	2.89	
SI	5	BOATHARBOUR DR	GSECT11	10930	D	E	B/F	M	2.94	5.54	
SI	7	BOATHARBOUR DR	GSECT11	10929	D	1	WB	M	2.92	3.66	
SI	9	BOATHARBOUR DR	GSECT11	10928	D	1	WB	M	2.87	3.15	
SI	11	BOATHARBOUR DR	GSECT11	10927	D	1	B	M	3.06	3.30	
SI	13	BOATHARBOUR DR	GSECT11	10926	D	1	B	M	3.08	3.31	
SI	15	BOATHARBOUR DR	GSECT11	10925	D	1	F	M	2.98	3.32	
SI	17	BOATHARBOUR DR	GSECT11	10924	D	2	B/F	M	3.28	3.42	
SI	19	BOATHARBOUR DR	GSECT11	10923	D	1	B	M	3.33	3.73	
SI	21	BOATHARBOUR DR	GSECT11	10922	D	1	B	M	3.47	3.62	
SI	23	BOATHARBOUR DR	GSECT11	10921	D	1	B	M	3.61	3.85	
SI	25	BOATHARBOUR DR	GSECT11	10920	D	1	B	M	3.52	3.96	
SI	27	BOATHARBOUR DR	GSECT11	10919	D	E	WB	M	3.90	6.70	
SI	29	BOATHARBOUR DR	GSECT11	10918	D	1	WB	M	3.99	4.49	
SI	31	BOATHARBOUR DR	GSECT11	10917	D	1	B	M	3.80	4.19	
SI	I CALLED THIS NO.1 BOATHARBOUR DR		GSECT11	10932	D	2	B/F	M	2.78	2.94	
SI	1	CATER CRES	GBAD3	10949	D	1	F	M	2.37	1.99	
SI	2	CATER CRES	GBAD3	11020	D	2	B/F	M	2.03	1.96	
SI	4	CATER CRES	GBAD3	11019	D	1	WB	M	2.63	1.36	
SI	5	CATER CRES	GBAD3	10951	D	E	B/F	M	5.20	2.06	
SI	6	CATER CRES	GBAD3	11018	D	1	F	M	2.60	2.08	
SI	7	CATER CRES	GBAD3	10952	D	1	B	S	2.64	2.07	
SI	8	CATER CRES	GBAD3	11017	D	1	B	M	2.36	2.18	
SI	9	CATER CRES	GBAD3	10953	D	1	B	M	2.34	2.20	
SI	10	CATER CRES	GBAD3	11015	D	2	F	M	2.13	2.02	
SI	11	CATER CRES	GBAD3	10954	D	1	B	M	2.16	2.04	
SI	13	CATER CRES	GBAD3	10956	D	2	B	M	2.43	2.18	
SI	14	CATER CRES	GBAD3	11014	D	E	B/F	M	4.39	2.42	
SI	15	CATER CRES	GBAD3	10957	D	1	F	M	2.36	2.09	
SI	17	CATER CRES	GBAD3	10958	D	2	B	M	2.32	2.47	
SI	19	CATER CRES	GBAD3	10959	D	E	WB	M	5.40	2.69	
SI	23	CATER CRES	GBAD3	86717	D	1	B	M	4.64	4.48	
SI	25	CATER CRES	GBAD3	10962	D	1	B	M	5.32	5.08	
SI	27	CATER CRES	GBAD3	10963	D	1	B	M	5.03	4.53	
SI	29	CATER CRES	GBAD3	10964	D	1	B	M	4.01	3.29	
SI	31	CATER CRES	GBAD3	10965	D	1	B	M	2.61	2.31	
SI	33	CATER CRES	GBAD3	10966	D	2	B	M	2.53	2.13	
SI	35	CATER CRES	GBAD3	10967	D	2	B	M	1.92	2.14	
SI	36	CATER CRES	GBAD3	11003	D	2	B/F	M	2.34	2.60	
SI	38	CATER CRES	GBAD3	11002	D	1	B	M	2.07	2.38	
SI	39	CATER CRES	GBAD3	10969	D	1	B	M	2.01	2.50	
SI	40	CATER CRES	GBAD3	11001	D	1	F	M	1.74	2.41	
SI	41	CATER CRES	GBAD3	10970	D	2	WB	M	1.93	2.51	
SI	42	CATER CRES	GBAD3	11000	D	1	B	S	1.93	2.08	
SI	43	CATER CRES	GBAD3	10971	D	1	B/F	M	1.92	2.27	
SI	44	CATER CRES	GBAD3	10999	D	1	WB	S	1.88	2.42	
SI	45	CATER CRES	GBAD3	10972	D	2	B	M	2.00	2.35	
SI	46	CATER CRES	GBAD3	10998	D	2	B/F	M	2.03	2.09	
SI	47	CATER CRES	GBAD3	10973	D	2	B/F	M	1.95	2.07	
SI	48	CATER CRES	GBAD3	10997	D	1	B	S	2.09	2.31	
SI	49	CATER CRES	GBAD3	10974	D	2	B	M	1.99	2.30	
SI	50	CATER CRES	GBAD3	10996	D	2	B	M	2.11	2.22	
SI	51	CATER CRES	GBAD3	10975	D	2	B/F	M	1.87	2.03	
SI	52	CATER CRES	GBAD3	10995	D	1	B	M	1.95	2.45	
SI	53	CATER CRES	GBAD3	10976	D	2	B/F	M	1.83	2.02	
SI	54	CATER CRES	GBAD3	10994	D	1	B	M	2.15	2.39	
SI	55	CATER CRES	GBAD3	10977	D	2	B/F	M	1.80	1.94	
SI	56	CATER CRES	GBAD3	10993	D	2	F	M	1.87	2.18	
SI	57	CATER CRES	GBAD3	10978	D	2	B/F	M	1.85	1.90	
SI	58	CATER CRES	GBAD3	10992	D	2	B/F	M	2.10	2.38	
SI	59	CATER CRES	GBAD3	10979	D	2	B/F	M	1.87	1.88	
SI	60	CATER CRES	GBAD3	10991	D	2	B/F	M	2.05	2.25	
SI	61	CATER CRES	GBAD3	10980	D	2	B/F	M	2.01	2.03	
SI	62	CATER CRES	GBAD3	10990	D	2	B/F	M	2.04	2.27	
SI	63	CATER CRES	GBAD3	10981	D	2	B/F	M	1.97	2.05	
SI	65	CATER CRES	GBAD3	10982	D	2	B/F	M	1.92	2.18	
SI	66	CATER CRES	GBAD3	10988	D	2	B/F	M	2.05	2.29	
SI	67	CATER CRES	GBAD3	10983	D	2	B/F	M	1.80	1.74	
SI	68	CATER CRES	GBAD3	10987	D	1	B	M	2.05	2.28	
SI	69	CATER CRES	GBAD3	10984	D	1	B	M	1.86	2.45	
SI	1	CORANG AVE	GBAD3	11056	D	1	B	M	1.99	2.31	

LEGEND:

Material: B - brick; W/B - weatherboard; F - fibro; CONC - concrete; AL - aluminium

Zone Location: BF - Basin Foreshore; SP - Sanctuary Point; SI - Sussex Inlet

Type: D - dwelling; U - units; C - commercial

Size: S - small; M - medium; L - large

ZONE LOCATION	ST No.	STREET NAME	RELEVANT GRIDPOINT IN HYDRAULIC MODEL	GIS UPN	TYPE	STOREYS	MATERIAL	SIZE	GROUND RL	FLOOR RL	REMARKS
SI	3	CORANG AVE	GBAD3	11057	D	1	B	M	2.07	2.18	
SI	5	CORANG AVE	GBAD3	11058	D	1	B	M	2.10	2.40	
SI	7	CORANG AVE	GBAD3	11059	D	1	B	M	1.66	2.36	
SI	11	CORANG AVE	GBAD3	11035	D	2	B	L	1.66	2.43	
SI	13	CORANG AVE	GBAD3	11036	D	1	B	M	1.75	2.46	
SI	15	CORANG AVE	GBAD3	11037	D	1	B	M	1.78	2.14	
SI	17	CORANG AVE	GBAD3	11038	D	1	B	M	1.85	2.32	
SI	21	CORANG AVE	GBAD3	11040	D	SPLIT	B	L	2.60	2.65	
SI	25	CORANG AVE	GBAD3	11042	D	2	B	M	5.00	5.14	
SI	1	DRIFT WOOD AVE	GSECT11	11071	D	2	B	M	3.63	3.75	
SI	2	DRIFT WOOD AVE	GSECT11	11060	D	1	B/WB	M	3.53	3.65	
SI	3	DRIFT WOOD AVE	GSECT11	11070	D	2	B/WB	M	3.51	3.68	
SI	4	DRIFT WOOD AVE	GSECT11	11061	D	1	F	M	3.34	3.90	
SI	5	DRIFT WOOD AVE	GSECT11	11069	D	1	B	M	3.40	3.69	
SI	6	DRIFT WOOD AVE	GSECT11	11062	D	1	B	M	3.37	3.52	
SI	8	DRIFT WOOD AVE	GSECT11	11063	D	2	B/WB	M	3.19	3.30	
SI	10	DRIFT WOOD AVE	GSECT11	11064	D	1	B	M	2.98	3.19	
SI	11	DRIFT WOOD AVE	GSECT11	11066	D	2	B	M	3.14	3.24	
SI	12	DRIFT WOOD AVE	GSECT11	11065	D	1	WB	M	3.02	3.58	
SI	1	EDGEWATER AVE	GSECT11	11072	D				2.05	2.31	
SI	3	EDGEWATER AVE	GSECT11	11073	D	2	B/F	M	2.15	2.37	
SI	5	EDGEWATER AVE	GSECT11	11074	D	2	B/F	M	2.18	2.30	
SI	7	EDGEWATER AVE	GSECT11	11075	D	2	B	M	2.15	2.39	
SI	9	EDGEWATER AVE	GSECT11	11076	D	2	B	M	2.06	2.49	
SI	11	EDGEWATER AVE	GSECT11	11077	D	2	B	L	2.17	2.46	
SI	15	EDGEWATER AVE	GSECT11	11079	D	2	B/F	M	2.29	2.42	
SI	17	EDGEWATER AVE	GSECT11	11080	D	1	WB	M	2.47	2.88	
SI	19	EDGEWATER AVE	GSECT11	11081	D	1	WB	M	2.78	2.88	
SI	23	EDGEWATER AVE	GSECT11	11082	D	1	WB	M	2.95	3.54	
SI	25	EDGEWATER AVE	GSECT11	11083	D	2	B/F	M	3.25	3.46	
SI	27	EDGEWATER AVE	GSECT11	11084	D	E	WB	M	3.04	6.05	
SI	13	EDGEWATER AVE	GSECT11	11078	D	1	B	M	2.15	2.44	
SI	1	ELLMOOS AVE	GSECT22U	11088	D	1	F	M	1.57	2.31	
SI	5	ELLMOOS AVE	GSECT22U	11090	D	1	B	M	1.72	2.29	
SI	7	ELLMOOS AVE	GSECT22U	11091	D	1	F	M	1.67	2.35	
SI	9	ELLMOOS AVE	GSECT22U	11092	D	1	F	M	1.60	2.28	
SI	27	ELLMOOS AVE	GSECT22U	86218	U	1	B	M	1.61	2.36	VILLA UNIT
SI	27A	ELLMOOS AVE	GSECT22U	86218	U	1	B	M	1.61	2.36	VILLA UNIT
SI	11	ELLMOOS AVE	GSECT22U	11093	D	1	F	M	1.65	2.16	
SI	12	ELLMOOS AVE	GSECT22U	11136	D	1	F	S	1.74	2.19	
SI	13	ELLMOOS AVE	GSECT22U	11094	D	1	B	M	1.55	2.38	
SI	14	ELLMOOS AVE	GSECT22U	11135	D	1	F	M	1.88	2.55	
SI	15	ELLMOOS AVE	GSECT22U	11095	D	1	F	M	1.61	2.23	
SI	16	ELLMOOS AVE	GSECT22U	11134	D	1	F	M	1.72	2.50	
SI	17	ELLMOOS AVE	GSECT22U	11096	D	1	F	M	1.62	2.11	
SI	18	ELLMOOS AVE	GSECT22U	11133	D	1	WB	M	1.70	2.38	
SI	19	ELLMOOS AVE	GSECT22U	11098	D	1	F	M	1.62	2.16	
SI	20	ELLMOOS AVE	GSECT22U	11132	D	1	B	M	1.90	2.34	
SI	21	ELLMOOS AVE	GSECT22U	11097	D	1	WB	M	1.76	2.07	
SI	22	ELLMOOS AVE	GSECT22U	11131	D	1	B	M	1.74	2.78	
SI	23	ELLMOOS AVE	GSECT22U	11099	D	1	WB	M	1.62	2.22	
SI	24	ELLMOOS AVE	GSECT22U	11130	D	1	WB	M	1.70	2.14	
SI	26	ELLMOOS AVE	GSECT22U	11129	D	1	WB	M	1.68	2.12	
SI	27	ELLMOOS AVE	GSECT22U	86217	U	1	B	M	1.61	2.36	
SI	28	ELLMOOS AVE	GSECT22U	11128	D	1	F	M	1.67	2.67	
SI	30	ELLMOOS AVE	GSECT22U	11127	D	1	F	M	1.76	2.47	
SI	31	ELLMOOS AVE	GSECT22U	11104	D	1	B	M	1.62	2.42	
SI	32	ELLMOOS AVE	GSECT22U	11126	D	2	F	M	1.98	2.11	
SI	33	ELLMOOS AVE	GSECT22U	11105	D	1	F	M	1.69	2.39	
SI	34	ELLMOOS AVE	GSECT22U	11125	D	2	B/F	M	1.95	2.09	
SI	35	ELLMOOS AVE	GSECT22U	11087	D	1	B	M	1.89	2.33	
SI	35	ELLMOOS AVE	GSECT22U	11103	D	1	B	M	1.89	2.33	
SI	36	ELLMOOS AVE	GSECT22U	11124	D	1	B	M	1.87	2.07	
SI	37	ELLMOOS AVE	GSECT22U	73617	D	1	F	M	1.70	2.55	
SI	38	ELLMOOS AVE	GSECT22U	11123	D	1	B	M	1.82	2.39	
SI	40	ELLMOOS AVE	GSECT22U	11122	D	2	B/F	M	2.18	2.44	
SI	42	ELLMOOS AVE	GSECT22U	11121	D	1	WB	M	1.79	2.46	
SI	43	ELLMOOS AVE	GSECT22U	55420	D	1	B	M	1.70	2.36	
SI	48	ELLMOOS AVE	GSECT22U	11118	D	2	B/F	M	1.80	1.84	
SI	50	ELLMOOS AVE	GSECT22U	11117	D	1	F	M	1.10	1.62	
SI	52	ELLMOOS AVE	GSECT22U	11116	D	2	WB	M	1.24	1.08	
SI	54	ELLMOOS AVE	GSECT22U	11115	D	1	F	M	1.29	1.36	
SI	56	ELLMOOS AVE	GSECT22U	11114	D	1	F	M	1.37	2.18	
SI	58	ELLMOOS AVE	GSECT22U	11113	D	1	WB	M	1.25	1.64	
SI	60	ELLMOOS AVE	GSECT22U	11112	D	2	B	M	1.21	1.26	
SI	62	ELLMOOS AVE	GSECT22U	11111	D	1	B	M	1.37	2.34	
SI	64	ELLMOOS AVE	GSECT22U	11110	D	1	B	M	1.47	1.59	

LEGEND:

Material: B - brick; W/B - weatherboard; F - fibro; CONC - concrete; AL - aluminium

Zone Location: BF - Basin Foreshore; SP - Sanctuary Point; SI - Sussex Inlet

Type: D - dwelling; U - units; C - commercial

Size: S - small; M - medium; L - large

ZONE LOCATION	ST No.	STREET NAME	RELEVANT GRIDPOINT IN HYDRAULIC MODEL	GIS UPN	TYPE	STOREYS	MATERIAL	SIZE	GROUND RL	FLOOR RL	REMARKS
SI	1	FAIRVIEW CRES	GSECT29	11162	D	2	B/F	M	1.86	2.11	
SI	3	FAIRVIEW CRES	GSECT29	11161	D	2	B/F	M	1.51	2.62	
SI	5	FAIRVIEW CRES	GSECT29	11160	D	S	B/F	M	1.56	1.98	
SI	7	FAIRVIEW CRES	GSECT29	11159	D	2	B	M	1.36	1.86	
SI	9	FAIRVIEW CRES	GSECT29	11158	D	2	F	M	1.33	1.38	
SI	11	FAIRVIEW CRES	GSECT29	11157	D	2	B	M	1.27	1.67	
SI	13	FAIRVIEW CRES	GSECT29	11156	D	2	B/F	M	1.34	2.51	
SI	15	FAIRVIEW CRES	GSECT29	11155	D	2	B/W/B	M	1.28	2.16	
SI	17	FAIRVIEW CRES	GSECT29	11154	D	1	B	M	1.13	2.37	
SI	19	FAIRVIEW CRES	GSECT29	11153	D	2	B	M	0.99	4.66	3.1GAR,4.66
SI	23	FAIRVIEW CRES	GSECT29	11151	D	2	B/W/B	M	1.26	1.57	
SI	27	FAIRVIEW CRES	GSECT29	11149	D	2	W/B	M	0.94	2.25	
SI	29	FAIRVIEW CRES	GSECT29	11148	D	1	B/F	M	0.99	2.73	1.33GAR 2.73
SI	33	FAIRVIEW CRES	GSECT29	11146	D	2	B	M	1.24	2.14	
SI	35	FAIRVIEW CRES	GSECT29	20709	D	2	B/F	M	1.20	2.89	
SI	36	FAIRVIEW CRES	GSECT29	11145	D	2	F	M	1.27	2.53	
SI	70	GLANVILLE RD	GSECT13	11239	D	1	B/F	M	2.04	3.64	
SI	1	GREENTREE AVE	GSECT11	11582	D	2	B/F	M	4.55	4.66	
SI	2	GREENTREE AVE	GSECT11	11301	D	1	F	M	4.29	4.52	
SI	3	GREENTREE AVE	GSECT11	11310	D	1	B	M	4.14	4.45	
SI	4	GREENTREE AVE	GSECT11	11302	D	1	B	M	4.08	4.76	
SI	5	GREENTREE AVE	GSECT11	11309	D	1	B	M	4.09	4.29	
SI	6	GREENTREE AVE	GSECT11	11303	D	1	B	M	3.93	4.24	
SI	7	GREENTREE AVE	GSECT11	11308	D	1	F	M	3.84	4.66	
SI	8	GREENTREE AVE	GSECT11	11304	D	1	B	M	3.35	4.15	
SI	11	GREENTREE AVE	GSECT11	11306	D	2	B	M	3.61	3.82	
SI	24	IVERISON RD	GSECT13	77557	C	3	B	L	1.97	2.63	NURSING HOME
SI	26	IVERISON RD	GSECT13	11367	C	1	B	M	2.00	2.40	NURSING HOME
SI	28	IVERISON RD	GSECT13	11368	D	1	WB	M	5.74	5.96	
SI	1	JACOBS DR	GSECT22U	11406	C	1	B	M	2.70	2.71	SERVICE STN
SI	1/160	JACOBS DR	GSECT22U	87740	U	1	B	M	1.85	2.35	
SI	104	JACOBS DR	GBAD4	11525	D	1	F	M	2.34	2.57	
SI	106	JACOBS DR	GBAD4	11524	D	2	B	L	2.21	2.61	
SI	108	JACOBS DR	GBAD4	11523	D	2	B	L	2.24	2.46	
SI	110	JACOBS DR	GBAD4	11522	D	1	B	M	2.31	2.69	
SI	111	JACOBS DR	GBAD5	11446	D	2	B/F	M	1.39	1.59	
SI	113	JACOBS DR	GBAD5	11447	D	1	B	M	1.49	2.31	
SI	116	JACOBS DR	GBAD4	11517	D	1	B	M	1.42	2.34	
SI	117	JACOBS DR	GBAD5	11449	C	1	B	M	1.54	2.55	
SI	118	JACOBS DR	GBAD4	11516	D	2	B/F	M	1.26	1.43	
SI	119	JACOBS DR	GBAD5	11452	D	1	WB	S	1.72	2.65	
SI	120	JACOBS DR	GBAD4	11515	D	2	B/F	M	1.02	1.12	
SI	121	JACOBS DR	GBAD5	11453	D	1	F	S	1.72	2.56	
SI	122	JACOBS DR	GBAD4	11514	D	2	F	M	1.22	1.48	
SI	123	JACOBS DR	GBAD5	11450	D	1	B	M	1.74	2.47	
SI	125	JACOBS DR	GBAD5	11451	D	1	B	M	1.48	2.21	
SI	126	JACOBS DR	GBAD4	11513	C	1	WB/B	L	1.34	1.98	
SI	127	JACOBS DR	GBAD5	11454	U	1	B	M	1.94	2.30	
SI	128	JACOBS DR	GSECT22U	11511	D	1	B	M	1.62	2.27	
SI	132	JACOBS DR	GSECT22U	11510	D	2	B	M	1.60	2.12	
SI	135	JACOBS DR	GSECT25	12418	U	1	B	M	1.94	2.30	
SI	136	JACOBS DR	GSECT22U	11508	D	1	F	M	1.49	2.17	
SI	137	JACOBS DR	GSECT25	11455	U	2	B/F	M	0.94	2.37	
SI	138	JACOBS DR	GSECT22U	11507	D	2	F	M	1.61	1.79	
SI	139	JACOBS DR	GSECT25	11456	D	1	F	M	1.26	1.76	
SI	140	JACOBS DR	GSECT22U	11506	D	1	F	M	1.50	2.01	
SI	142	JACOBS DR	GSECT22U	11505	D	1	B/F	M	1.69	2.45	
SI	144	JACOBS DR	GSECT22U	11504	D	1	F	M	1.60	2.33	
SI	145	JACOBS DR	GSECT25	11459	D	1	F	M	1.48	1.95	
SI	146	JACOBS DR	GSECT22U	11503	U	1	B	M	1.70	2.53	
SI	147	JACOBS DR	GSECT25	11460	D	1	WB	S	1.50	2.29	
SI	148	JACOBS DR	GSECT22U	11502	D	1	F	M	1.74	2.30	
SI	149	JACOBS DR	GSECT25	11461	D	1	F	M	1.51	2.00	
SI	151	JACOBS DR	GSECT25	11462	D	1	WB	M	1.44	1.99	
SI	152	JACOBS DR	GSECT22U	11500	D	1	F	S	1.79	2.18	
SI	153	JACOBS DR	GSECT25	50915	D	1	WB	M	1.70	1.81	
SI	155	JACOBS DR	GSECT25	50916	D	1	WB	S	1.62	2.04	
SI	158	JACOBS DR	GSECT22U	11497	D	1	WB	S	1.62	2.09	HOLIDAY CABINS
SI	159	JACOBS DR	GSECT25	11463	C	1	B	M	1.81	2.02	
SI	1/160	JACOBS DR	GSECT25	11463	D	1	B	M	1.85	2.35	
SI	2/160	JACOBS DR	GSECT25	11463	D	1	B	M	1.85	2.35	
SI	3/160	JACOBS DR	GSECT25	11463	D	1	B	M	1.85	2.35	
SI	161	JACOBS DR	GSECT25	11465	C	1	B	M	2.20	2.45	
SI	162	JACOBS DR	GSECT22U	87735	D	2	B/WB	M	1.62	1.69	
SI	164	JACOBS DR	GSECT22U	86612	C	1	B	M	1.76	2.01	
SI	165	JACOBS DR	GSECT25	62361	C	1	F	M	1.80	2.02	
SI	166	JACOBS DR	GSECT22U	86009	C	1	B	M	1.69	2.02	

LEGEND:

Material: B - brick; W/B - weatherboard; F - fibro; CONC - concrete; AL - aluminium

Zone Location: BF - Basin Foreshore; SP - Sanctuary Point; SI - Sussex Inlet

Type: D - dwelling; U - units; C - commercial

Size: S - small; M - medium; L - large

ZONE LOCATION	ST No.	STREET NAME	RELEVANT GRIDPOINT IN HYDRAULIC MODEL	GIS UPN	TYPE	STOREYS	MATERIAL	SIZE	GROUND RL	FLOOR RL	REMARKS
SI	167	JACOBS DR	GSECT25	62360	C	1	B	L	1.81	2.29	
SI	168	JACOBS DR	GSECT22U	84538	C	1	B	L	2.00	2.05	
SI	169	JACOBS DR	GSECT25	11468	C	1	B	S	1.79	1.86	
SI	170	JACOBS DR	GSECT22U	79749	C	1	B	L	2.00	2.05	
SI	173	JACOBS DR	GSECT25	20693	C	1	F	L	1.88	2.15	
SI	174	JACOBS DR	GSECT22U	11490	C	1	B	M	1.74	1.85	
SI	175	JACOBS DR	GSECT25	20694	C	1	WB	L	1.59	2.18	CHURCH
SI	176	JACOBS DR	GSECT22U	11489	C	1	B	M	1.95	2.06	
SI	178	JACOBS DR	GSECT22U	11486	D	1	F	M	1.63	2.12	
SI	180	JACOBS DR	GSECT22U	11484	C	1	B	M	1.77	2.02	
SI	181	JACOBS DR	GSECT25	11470	C	1	F	S	1.71	1.83	
SI	182	JACOBS DR	GSECT22U	11483	C	2	B	L	1.97	2.03	
SI	183	JACOBS DR	GSECT25	11471	C	1	B	L	1.72	2.07	
SI	185	JACOBS DR	GSECT25	75271	D	1	F	S	1.61	1.92	
SI	187A	JACOBS DR	GSECT25	11478	D	1	WB	M	1.62	2.17	
SI	187B	JACOBS DR	GSECT25	11479	D	1	F	M	1.70	2.05	
SI	187C	JACOBS DR	GSECT25	20716	D	1	F	M	1.59	2.12	
SI	189	JACOBS DR	GSECT25	11473	C	2	B/F	L	1.83	1.84	
SI	190	JACOBS DR	GSECT22U	88433	D	2	B	L	2.03	2.29	
SI	191	JACOBS DR	GSECT25	11474	C	2	B/F	L	1.83	1.84	
SI	192	JACOBS DR	GSECT22U	20486	C	1	B	L	1.84	2.02	
SI	193	JACOBS DR	GSECT25	25764	C	1	F	S	1.81	1.98	
SI	194	JACOBS DR	GSECT22U	20487	C	2	B/F	M	1.79	1.83	
SI	195	JACOBS DR	GSECT25	11475	C	1	B/F	L	1.85	2.03	
SI	196	JACOBS DR	GSECT22U	78010	C	2	B	L	1.73	2.05	
SI	200	JACOBS DR	GSECT22U	11480	C	1	B	L	1.86	2.47	RSL
SI	209	JACOBS DR	GSECT25	11477	D	2	B	L	1.58	1.66	
SI	3	JACOBS DR	GBAD5	11405	D	2	WB	M	2.34	2.43	
SI	33	JACOBS DR	GBAD5	11408	D	1	WB	M	1.25	2.35	
SI	35	JACOBS DR	GBAD5	11409	D	1	F	M	1.55	2.76	
SI	37	JACOBS DR	GBAD5	11410	D	2	B/F	M	1.62	1.59	
SI	39	JACOBS DR	GBAD5	11411	D	2	B/F	M	1.64	1.71	
SI	57	JACOBS DR	GBAD5	11419	D	1	F	S	1.48	1.77	
SI	59	JACOBS DR	GBAD5	11420	D	2	B	M	1.51	1.90	
SI	61	JACOBS DR	GBAD5	11421	D	1	F	S	1.35	1.94	
SI	63	JACOBS DR	GBAD5	11422	D	1	F	M	1.57	2.20	
SI	65	JACOBS DR	GBAD5	11423	D	2	B	M	1.51	1.70	
SI	75	JACOBS DR	GBAD5	11428	D	1	F	M	1.66	2.19	
SI	77	JACOBS DR	GBAD5	11429	D	1	B	M	1.77	2.09	
SI	79	JACOBS DR	GBAD5	11430	D	1	F	M	1.62	2.08	
SI	81	JACOBS DR	GBAD5	11431	D	2	B	M	1.71	1.72	
SI	83	JACOBS DR	GBAD5	11431	D	1	F	M	1.68	2.10	
SI	92	JACOBS DR	GBAD4	11529	D	1	B	M	1.99	2.56	
SI	94	JACOBS DR	GBAD4	11528	D	1	B	M	2.15	2.86	
SI	1	LAGOON CRES	GBAD5	11546	D	2	BF	M	1.78	1.90	
SI	2	LAGOON CRES	GBAD5	11545	D	2	B	M	2.03	2.16	
SI	3	LAGOON CRES	GBAD5	11547	D	2	F	M	1.98	2.05	
SI	4	LAGOON CRES	GBAD5	11548	D	2	BF	M	2.10	2.16	
SI	5	LAGOON CRES	GBAD5	11549	D	2	B	M	2.20	2.42	
SI	6	LAGOON CRES	GBAD5	11550	D	2	BF	M	2.29	2.41	
SI	7	LAGOON CRES	GBAD5	11551	D	1	B	M	2.19	2.93	
SI	8	LAGOON CRES	GBAD5	11552	D	2	B	M	2.12	2.29	
SI	9	LAGOON CRES	GBAD5	11553	D	1	B	M	2.31	2.78	
SI	10	LAGOON CRES	GBAD5	11554	D	1	B	M	2.06	2.36	
SI	11	LAGOON CRES	GBAD5	11555	D	2	BWB	M	2.01	2.03	
SI	12	LAGOON CRES	GBAD5	11556	D	1	WB	M	2.02	2.48	
SI	13	LAGOON CRES	GBAD5	11557	D	1	BWB	M	2.01	2.20	
SI	14	LAGOON CRES	GBAD5	11558	D	1	B	M	2.09	2.30	
SI	15	LAGOON CRES	GBAD5	11559	D	1	B	M	2.16	2.36	
SI	16	LAGOON CRES	GBAD5	11560	D	1	B	M	2.10	2.39	
SI	17	LAGOON CRES	GBAD5	11561	D	1	B	S	1.27	2.16	
SI	1	LAKEHAVEN DR	GSECT11	11626	D	2	B	L	1.61	1.85	
SI	2	LAKEHAVEN DR	GSECT11	11562	D	1	B	M	2.32	3.01	
SI	3	LAKEHAVEN DR	GSECT13	11627	D	2	B	L	1.61	1.85	
SI	4	LAKEHAVEN DR	GSECT11	11563	D	1	WB	M	2.36	2.86	
SI	5	LAKEHAVEN DR	GSECT13	69457	D	1	B	M	2.04	2.40	
SI	6	LAKEHAVEN DR	GSECT11	11564	D	2	B	M	2.54	2.88	
SI	7	LAKEHAVEN DR	GSECT13	11625	D	2	B/F	M	2.34	2.47	
SI	8	LAKEHAVEN DR	GSECT11	11565	D	1	F	S	2.47	2.75	
SI	9	LAKEHAVEN DR	GSECT13	11624	D	1	F	S	2.65	2.73	
SI	10	LAKEHAVEN DR	GSECT11	11566	D	1	F	M	2.90	3.28	
SI	12	LAKEHAVEN DR	GSECT11	11567	D	2	B/F	M	2.88	3.14	
SI	14	LAKEHAVEN DR	GSECT11	11568	D	1	B	M	2.93	3.41	
SI	16	LAKEHAVEN DR	GSECT11	11569	D	1	B	M	3.11	3.35	
SI	18	LAKEHAVEN DR	GSECT11	11570	D	1	WB	M	2.99	3.67	
SI	20	LAKEHAVEN DR	GSECT11	11571	D	2	B/F	M	3.15	3.25	
SI	22	LAKEHAVEN DR	GSECT11	11572	D	1	B	M	3.24	3.68	

LEGEND:

Material: B - brick; W/B - weatherboard; F - fibro; CONC - concrete; AL - aluminium

Zone Location: BF - Basin Foreshore; SP - Sanctuary Point; SI - Sussex Inlet

Type: D - dwelling; U - units; C - commercial

Size: S - small; M - medium; L - large

ZONE LOCATION	ST No.	STREET NAME	RELEVANT GRIDPOINT IN HYDRAULIC MODEL	GIS UPN	TYPE	STOREYS	MATERIAL	SIZE	GROUND RL	FLOOR RL	REMARKS
SI	24	LAKEHAVEN DR	GSECT11	11573	D	1	B	M	3.59	4.16	
SI	26	LAKEHAVEN DR	GSECT11	11574	D	1	F	M	3.78	4.44	
SI	28	LAKEHAVEN DR	GSECT11	11575	D	1	WB	M	3.93	4.30	
SI	30	LAKEHAVEN DR	GSECT11	11576	D	2	B/F	M	4.09	4.34	
SI	32	LAKEHAVEN DR	GSECT11	11577	D	1	B	M	4.11	4.38	
SI	34	LAKEHAVEN DR	GSECT11	11578	D	1	B	M	4.33	4.42	
SI	36	LAKEHAVEN DR	GSECT11	11579	D	1	F	M	4.58	4.97	
SI	40	LAKEHAVEN DR	GSECT11	11581	D	1	F	M	4.52	4.63	
SI	42	LAKEHAVEN DR	GSECT11	11583	D	2	B/F	M	4.27	4.27	
SI	44	LAKEHAVEN DR	GSECT11	11584	D	1	B	M	4.52	4.82	
SI	46	LAKEHAVEN DR	GSECT11	11585	D	1	B	M	4.57	4.90	
SI	48	LAKEHAVEN DR	GSECT11	11586	D	1	F	M	4.26	4.63	
SI	50	LAKEHAVEN DR	GSECT11	11587	D	2	B	L	3.82	4.02	
SI	52	LAKEHAVEN DR	GSECT11	11588	D	1	B	M	3.62	3.96	
SI	19	LAKESHORE PDE	GSECT29	23499	D	1	B	M	3.13	3.81	
SI	20	LAKESHORE PDE	GSECT29	11637	D	1	B	M	3.35	3.97	
SI	22	LAKESHORE PDE	GSECT29	11638	D	1	B	M	2.78	3.24	
SI	24	LAKESHORE PDE	GSECT29	11639	D	1	B	M	2.43	2.67	
SI	6	MARY ST	GSECT15	11703	D	1	F	M	4.07	4.38	
SI	8	MARY ST	GSECT15	11702	D	1	F	M	2.34	4.23	
SI	12	MARY ST	GSECT15	11700	D	1	F	M	1.71	2.13	
SI	1	NIELSON LANE	GSECT25	12021	D	1	B	M	1.30	2.46	
SI	2	NIELSON LANE	GSECT25	25743	D	1	F	M	1.58	2.04	
SI	3	NIELSON LANE	GSECT25	12020	D	1	B	M	1.25	2.30	
SI	4	NIELSON LANE	GSECT25	25744	D	1	F	M	1.45	2.11	
SI	7	NIELSON LANE	GSECT25	12022	D	2	B	M	1.31	2.54	
SI	9	NIELSON LANE	GSECT25	12024	D	2	B/WB	M	1.40	1.41	
SI	11	NIELSON RD	GSECT25	13813	D	1	F	M	1.71	2.49	
SI	12	NIELSON RD	GSECT25	11712	D	1	f	M	1.63	2.08	
SI	18	NIELSON RD	GSECT25	87040	C	1	B/F	M	1.81	1.86	RSL
SI	23	NIELSON RD	GSECT22U	20697	D	1	B/F	M	1.70	1.98	
SI	25	NIELSON RD	GSECT22U	73618	D	1	F	M	1.63	2.54	
SI	1	PACIFICANA DR	GSECT11	11758	D	1	F	M	3.12	3.89	
SI	3	PACIFICANA DR	GSECT11	11757	D	2	B/F	M	3.28	3.40	
SI	5	PACIFICANA DR	GSECT11	11756	D	1	F	M	3.21	3.82	
SI	7	PACIFICANA DR	GSECT11	11755	D	1	B	M	3.30	3.47	
SI	9	PACIFICANA DR	GSECT11	11754	D	1	F	M	3.13	3.71	
SI	11	PACIFICANA DR	GSECT11	11753	D	1	B	M	3.14	3.34	
SI	13	PACIFICANA DR	GSECT11	11752	D	1	B	M	3.01	3.37	
SI	4	PARADISE CRES	GBAD5	11773	D	1	B	M	1.93	2.05	
SI	2	PARADISE CRES	GBAD5	11775	D	2	B	L	1.96	2.49	
SI	3	PARADISE CRES	GBAD5	11774	D	1	F	M	2.06	2.42	
SI	5	PARADISE CRES	GBAD5	11772	D	1	WB	M	1.94	2.39	
SI	7	PARADISE CRES	GBAD5	11770	D	2	WB	M	1.68	1.85	
SI	8	PARADISE CRES	GBAD5	11767	D	2	WB	M	2.02	2.20	
SI	9	PARADISE CRES	GBAD5	11766	D	1	B	M	2.12	2.38	
SI	1	PARADISE CRES	GBAD5	11776	D	2	B/F	M	2.00	2.10	
SI	10	PARADISE CRES	GBAD5	11765	D	1	B	M	2.29	2.46	
SI	11	PARADISE CRES	GBAD5	11764	D	2	B	L	2.21	2.69	
SI	12	PARADISE CRES	GBAD5	11763	D	1	B	M	2.20	2.85	
SI	13	PARADISE CRES	GBAD5	11762	D	2	WB	M	2.14	2.16	
SI	14	PARADISE CRES	GBAD5	11761	D	1	B	M	2.09	3.03	
SI	15	PARADISE CRES	GBAD5	11760	D	2	B/F	M	1.84	2.12	
SI	16	PARADISE CRES	GBAD5	11448	D	1	B	M	2.06	2.34	
SI	1	POOLE AVE	GSECT25	11801	D	1	F	M	0.76	2.45	
SI	2	POOLE AVE	GSECT25	25712	D	1	F	M	1.03	1.52	
SI	3	POOLE AVE	GSECT25	11802	D	1	WB	S	0.86	2.15	
SI	4	POOLE AVE	GSECT25	11800	D	2	BWB	M	1.10	1.18	
SI	2	RIDGE AVE	GSECT15	11866	D	1	WB	M	1.53	2.20	
SI	4	RIDGE AVE	GSECT15	11865	D	1	F	M	1.69	1.66	
SI	6	RIDGE AVE	GSECT15	11864	D	1	WB	M	1.78	2.25	
SI	113	RIVER RD	GBAD5	11924	D	1	B	M	1.28	2.12	
SI	115	RIVER RD	GBAD5	11925	D	1	WB	M	1.35	1.97	
SI	117	RIVER RD	GBAD5	11926	D	1	F	M	1.25	1.77	
SI	119	RIVER RD	GBAD5	11927	D	1	WB	M	1.48	1.85	
SI	120	RIVER RD	GSECT29	12043	D	1	B	M	1.23	2.95	
SI	121	RIVER RD	GBAD5	11928	D	2	WB	M	1.52	1.47	
SI	123	RIVER RD	GBAD5	11929	D	1	B	M	1.51	2.33	
SI	125	RIVER RD	GBAD5	11931	D	2	B	M	1.42	1.78	
SI	127	RIVER RD	GBAD5	11930	D	1	WB	M	1.28	2.26	
SI	129	RIVER RD	GSECT25	11932	D	1	B	M	1.18	2.43	
SI	133	RIVER RD	GSECT25	11935	D	1	B	M	1.28	2.36	
SI	135	RIVER RD	GSECT25	11936	D	1	B	M	1.03	1.94	
SI	137	RIVER RD	GSECT25	11937	D	1	WB	M	1.17	2.37	
SI	139	RIVER RD	GSECT25	11938	D	1	F	M	1.15	1.95	
SI	141	RIVER RD	GSECT25	11939	D	2	BF	M	1.20	1.41	
SI	143	RIVER RD	GSECT25	11940	D	1	WB	M	1.04	2.36	

LEGEND:

Material: B - brick; W/B - weatherboard; F - fibro; CONC - concrete; AL - aluminium

Zone Location: BF - Basin Foreshore; SP - Sanctuary Point; SI - Sussex Inlet

Type: D - dwelling; U - units; C - commercial

Size: S - small; M - medium; L - large

ZONE LOCATION	ST No.	STREET NAME	RELEVANT GRIDPOINT IN HYDRAULIC MODEL	GIS UPN	TYPE	STOREYS	MATERIAL	SIZE	GROUND RL	FLOOR RL	REMARKS
SI	145	RIVER RD	GSECT25	11941	D	1	F	M	1.10	1.86	
SI	147	RIVER RD	GSECT25	11942	D	1	WB	M	1.11	2.38	
SI	149	RIVER RD	GSECT25	11943	U	1	B	M	1.37	2.20	
SI	151	RIVER RD	GSECT25	11944	U	1	B	M	1.37	2.20	
SI	153	RIVER RD	GSECT25	11945	D	2	WB	M	1.19	2.35	
SI	155	RIVER RD	GSECT25	11946	D	2	WB	M	1.29	1.35	
SI	157	RIVER RD	GSECT25	11947	D	1	F	S	1.37	1.95	
SI	159	RIVER RD	GSECT25	11948	D	1	B	M	1.49	2.39	
SI	161	RIVER RD	GSECT25	11949	D	2	BF	M	1.79	1.86	
SI	163	RIVER RD	GSECT25	11950	D	1	F	S	1.56	1.60	
SI	170	RIVER RD	GSECT25	12032	D	1	F	M	1.02	2.17	
SI	172	RIVER RD	GSECT25	20680	D	1	F	M	0.84	2.19	
SI	174	RIVER RD	GSECT25	12031	D	1	B	M	1.03	2.59	
SI	176	RIVER RD	GSECT25	20500	D	1	F	M	1.10	1.83	
SI	177	RIVER RD	GSECT25	11953	D	1	F	M	1.62	2.19	
SI	179	RIVER RD	GSECT25	11954	D	1	WB	M	1.67	2.09	
SI	181	RIVER RD	GSECT25	11955	D	1	F	M	1.60	2.37	
SI	182A	RIVER RD	GSECT25	88513	D	1	F	M	1.16	1.63	
SI	182	RIVER RD	GSECT25	88514	D	1	B	M	1.21	1.85	
SI	184A	RIVER RD	GSECT25	12026	D	1	WB	M	1.17	2.42	
SI	184	RIVER RD	GSECT25	12027	D	1	F	M	1.29	1.59	
SI	186A	RIVER RD	GSECT25	25748	D	1	F	M	1.33	1.81	
SI	186	RIVER RD	GSECT25	12025	D	1	F	M	1.28	2.09	
SI	188	RIVER RD	GSECT25	25747	D	1	WB	M	1.36	1.87	
SI	191	RIVER RD	GSECT22U	88434	C	1	B	L	1.65	2.34	
SI	192	RIVER RD	GSECT25	20679	D	1	B	M	1.41	2.28	
SI	194	RIVER RD	GSECT25	25746	D	1	F	M	1.56	1.94	
SI	199	RIVER RD	GSECT25	11109	D	2	B	M	1.24	1.71	
SI	201	RIVER RD	GSECT22U	11956	D	1	F	M	1.48	2.81	
SI	203	RIVER RD	GSECT22U	11957	D	2	B/F	M	1.56	1.76	
SI	207	RIVER RD	GSECT22U	11959	D	1	B	M	1.26	2.50	
SI	208	RIVER RD	GSECT25	25742	D	1	F	M	1.63	2.09	
SI	210	RIVER RD	GSECT25	25741	D	1	F	M	1.59	1.74	
SI	211	RIVER RD	GSECT25	11961	D	1	F	S	0.94	1.53	
SI	213	RIVER RD	GSECT25	11962	D	1	F	M	1.20	1.95	
SI	215	RIVER RD	GSECT25	11963	D	1	F	M	1.37	1.75	
SI	217	RIVER RD	GSECT25	11964	D	1	F	M	1.36	2.57	
SI	223	RIVER RD	GSECT25	11967	D	2	B/F	M	1.44	1.60	
SI	226	RIVER RD	GSECT22U	12018	C	1	B	L	1.88	2.63	
SI	227	RIVER RD	GSECT22U	11969	D	1	F	M	1.43	2.08	
SI	228	RIVER RD	GSECT22U	12017	D	1	WB	M	1.73	2.17	
SI	229	RIVER RD	GSECT22U	11970	D	1	B	M	1.51	2.44	
SI	230	RIVER RD	GSECT22U	12016	D	1	W/B	M	1.67	2.25	
SI	231	RIVER RD	GSECT22U	11971	D	1	F	M	1.80	2.44	
SI	232	RIVER RD	GSECT22U	12015	D	1	W/B	M	1.56	2.19	
SI	233	RIVER RD	GSECT22U	20499	D	1	B	M	2.06	2.34	
SI	235	RIVER RD	GSECT22U	11972	D	1	F	M	1.90	2.31	
SI	236	RIVER RD	GSECT22U	12014	D	1	F	M	1.03	2.09	
SI	237	RIVER RD	GSECT22U	11973	D	2	B/F	M	2.30	2.45	
SI	238	RIVER RD	GSECT22U	12012	D	1	F	M	0.82	2.18	
SI	239	RIVER RD	GSECT22U	11975	D	1	B	M	1.70	2.32	
SI	240	RIVER RD	GSECT22U	12011	D	2	F	M	0.83	2.37	
SI	241	RIVER RD	GSECT22U	11974	D	1	WB/F	M	1.62	2.33	
SI	243	RIVER RD	GSECT22U	11976	D	1	F	M	1.64	2.24	
SI	244	RIVER RD	GSECT22U	12009	D	1	F	M	0.87	1.68	
SI	247	RIVER RD	GSECT22U	11978	D	2	B/WB	M	1.87	2.14	
SI	248	RIVER RD	GSECT22U	12007	D	1	F	M	0.88	1.99	
SI	249	RIVER RD	GSECT22U	11979	D	1	F	M	1.60	2.15	
SI	250	RIVER RD	GSECT22U	12006	D	1	B	M	1.28	1.93	
SI	251	RIVER RD	GSECT22U	11980	D	1	F	M	1.59	2.13	
SI	252	RIVER RD	GSECT22U	12005	D	1	F	M	1.00	1.78	
SI	253	RIVER RD	GSECT22U	11981	D	2	B/F	M	1.61	1.68	
SI	254	RIVER RD	GSECT22U	12004	D	1	F	M	1.17	2.13	
SI	256	RIVER RD	GSECT22U	12003	D	2	B/F	M	1.21	1.45	
SI	258	RIVER RD	GSECT22U	20676	D	2	B	L	1.15	1.40	
SI	260	RIVER RD	GSECT22U	12002	D	1	F	M	1.01	2.03	
SI	262	RIVER RD	GSECT22U	12001	D	1	F	M	0.88	1.91	
SI	264	RIVER RD	GSECT22U	12000	D	1	F	M	1.15	1.80	
SI	266	RIVER RD	GSECT22U	11999	D	2	B	L	1.06	1.22	
SI	268	RIVER RD	GSECT22U	11998	D	1	F	M	0.96	1.69	
SI	270	RIVER RD	GSECT22U	11997	D	2	B	L	1.06	1.22	
SI	272	RIVER RD	GSECT22U	11996	C	1	F	M	1.88	2.06	
SI	274	RIVER RD	GSECT22U	20675	D	1	F	S	1.28	1.44	
SI	276	RIVER RD	GSECT22U	11995	D	1	F	M	1.65	2.05	
SI	278	RIVER RD	GSECT22U	11994	D	1	F	M	1.69	2.08	
SI	28	RIVER RD	GSECT29	12088	SHED	1	M	S	2.53	2.82	
SI	280	RIVER RD	GSECT22U	11993	D	1	F	M	1.56	2.18	

LEGEND:

Material: B - brick; W/B - weatherboard; F - fibro; CONC - concrete; AL - aluminium

Zone Location: BF - Basin Foreshore; SP - Sanctuary Point; SI - Sussex Inlet

Type: D - dwelling; U - units; C - commercial

Size: S - small; M - medium; L - large

ZONE LOCATION	ST No.	STREET NAME	RELEVANT GRIDPOINT IN HYDRAULIC MODEL	GIS UPN	TYPE	STOREYS	MATERIAL	SIZE	GROUND RL	FLOOR RL	REMARKS
SI	282	RIVER RD	GSECT22U	11992	D	1.00	B	M	1.49	2.37	
SI	30	RIVER RD	GSECT29	12087	D	2	B	M	2.02	3.25	
SI	34	RIVER RD	GSECT29	12085	D	2	B/F	M	1.17	1.90	
SI	36	RIVER RD	GSECT29	12084	D	2	B/F	M	1.62	2.32	
SI	1	RIVIERA AVE	GSECT11	12091	D	1	F	S	2.11	2.51	
SI	2	RIVIERA AVE	GSECT11	12104	D	2	B/WB	M	2.45	2.47	
SI	3	RIVIERA AVE	GSECT11	12092	D	1	WB	M	2.14	2.60	
SI	4	RIVIERA AVE	GSECT11	12103	D	1	B	M	2.37	2.62	
SI	5	RIVIERA AVE	GSECT11	12093	D	2	B/WB	M	2.25	2.48	
SI	7	RIVIERA AVE	GSECT11	12094	D	1	W/B	M	2.44	2.82	
SI	8	RIVIERA AVE	GSECT11	12101	D	2	F	M	2.58	3.24	
SI	9	RIVIERA AVE	GSECT11	12095	D	2	B	M	2.84	2.92	
SI	10	RIVIERA AVE	GSECT11	12100	D	2	B/F	M	2.99	2.81	
SI	11	RIVIERA AVE	GSECT11	12096	D	1	B	M	3.05	3.14	
SI	12	RIVIERA AVE	GSECT11	12099	D	1	B	M	3.18	3.39	
SI	13	RIVIERA AVE	GSECT11	12097	D	2	B/F	M	3.14	3.18	
SI	14	RIVIERA AVE	GSECT11	12098	D	2	B/F	M	3.30	3.43	
SI	41	SUSSEX INLET RD	GBAD3	12196	D	1	B	M	2.85	3.13	
SI	43	SUSSEX INLET RD	GBAD3	12197	D	2	B/F	M	3.00	3.03	
SI	45	SUSSEX INLET RD	GBAD3	12198	D	1	F	M	2.99	3.54	
SI	47	SUSSEX INLET RD	GBAD3	12199	D	1	B	M	2.78	3.06	
SI	49	SUSSEX INLET RD	GBAD3	12200	D	1	F	M	3.03	3.10	
SI	51	SUSSEX INLET RD	GBAD3	12201	D	2	B	L	2.77	3.42	
SI	53	SUSSEX INLET RD	GBAD3	12202	D	2	B	M	3.42	3.61	
SI	55	SUSSEX INLET RD	GBAD3	12203	D	1	WB	M	3.17	3.65	
SI	57	SUSSEX INLET RD	GBAD3	12204	D	1	F	M	3.14	3.64	
SI	59	SUSSEX INLET RD	GBAD3	12205	D	2	B/F	M	2.68	3.34	
SI	61	SUSSEX INLET RD	GBAD3	12206	D	1	F	M	2.64	2.91	
SI	63	SUSSEX INLET RD	GBAD3	12207	D	1	WB	M	2.41	2.81	
SI	65	SUSSEX INLET RD	GBAD3	12208	D	1	WB	M	2.41	5.21	
SI	67	SUSSEX INLET RD	GBAD3	12209	D	1	F	M	2.50	2.53	
SI	69	SUSSEX INLET RD	GBAD3	12210	D	1	WB	M	4.96	5.68	
SI	18	SUSSEX RD	GSECT13	20706	C	1	B	M	1.73	2.37	NURSING HOME
SI	18	THORA ST	GBAD3	50488	D	1	B	M	2.43	2.69	
SI	19	THORA ST	GBAD3	50486	D	2	B/WB	M	2.46	2.68	
SI	20	THORA ST	GBAD3	50487	D	1	B	M	2.64	3.02	
SI	40	THORA ST	GBAD3	50504	D	2	B	L	2.46	2.66	
SI	41	THORA ST	GBAD3	50505	D	1	B	M	2.34	2.62	
SI	42	THORA ST	GBAD3	50506	D	1	B	M	2.35	2.59	
SI	52	THORA ST	GSECT22U	20701	C	1	F	M	1.88	2.06	
SI	25	WHIMBREL DR	GBAD3	53188	D	1	B	M	2.38	2.75	
SI	26	WHIMBREL DR	GBAD3	53177	D	2	B	L	2.44	2.74	
SI	27	WHIMBREL DR	GBAD3	53189	D	2	B	L	2.44	2.73	
SI	28	WHIMBREL DR	GBAD3	53178	D	2	B	M	2.62	3.83	
SI	30	WHIMBREL DR	GBAD3	53179	D	2	B	L	2.49	3.46	
SI	31	WHIMBREL DR	GBAD3	53191	D	1	B	M	2.48	2.86	
SI	32	WHIMBREL DR	GBAD3	53180	D	1	B	M	2.54	2.85	
SI	1	WUNDA AVE	GSECT25	11934	D	1	WB	M	1.01	1.83	
SI	3	WUNDA AVE	GSECT25	12406	D	1	WB	M	0.99	1.88	
SI	5	WUNDA AVE	GSECT25	12407	D	1	F	M	0.92	0.97	
SI	7	WUNDA AVE	GSECT25	12408	D	1	F	M	1.08	2.22	
SI	8	WUNDA AVE	GSECT25	12424	D	2	B/F	M	0.97	1.11	
SI	9	WUNDA AVE	GSECT25	12409	D	1	F	M	0.81	2.46	
SI	10	WUNDA AVE	GSECT25	12423	D	2	B/F	M	1.03	1.12	
SI	11	WUNDA AVE	GSECT25	12410	D	2	B/F	M	0.97	0.97	
SI	12	WUNDA AVE	GSECT25	12422	D	1	F	S	1.21	2.11	
SI	13	WUNDA AVE	GSECT25	12411	D	1	F	S	0.86	1.05	
SI	14	WUNDA AVE	GSECT25	12421	D	1	F	S	1.21	2.34	
SI	15	WUNDA AVE	GSECT25	12412	D	1	F	S	0.86	2.01	
SI	16	WUNDA AVE	GSECT25	12420	D	1	F	M	1.20	2.07	
SI	17	WUNDA AVE	GSECT25	12413	D	1	F	S	1.02	1.81	
SI	18	WUNDA AVE	GSECT25	12419	D	1	F	S	1.21	2.07	
SI	19	WUNDA AVE	GSECT25	12414	D	2	B/F	M	1.12	1.91	
SI	21	WUNDA AVE	GSECT25	12415	D	1	F	S	1.03	1.70	
SI	23	WUNDA AVE	GSECT25	12416	D	1	F	M	1.14	1.93	
SI	25	WUNDA AVE	GSECT25	12417	D	2	B	L	1.31	1.41	
SI		FINCHPL	GBAD3	56310	D						
SI		SANDPIPERWAY	GBAD3	50463	D						
SI		CORMORANTAVE	GBAD3	56717	C						
SI		8FINCHPL	GBAD3	56302	D						
SI		28SANDPIPERWAY	GBAD3	50462	D						
SI		9FINCHPL	GBAD3	56301	D						
SI		7FINCHPL	GBAD3	56303	D						
SI		HARBORDST	GBAD3	50468	C						
SI		27SANDPIPERWAY	GBAD3	50461	D						

Note:
Shading indicates properties where detailed survey information is not available. Typical values were interpreted for the purposes

LEGEND:

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ZONE LOCATION	ST No.	STREET NAME	RELEVANT GRIDPOINT IN HYDRAULIC MODEL	GIS UPN	TYPE	STOREYS	MATERIAL	SIZE	GROUND RL	FLOOR RL	REMARKS
SI	6	FINCHPL	GBAD3	56304	D						of damages
SI	10	FINCHPL	GBAD3	56300	D						assessment.
SI	5	FINCHPL	GBAD3	56305	D						
SI	26	SANDPIPERWAY	GBAD3	50460	D						
SI	11	FINCHPL	GBAD3	56299	D						
SI	4	FINCHPL	GBAD3	56306	D						
SI	8	THORAST	GBAD3	50472	D						
SI	7	THORAST	GBAD3	50471	D						
SI	9	THORAST	GBAD3	50473	D						
SI	6	THORAST	GBAD3	50470	D						
SI	12	FINCHPL	GBAD3	56298	D						
SI	10	THORAST	GBAD3	50474	D						
SI	13	FINCHPL	GBAD3	56297	D						
SI	25	SANDPIPERWAY	GBAD3	50459	D						
SI	11	THORAST	GBAD3	50475	D						
SI	3	FINCHPL	GBAD3	56307	D						
SI	12	THORAST	GBAD3	50476	D						
SI	24	SANDPIPERWAY	GBAD3	50458	D						
SI	2	FINCHPL	GBAD3	56308	D						
SI	1	WHIMBRELDR	GBAD3	50437	D						
SI	1	FINCHPL	GBAD3	56309	D						
SI	23	SANDPIPERWAY	GBAD3	50457	D						
SI	3	WHIMBRELDR	GBAD3	50438	D						
SI	47	THORAST	GBAD3	50511	D						
SI	15	THORAST	GBAD3	50479	D						
SI	22	SANDPIPERWAY	GBAD3	50456	D						
SI	5	WHIMBRELDR	GBAD3	50439	D						
SI	46	THORAST	GBAD3	50510	D						
SI	21	SANDPIPERWAY	GBAD3	50455	D						
SI	16	THORAST	GBAD3	50480	D						
SI	15	SANDPIPERWAY	GBAD3	50448	D						
SI	2	WHIMBRELDR	GBAD3	50447	D						
SI	20	SANDPIPERWAY	GBAD3	50454	D						
SI	45	THORAST	GBAD3	50509	D						
SI	7	WHIMBRELDR	GBAD3	50440	D						
SI	4	CORMORANTAVE	GBAD3	56670	D						
SI	5	CORMORANTAVE	GBAD3	56671	D						
SI	16	SANDPIPERWAY	GBAD3	50450	D						
SI	19	SANDPIPERWAY	GBAD3	50453	D						
SI	17	THORAST	GBAD3	50481	D						
SI	3	CORMORANTAVE	GBAD3	56669	D						
SI	18	SANDPIPERWAY	GBAD3	50452	D						
SI		HARBORDST	GBAD3	50466	C						
SI	4	WHIMBRELDR	GBAD3	50449	D						
SI	17	SANDPIPERWAY	GBAD3	50451	D						
SI	6	CORMORANTAVE	GBAD3	56672	D						
SI	44	THORAST	GBAD3	50508	D						
SI	9	WHIMBRELDR	GBAD3	50441	D						
SI	2	CORMORANTAVE	GBAD3	56668	D						
SI	43	THORAST	GBAD3	50507	D						
SI	6	WHIMBRELDR	GBAD3	50446	D						
SI	11	WHIMBRELDR	GBAD3	50442	D						
SI	7	CORMORANTAVE	GBAD3	56673	D						
SI	45	WHIMBRELDR	GBAD3	56667	D						
SI	43	WHIMBRELDR	GBAD3	56666	D						
SI		WHIMBRELDR	GBAD3	53197	C						
SI	8	WHIMBRELDR	GBAD3	50445	D						
SI	13	WHIMBRELDR	GBAD3	52431	D						
SI	41	WHIMBRELDR	GBAD3	53196	D						
SI	39	WHIMBRELDR	GBAD3	53195	D						
SI	37	WHIMBRELDR	GBAD3	53194	D						
SI	35	WHIMBRELDR	GBAD3	53193	D						
SI	33	WHIMBRELDR	GBAD3	53192	D						
SI	8	CORMORANTAVE	GBAD3	56674	D						
SI	15	WHIMBRELDR	GBAD3	52432	D						
SI	23	WHIMBRELDR	GBAD3	53187	D						
SI	10	WHIMBRELDR	GBAD3	50444	D						
SI	21	WHIMBRELDR	GBAD3	53186	D						
SI	17	WHIMBRELDR	GBAD3	52433	D						
SI	19	WHIMBRELDR	GBAD3	53185	D						
SI	21	THORAST	GBAD3	50482	D						
SI	9	CORMORANTAVE	GBAD3	56675	D						
SI	12	WHIMBRELDR	GBAD3	50443	D						
SI	22	THORAST	GBAD3	50483	D						
SI	2	HARBORDST	GBAD3	11982	D						
SI	10	CORMORANTAVE	GBAD3	56676	D						
SI	39	THORAST	GBAD3	50503	D						

LEGEND:

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Size: S - small; M - medium; L - large

ZONE LOCATION	ST No.	STREET NAME	RELEVANT GRIDPOINT IN HYDRAULIC MODEL	GIS UPN	TYPE	STOREYS	MATERIAL	SIZE	GROUND RL	FLOOR RL	REMARKS
SI	23	THORAST	GBAD3	50484	D						
SI		WHIMBRELDR	GBAD3	56716	D						
SI	27	DOTTERELPL	GBAD3	52417	D						
SI	40	WHIMBRELDR	GBAD3	53184	D						
SI	11	CORMORANTAVE	GBAD3	56677	D						
SI	38	WHIMBRELDR	GBAD3	53183	D						
SI	38	THORAST	GBAD3	50502	D						
SI	36	WHIMBRELDR	GBAD3	53182	D						
SI	34	WHIMBRELDR	GBAD3	53181	D						
SI	26	DOTTERELPL	GBAD3	52418	D						
SI	24	THORAST	GBAD3	50485	D						
SI	25	DOTTERELPL	GBAD3	52419	D						
SI	24	WHIMBRELDR	GBAD3	53176	D						
SI	12	CORMORANTAVE	GBAD3	56678	D						
SI	22	WHIMBRELDR	GBAD3	53175	D						
SI	16	WHIMBRELDR	GBAD3	53172	D						
SI	24	DOTTERELPL	GBAD3	52420	D						
SI	20	WHIMBRELDR	GBAD3	53174	D						
SI	37	THORAST	GBAD3	50501	D						
SI	18	WHIMBRELDR	GBAD3	53173	D						
SI	23	DOTTERELPL	GBAD3	52421	D						
SI	25	THORAST	GBAD3	50489	D						
SI	13	CORMORANTAVE	GBAD3	56679	D						
SI	2	DOTTERELPL	GBAD3	53171	D						
SI	22	DOTTERELPL	GBAD3	52422	D						
SI	36	THORAST	GBAD3	50500	D						
SI		WHIMBRELDR	GBAD3	53198	C						
SI	26	THORAST	GBAD3	50490	D						
SI	49	CORMORANTAVE	GBAD3	56715	D						
SI	14	CORMORANTAVE	GBAD3	56680	D						
SI	3	DOTTERELPL	GBAD3	53170	D						
SI	21	DOTTERELPL	GBAD3	52423	D						
SI	35	THORAST	GBAD3	50499	D						
SI	4	DOTTERELPL	GBAD3	53169	D						
SI	48	CORMORANTAVE	GBAD3	56714	D						
SI	27	THORAST	GBAD3	50491	D						
SI	5	DOTTERELPL	GBAD3	53168	D						
SI	15	CORMORANTAVE	GBAD3	56681	D						
SI	6	DOTTERELPL	GBAD3	53167	D						
SI	34	THORAST	GBAD3	50498	D						
SI	20	DOTTERELPL	GBAD3	52424	D						
SI	47	CORMORANTAVE	GBAD3	56713	D						
SI	28	THORAST	GBAD3	50492	D						
SI	7	DOTTERELPL	GBAD3	53166	D						
SI	16	CORMORANTAVE	GBAD3	56682	D						
SI	46	CORMORANTAVE	GBAD3	56712	D						
SI	45	CORMORANTAVE	GBAD3	56711	D						
SI	33	THORAST	GBAD3	50497	D						
SI	44	CORMORANTAVE	GBAD3	56710	D						
SI	29	THORAST	GBAD3	50493	D						
SI	43	CORMORANTAVE	GBAD3	56709	D						
SI	42	CORMORANTAVE	GBAD3	56708	D						
SI	19	DOTTERELPL	GBAD3	52425	D						
SI	17	CORMORANTAVE	GBAD3	56683	D						
SI	41	CORMORANTAVE	GBAD3	56707	D						
SI	40	CORMORANTAVE	GBAD3	56706	D						
SI	39	CORMORANTAVE	GBAD3	56705	D						
SI	8	DOTTERELPL	GBAD3	53165	D						
SI	32	THORAST	GBAD3	50496	D						
SI	38	CORMORANTAVE	GBAD3	56704	D						
SI	37	CORMORANTAVE	GBAD3	56703	D						
SI	30	THORAST	GBAD3	50494	D						
SI	18	DOTTERELPL	GBAD3	52426	D						
SI	36	CORMORANTAVE	GBAD3	56702	D						
SI	71	SUSSEXINLETRD	GBAD3	12211	D						
SI	18	CORMORANTAVE	GBAD3	56684	D						
SI		HARBORDST	GBAD3	11923	C						
SI	35	CORMORANTAVE	GBAD3	56701	D						
SI	34	CORMORANTAVE	GBAD3	56700	D						
SI	9	DOTTERELPL	GBAD3	53164	D						
SI	19	CORMORANTAVE	GBAD3	56685	D						
SI	16	CATERCRES	GBAD3	11013	D						
SI	17	DOTTERELPL	GBAD3	52427	D						
SI	20	CORMORANTAVE	GBAD3	56686	D						
SI	31	THORAST	GBAD3	50495	D						
SI	21	CORMORANTAVE	GBAD3	56687	D						
SI	22	CORMORANTAVE	GBAD3	56688	D						

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ZONE LOCATION	ST No.	STREET NAME	RELEVANT GRIDPOINT IN HYDRAULIC MODEL	GIS UPN	TYPE	STOREYS	MATERIAL	SIZE	GROUND RL	FLOOR RL	REMARKS
SI		10DOTTERELPL	GBAD3	53163	D						
SI		33CORMORANTAVE	GBAD3	56699	D						
SI		23CORMORANTAVE	GBAD3	56689	D						
SI		16DOTTERELPL	GBAD3	52428	D						
SI		HARBORDST	GBAD3	52435	C						
SI		24CORMORANTAVE	GBAD3	56690	D						
SI		25CORMORANTAVE	GBAD3	56691	D						
SI		26CORMORANTAVE	GBAD3	56692	D						
SI		27CORMORANTAVE	GBAD3	56693	D						
SI		11DOTTERELPL	GBAD3	53162	D						
SI		28CORMORANTAVE	GBAD3	56694	D						
SI		29CORMORANTAVE	GBAD3	56695	D						
SI		HARBORDST	GBAD3	25693	C						
SI		30CORMORANTAVE	GBAD3	56696	D						
SI		15DOTTERELPL	GBAD3	52429	D						
SI		32CORMORANTAVE	GBAD3	56698	D						
SI		31CORMORANTAVE	GBAD3	56697	D						
SI		12DOTTERELPL	GBAD3	53161	D						
SI		14DOTTERELPL	GBAD3	52430	D						
SI		13DOTTERELPL	GBAD3	53160	D						
SI		CORMORANTAVE	GBAD3	56718	D						
SI		34CATERCRES	GBAD3	11004	D						
SI		45RAYST	GBAD3	11851	D						
SI		43RAYST	GBAD3	11850	D						
SI		47RAYST	GBAD3	11852	D						
SI		41RAYST	GBAD3	11849	D						
SI		49RAYST	GBAD3	11853	D						
SI		51RAYST	GBAD3	11854	D						
SI		53RAYST	GBAD3	11855	D						
SI		55RAYST	GBAD3	11856	D						
SI		SUSSEXINLETRD	GBAD3	25733	D						
SI		39RAYST	GBAD3	11848	D						
SI		255RIVERRD	GBAD3	11983	D						
SI		114JACOBSDR	GBAD4	11520	D						
SI		112JACOBSDR	GBAD4	11521	D						
SI		102JACOBSDR	GBAD4	11526	D						
SI		1SANDPIPERWAY	GBAD4	50425	D						
SI		30IBISPL	GBAD4	11338	D						
SI		98JACOBSDR	GBAD4	20488	D						
SI		96JACOBSDR	GBAD4	11527	D						
SI		JACOBSDR	GBAD4	11519	C						
SI		90JACOBSDR	GBAD4	11530	D						
SI		29IBISPL	GBAD4	11337	D						
SI		2SANDPIPERWAY	GBAD4	50426	D						
SI		88JACOBSDR	GBAD4	11531	D						
SI		2IBISPL	GBAD4	11311	D						
SI		25TEALPL	GBAD4	12285	D						
SI		2TEALPL	GBAD4	12260	D						
SI		3SANDPIPERWAY	GBAD4	50427	D						
SI		28IBISPL	GBAD4	11336	D						
SI		80JACOBSDR	GBAD4	11533	D						
SI		3IBISPL	GBAD4	20692	D						
SI		78JACOBSDR	GBAD4	11534	D						
SI		76JACOBSDR	GBAD4	11535	D						
SI		4SANDPIPERWAY	GBAD4	50428	D						
SI		27IBISPL	GBAD4	11335	D						
SI		74JACOBSDR	GBAD4	11536	D						
SI		72JACOBSDR	GBAD4	11537	D						
SI		24TEALPL	GBAD4	12284	D						
SI		70JACOBSDR	GBAD4	11538	D						
SI		ELLMOOSAVE	GBAD4	25756	D						
SI		4IBISPL	GBAD4	11312	D						
SI		3TEALPL	GBAD4	12261	D						
SI		68JACOBSDR	GBAD4	11539	D						
SI		5SANDPIPERWAY	GBAD4	50429	D						
SI		26IBISPL	GBAD4	11334	D						
SI		66JACOBSDR	GBAD4	11540	D						
SI		23TEALPL	GBAD4	12283	D						
SI		25PLOVERCL	GBAD4	11799	D						
SI		5IBISPL	GBAD4	11313	D						
SI		4TEALPL	GBAD4	12262	D						
SI		62JACOBSDR	GBAD4	11541	D						
SI		25IBISPL	GBAD4	11333	D						
SI		6SANDPIPERWAY	GBAD4	50430	D						
SI		60JACOBSDR	GBAD4	71807	D						
SI		22TEALPL	GBAD4	12282	D						
SI		58JACOBSDR	GBAD4	71809	D						

LEGEND:

Material: B - brick; W/B - weatherboard; F - fibro; CONC - concrete; AL - aluminium

Zone Location: BF - Basin Foreshore; SP - Sanctuary Point; SI - Sussex Inlet

Type: D - dwelling; U - units; C - commercial

Size: S - small; M - medium; L - large

ZONE LOCATION	ST No.	STREET NAME	RELEVANT GRIDPOINT IN HYDRAULIC MODEL	GIS UPN	TYPE	STOREYS	MATERIAL	SIZE	GROUND RL	FLOOR RL	REMARKS
SI	6	IBISPL	GBAD4	11314	D						
SI	5	TEALPL	GBAD4	12263	D						
SI	50	JACOBSDR	GBAD4	86995	D						
SI	7	SANDPIPERWAY	GBAD4	50431	D						
SI	24	IBISPL	GBAD4	11332	D						
SI	21	TEALPL	GBAD4	12279	D						
SI	24	PLOVERCL	GBAD4	11798	D						
SI	2	PLOVERCL	GBAD4	11780	D						
SI	7	IBISPL	GBAD4	11315	D						
SI	6	TEALPL	GBAD4	12264	D						
SI	16	PLOVERCL	GBAD4	11792	D						
SI	8	SANDPIPERWAY	GBAD4	50432	D						
SI	23	IBISPL	GBAD4	11331	D						
SI	23	PLOVERCL	GBAD4	11797	D						
SI	17	PLOVERCL	GBAD4	11793	D						
SI	20	TEALPL	GBAD4	12278	D						
SI	15	PLOVERCL	GBAD4	20494	D						
SI	18	PLOVERCL	GBAD4	11794	D						
SI	3	PLOVERCL	GBAD4	11781	D						
SI	22	PLOVERCL	GBAD4	20496	D						
SI	8	IBISPL	GBAD4	11316	D						
SI	19	PLOVERCL	GBAD4	11795	D						
SI	1/50	JACOBSDR	GBAD4	86996	D						
SI	9	SANDPIPERWAY	GBAD4	50433	D						
SI	7	TEALPL	GBAD4	12265	D						
SI	20	PLOVERCL	GBAD4	11796	D						
SI	22	IBISPL	GBAD4	11330	D						
SI	21	PLOVERCL	GBAD4	20495	D						
SI	2/50	JACOBSDR	GBAD4	86997	D						
SI	19	TEALPL	GBAD4	12277	D						
SI	3/50	JACOBSDR	GBAD4	86998	D						
SI	4	PLOVERCL	GBAD4	11782	D						
SI	9	IBISPL	GBAD4	11317	D						
SI	4/50	JACOBSDR	GBAD4	86999	D						
SI	10	SANDPIPERWAY	GBAD4	50434	D						
SI	8	TEALPL	GBAD4	12266	D						
SI	21	IBISPL	GBAD4	11329	D						
SI	5/50	JACOBSDR	GBAD4	87000	D						
SI	18	TEALPL	GBAD4	12276	D						
SI	5	PLOVERCL	GBAD4	11783	D						
SI	6/50	JACOBSDR	GBAD4	87001	D						
SI	14	PLOVERCL	GBAD4	20493	D						
SI	10	IBISPL	GBAD4	11318	D						
SI	11	SANDPIPERWAY	GBAD4	50435	D						
SI	20	IBISPL	GBAD4	11328	D						
SI	9	TEALPL	GBAD4	12267	D						
SI	7/50	JACOBSDR	GBAD4	87002	D						
SI	6	PLOVERCL	GBAD4	11784	D						
SI	17	TEALPL	GBAD4	12275	D						
SI	12	PLOVERCL	GBAD4	11790	D						
SI	13	PLOVERCL	GBAD4	11791	D						
SI	7	PLOVERCL	GBAD4	11785	D						
SI	11	PLOVERCL	GBAD4	11789	D						
SI	11	IBISPL	GBAD4	11319	D						
SI	10	PLOVERCL	GBAD4	11788	D						
SI	8	PLOVERCL	GBAD4	11786	D						
SI	19	IBISPL	GBAD4	11327	D						
SI	10	TEALPL	GBAD4	12268	D						
SI	9	PLOVERCL	GBAD4	11787	D						
SI	12	SANDPIPERWAY	GBAD4	50436	D						
SI	16	TEALPL	GBAD4	12274	D						
SI	12	IBISPL	GBAD4	11320	D						
SI	11	TEALPL	GBAD4	12269	D						
SI	18	IBISPL	GBAD4	11326	D						
SI	15	TEALPL	GBAD4	12273	D						
SI	13	IBISPL	GBAD4	11321	D						
SI	17	IBISPL	GBAD4	11325	D						
SI	14	TEALPL	GBAD4	12272	D						
SI	12	TEALPL	GBAD4	12270	D						
SI		JACOBSDR	GBAD4	87003	D						
SI		JACOBSDR	GBAD4	87013	D						
SI		JACOBSDR	GBAD4	87004	D						
SI		JACOBSDR	GBAD4	87014	D						
SI	13	TEALPL	GBAD4	12271	D						
SI		JACOBSDR	GBAD4	87005	D						
SI		JACOBSDR	GBAD4	87015	D						
SI	14	IBISPL	GBAD4	11322	D						

LEGEND:

Material: B - brick; W/B - weatherboard; F - fibro; CONC - concrete; AL - aluminium

Zone Location: BF - Basin Foreshore; SP - Sanctuary Point; SI - Sussex Inlet

Type: D - dwelling; U - units; C - commercial

Size: S - small; M - medium; L - large

ZONE LOCATION	ST No.	STREET NAME	RELEVANT GRIDPOINT IN HYDRAULIC MODEL	GIS UPN	TYPE	STOREYS	MATERIAL	SIZE	GROUND RL	FLOOR RL	REMARKS
SI		JACOBSDR	GBAD4	87006	D						
SI		JACOBSDR	GBAD4	87016	D						
SI		16IBISPL	GBAD4	11324	D						
SI		JACOBSDR	GBAD4	87007	D						
SI		JACOBSDR	GBAD4	87017	D						
SI		JACOBSDR	GBAD4	87008	D						
SI		JACOBSDR	GBAD4	87018	D						
SI		15IBISPL	GBAD4	11323	D						
SI		JACOBSDR	GBAD4	87009	D						
SI		JACOBSDR	GBAD4	87010	D						
SI		JACOBSDR	GBAD4	87011	D						
SI		JACOBSDR	GBAD4	87012	D						
SI		JACOBSDR	GBAD4	87021	D						
SI		JACOBSDR	GBAD5	11407	D						
SI		RIVERRD	GBAD5	25694	C						
SI		RIVERRD	GBAD5	25732	C						
SI		31JACOBSDR	GBAD5	20703	D						
SI		PARADISECRES	GBAD5	48450	D						
SI		PARADISECRES	GBAD5	11769	C						
SI		107JACOBSDR	GBAD5	11445	D						
SI		105JACOBSDR	GBAD5	11443	D						
SI		103JACOBSDR	GBAD5	11442	D						
SI		101JACOBSDR	GBAD5	11441	D						
SI		99JACOBSDR	GBAD5	11440	D						
SI		97JACOBSDR	GBAD5	11439	D						
SI		95JACOBSDR	GBAD5	11438	D						
SI		93JACOBSDR	GBAD5	11437	D						
SI		SUSSEXINLETRD	GBAD5	69625	D						
SI		91JACOBSDR	GBAD5	11436	D						
SI		89JACOBSDR	GBAD5	11435	D						
SI		87JACOBSDR	GBAD5	11434	D						
SI		85JACOBSDR	GBAD5	11433	D						
SI		JACOBSDR	GBAD5	11407	D						
SI		73JACOBSDR	GBAD5	11427	D						
SI		71JACOBSDR	GBAD5	11426	D						
SI		69JACOBSDR	GBAD5	11425	D						
SI		67JACOBSDR	GBAD5	11424	D						
SI		JACOBSDR	GBAD5	20702	D						
SI		55JACOBSDR	GBAD5	20704	D						
SI		53JACOBSDR	GBAD5	11418	D						
SI		51JACOBSDR	GBAD5	11417	D						
SI		49JACOBSDR	GBAD5	11416	D						
SI		47JACOBSDR	GBAD5	11415	D						
SI		45JACOBSDR	GBAD5	11414	D						
SI		43JACOBSDR	GBAD5	11413	D						
SI		41JACOBSDR	GBAD5	11412	D						
BF		MATHIE ST	GPAT1	84577	PUMPSTATION					2.70	
BF		WOOL RD	GHOM2	68931	PUMPSTATION					2.66	
BF		LORALYNE AVE	GDUMWU	33174	PUMPSTATION					2.69	
BF		WALMER AVE	GDUMWU	38029	PUMPSTATION					2.58	
BF		SANCTUARY POINT	GDUMWU	34437	PUMPSTATION					2.64	
BF		LORALYN AVE	GDUMWU	8780	PUMPST.					2.60	
SP		THE PARK DRIVE	G99TOM9U	34440	SEWER PUMP STN					2.67	
BF		SANCT PT RD	GDUMWU	39607	SEWER PUMP STN					2.64	
SP		VOST DR	G99TOM15	10164	SEWER PUMP STN					2.84	
BF		PRENTICE AVE	GDUMWU	29911	SEWER PUMP STN					2.35	
SP		MACGIBBON PDE	GWOR4	14752	SEWER PUMP STN					5.12	
BF		NAVAL PDE	GDUMWU	62450	SEWER PUMP STN					2.71	
SI	PSNO.11	EDGEWATER PUMP STATION	GSECT11	70629	ELECT PLINTH					2.35	
SI	PSNO.7	RIVER RD PUMPST.	GSECT29	25711	ELECT PLINTH					2.14	
SI	PSNO.9	CORANG AVE.	GBAD2	10985	ELECT PLINTH					1.90	
SI	PSN	SANDPIPER WAY	GBAD3	11518	ELECT PLINTH					1.97	

LEGEND:

Material: B - brick; W/B - weatherboard; F - fibro; CONC - concrete; AL - aluminium

Zone Location: BF - Basin Foreshore; SP - Sanctuary Point; SI - Sussex Inlet

Type: D - dwelling; U - units; C - commercial

Size: S - small; M - medium; L - large

ZONE LOCATION	ST No.	STREET NAME	RELEVANT GRIDPOINT IN HYDRAULIC MODEL	GIS UPN	TYPE	STOREYS	MATERIAL	SIZE	GROUND RL	FLOOR RL	REMARKS
	O.6										
SI	PSN	JACOBS DR	GSECT25	11532	ELECT PLINTH					2.03	
	O.5										
SI	PSN	36 RIVER RD	GSECT29	12147	ELECT PLINTH					1.86	
	O1										
SI	PSN	27 FAIRVIRW CRES	GSECT29	25711	ELECT PLINTH					1.95	
	O2										
SI	162	SUSSEX RD	GSECT15	70476	RIVERSIDE VAN PARK						
	LOT										
SI		SUSSEX RD	GSECT15	70476	Ameneites					1.78	
SI		SUSSEX RD	GSECT15	70476	Sites(Approx 90)				1.06	1.06	1.06 1.58
SI		SUSSEX RD	GSECT15	70476	Manager				1.43	1.80	
SI	40	SUSSEX RD	GSECT15	12247	SUSSEX PALMS VAN PARK						
	LOT										
SI		SUSSEX RD	GSECT15	12247	Ameneites				1.53	1.99	
SI		SUSSEX RD	GSECT15	12247	Sites (37)					1.53	1.53 1.9
SI		SUSSEX RD	GSECT15	12247	Manager				1.62	2.06	
SI	199	JACOBS DR	GSECT25	11476	SUSSEX HOUSE VAN PARK						
SI		JACOBS DR	GSECT25	11476	Manager	1	WB/F	M		2.07	
SI		JACOBS DR	GSECT25	11476	Amenities					1.83	
SI		JACOBS DR	GSECT25	11476	Sites (32)					1.54	1.54 1.79
SI		JACOBS DR	GSECT25	11476	Cottages				1.32	1.32	
SI	148	RIVER RD	GSECT25	88947	BADGEE VAN PARK	1	B	M			
SI		RIVER RD	GSECT25	88947	Manager				1.20	1.31	
SI		RIVER RD	GSECT25	88947	Amenities					1.42	
SI		RIVER RD	GSECT25	88947	Sites (50)				1.17	1.17	1.17 1.99
SI	158	RIVER RD	GSECT25	20683	RIVIERA VAN PARK						
SI		RIVER RD	GSECT25	20683	Manager	2	BWB	L	1.40	1.44	
SI		RIVER RD	GSECT25	20683	Amenities					1.44	
SI		RIVER RD	GSECT25	20683	Sites (Approx. 50)				1.38	1.38	1.38 2.08
SI		RIVER RD	GSECT25	20683	Cabins					2.08	2.08(H)
SI	160	RIVER RD	GSECT25	12034	LAGUNA LODGE						
SI		RIVER RD	GSECT25	12034	Manager	3	BWB	M	1.10	2.31	
SI		RIVER RD	GSECT25	12034	Amenities					1.30	
SI		RIVER RD	GSECT25	12034	Motel (6units)	1	WB	L		1.93	1.93 (H)
SI		RIVER RD	GSECT25	12034	Sites(6)				1.10	1.21	1.21 1.93
SI	165	RIVER RD	GSECT25	11951	SIESTA VAN PARK						
SI	169	RIVER RD	GSECT25	11951	Manager				1.80	1.98	
SI		RIVER RD	GSECT25	11951	Amenities					2.33	
SI		RIVER RD	GSECT25	11951	Sites (Approx. 58)				1.67	1.67	1.67 2.07
SI	164	RIVER RD	GSECT25	12033	BENTLEY MOTEL	1	BWB	M			
SI		RIVER RD	GSECT25	12033	Manager				0.83	2.35	
SI		RIVER RD	GSECT25	12033	Cabins (Approx. 20)				0.83	1.71	1.71 2.36
SI	166	RIVER RD	GSECT25	20682	ALONGA						
SI		RIVER RD	GSECT25	20682	Manager	2	B	L	1.05	2.26	
SI		RIVER RD	GSECT25	20682	Cabins (Approx. 12)				1.05	1.81	1.81 1.87
SI	173	RIVER RD	GSECT25	11469	CARAVAN PARK						
SI		RIVER RD	GSECT25	11469	Manager				1.61	1.76	
SI		RIVER RD	GSECT25	11469	Amenities					1.68	
SI		RIVER RD	GSECT25	11469	Sites (Approx 40)					1.76	1.76 2.24
SI	178	RIVER RD	GSECT25	12030	TALOFA VAN PARK						
SI		RIVER RD	GSECT25	12030	Manager	2	F	M	1.04	2.09	
SI		RIVER RD	GSECT25	12030	Amenities					1.71	
SI		RIVER RD	GSECT25	12030	Sites (Approx.32)				1.04	1.28	1.28 1.45
SI	200	RIVER RD	GSECT25	25714	ANCHORAGE VAN PARK						
SI		RIVER RD	GSECT25	25714	Manager				1.68	2.25	
SI		RIVER RD	GSECT25	25714	Amenities					1.59	
SI		RIVER RD	GSECT25	25714	Sites					1.51	1.51 1.98
SI		RIVER RD	GSECT25	25714	Cottage				1.51	1.51	1.51 1.98
SI	204	RIVER RD	GSECT25	20678	CEDAR PINES VAN PARK						
SI		RIVER RD	GSECT25	20678	Manager	1	F	M	1.45	2.13	
SI		RIVER RD	GSECT25	20678	Amenities					1.69	
SI		RIVER RD	GSECT25	20678	Sites					1.51	1.51 2.05
SI		RIVER RD	GSECT25	20678	Cottage				1.45	1.51	1.51 2.05
SI	212	RIVER RD	GSECT25	20677	SHANG RI LA VAN PARK						
SI		RIVER RD	GSECT25	20677	Manager	1	ALU	S	1.75	2.05	
SI		RIVER RD	GSECT25	20677	Amenities					2.01	
SI		RIVER RD	GSECT25	20677	Sites (25)				1.42	1.42	1.42 2.3
SI		RIVER RD	GSECT25	20677	Cottages					2.30	

LEGEND:

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Zone Location: BF - Basin Foreshore; SP - Sanctuary Point; SI - Sussex Inlet

Type: D - dwelling; U - units; C - commercial

Size: S - small; M - medium; L - large

ZONE LOCATION	ST No.	STREET NAME	RELEVANT GRIDPOINT IN HYDRAULIC MODEL	GIS UPN	TYPE	STOREYS	MATERIAL	SIZE	GROUND RL	FLOOR RL	REMARKS
SI		SUSSEX RD	GSECT15	69970	RIVERSIDE (Seacrest)VAN PARK						
SI		SUSSEX RD	GSECT15	69970	Manager				1.30	2.31	
SI		SUSSEX RD	GSECT15	69970	Amenities					1.50	
SI		SUSSEX RD	GSECT15	69970	Sites (96)				1.09	1.09	1.09 1.71
BF		ISLAND POINT RD	GDUMWU	38537	CARAVAN SITE 18 UNITS WITHIN FLOOD ZONE				2.23	2.23	2.23 2.81

Table D2: Properties Inundated above Floor Level 10% AEP Flood

No.	LOCATION	ST No.	STREET NAME	GROUND RL	FLOOR RL	DEPTH OF INUNDATION ABOVE			
						10%AEP		1%AEP	
						Ground	Floor	Ground	Floor
1	Basin Foreshore	9	FISHERMAN RD	3.03	3.57	1.58	1.04	1.69	1.15
2	Sanctuary Point	41	ROULSTONE CRES	2.20	2.13	0.55	0.62	1.24	1.31
3	Sanctuary Point	267	THE PARK DR	1.25	1.53	0.89	0.61	1.47	1.19
4	Sanctuary Point	14	PRENTICE AVE	0.94	0.94	0.60	0.60	1.41	1.41
5	Sussex Inlet	5	WUNDA AVE	0.92	0.97	0.61	0.56	1.38	1.33
6	Sussex Inlet	11	WUNDA AVE	0.97	0.97	0.56	0.56	1.33	1.33
7	Sanctuary Point	20	KALLAROO RD	3.10	3.43	0.81	0.48	0.96	0.63
8	Sussex Inlet	13	WUNDA AVE	0.86	1.05	0.67	0.48	1.44	1.25
9	Sanctuary Point	359	THE PARK DR	1.05	1.08	0.49	0.46	1.31	1.28
10	Sussex Inlet	52	ELLMOOS AVE	1.24	1.08	0.29	0.45	1.02	1.18
11	Sanctuary Point	338	THE PARK DR	0.98	1.09	0.56	0.45	1.38	1.27
12	Sussex Inlet	8	WUNDA AVE	0.97	1.11	0.56	0.42	1.33	1.19
13	Sanctuary Point	337	THE PARK DR	1.08	1.12	0.46	0.42	1.28	1.24
14	Sussex Inlet	120	JACOBS DR	1.02	1.12	0.51	0.41	1.28	1.18
15	Sussex Inlet	10	WUNDA AVE	1.03	1.12	0.50	0.41	1.27	1.18
16	Sanctuary Point	293	THE PARK DR	1.40	1.44	0.43	0.39	0.96	0.92
17	Sussex Inlet	4	POOLE AVE	1.10	1.18	0.43	0.35	1.20	1.12
18	Sanctuary Point	355	THE PARK DR	1.08	1.20	0.46	0.34	1.28	1.16
19	Sanctuary Point	347	THE PARK DR	1.07	1.21	0.47	0.33	1.29	1.15
20	Sussex Inlet	266	RIVER RD	1.06	1.22	0.47	0.31	1.20	1.04
21	Sussex Inlet	270	RIVER RD	1.06	1.22	0.47	0.31	1.20	1.04
22	Basin Foreshore	151	WALMER AVE	0.95	1.23	0.59	0.31	1.40	1.12
23	Sanctuary Point	341	THE PARK DR	1.08	1.25	0.46	0.29	1.28	1.11
24	Sanctuary Point	333	THE PARK DR	1.17	1.25	0.37	0.29	1.19	1.11
25	Sanctuary Point	363	THE PARK DR	1.21	1.26	0.33	0.28	1.15	1.10
26	Sussex Inlet	60	ELLMOOS AVE	1.21	1.26	0.32	0.27	1.05	1.00
27	Sanctuary Point	292	THE PARK DR	1.34	1.57	0.49	0.26	1.02	0.79
28	Sanctuary Point	271	THE PARK DR	1.43	1.89	0.71	0.25	1.29	0.83
29	Sanctuary Point	343	THE PARK DR	1.32	1.32	0.22	0.22	1.04	1.04
30	Sussex Inlet	155	RIVER RD	1.29	1.35	0.24	0.18	1.01	0.95
31	Sanctuary Point	111	LARMER AVE	1.55	1.65	0.28	0.18	0.81	0.71
32	Sussex Inlet	54	ELLMOOS AVE	1.29	1.36	0.24	0.17	0.97	0.90
33	Sanctuary Point	346	THE PARK DR	1.05	1.37	0.49	0.17	1.31	0.99
34	Sussex Inlet	9	BANKSIA ST	1.08	1.37	0.45	0.16	1.22	0.93
35	Sanctuary Point	22	PRENTICE AVE	0.92	1.38	0.62	0.16	1.43	0.97
36	Sussex Inlet	9	FAIRVIEW CRES	1.33	1.38	0.21	0.16	1.02	0.97
37	Sanctuary Point	336	THE PARK DR	1.10	1.39	0.44	0.15	1.26	0.97
38	Sanctuary Point	5	MOUNTAIN ST	1.47	1.52	0.19	0.14	0.89	0.84
39	Sussex Inlet	258	RIVER RD	1.15	1.40	0.38	0.13	1.11	0.86
40	Sanctuary Point	294	THE PARK DR	1.65	1.70	0.18	0.13	0.71	0.66
41	Sanctuary Point	353	THE PARK DR	1.10	1.41	0.44	0.13	1.26	0.95
42	Sanctuary Point	365	THE PARK DR	1.26	1.41	0.28	0.13	1.10	0.95
43	Sussex Inlet	141	RIVER RD	1.20	1.41	0.33	0.12	1.10	0.89
44	Sussex Inlet	25	WUNDA AVE	1.31	1.41	0.22	0.12	0.99	0.89
45	Sussex Inlet	9	NIELSON LANE	1.40	1.41	0.13	0.12	0.90	0.89
46	Sussex Inlet	118	JACOBS DR	1.26	1.43	0.27	0.10	1.04	0.87
47	Basin Foreshore	193	WALMER AVE	1.23	1.44	0.31	0.10	1.12	0.91
48	Sanctuary Point	280	THE PARK DR	1.80	1.86	0.16	0.10	0.71	0.65
49	Sanctuary Point	15	MOUNTAIN ST	1.54	1.57	0.12	0.09	0.82	0.79
50	Sussex Inlet	274	RIVER RD	1.28	1.44	0.25	0.09	0.98	0.82
51	Sussex Inlet	13	BANKSIA ST	1.37	1.45	0.16	0.08	0.93	0.85
52	Sussex Inlet	256	RIVER RD	1.21	1.45	0.32	0.08	1.05	0.81
53	Basin Foreshore	153	WALMER AVE	0.91	1.46	0.63	0.08	1.44	0.89
54	Sanctuary Point	255	THE PARK DR	1.90	2.07	0.24	0.07	0.82	0.65
55	Sussex Inlet	121	RIVER RD	1.52	1.47	0.01	0.06	0.78	0.83
56	Sussex Inlet	11	BANKSIA ST	1.08	1.48	0.45	0.05	1.22	0.82
57	Sussex Inlet	122	JACOBS DR	1.22	1.48	0.31	0.05	1.08	0.82
58	Sanctuary Point	12	MACGIBBON PDE	6.33	7.56	1.26	0.03	1.42	0.19
59	Sanctuary Point	10	MACGIBBON PDE	6.87	7.56	0.72	0.03	0.88	0.19
60	Sanctuary Point	130	THE WOOL RD	3.58	3.76	0.20	0.02	0.62	0.44
61	Sussex Inlet	2	POOLE AVE	1.03	1.52	0.50	0.01	1.27	0.78
62	Sanctuary Point	2	MOUNTAIN ST	1.42	1.65	0.24	0.01	0.94	0.71
63	Sussex Inlet	211	RIVER RD	0.94	1.53	0.59	0.00	1.36	0.77

Note: Shading indicates properties possibly suitable for house raising.

Table D3: Summary of Caravan Parks

NO.	LOCATION	PARK	FACILITY	GROUND RL	FLOOR RL*	FLOOD LEVELS	
						1% AEP	10% AEP
1	Sussex Inlet	RIVERSIDE VAN PARK					
			Amenities	N.A	1.78	2.11	1.52
			Sites (Approx 90)	1.06	1.06	2.11	1.52
			Manager	1.43	1.80	2.11	1.52
2	Sussex Inlet	SUSSEX PALMS VAN PARK					
			Amenities	1.53	1.99	2.11	1.52
			Sites (37)	N.A	1.53	2.11	1.52
			Manager	1.62	2.06	2.11	1.52
3	Sussex Inlet	SUSSEX HOUSE VAN PARK					
			Manager	N.A	2.07	2.30	1.53
			Amenities	N.A	1.83	2.30	1.53
			Sites (32)	N.A	1.54	2.30	1.53
			Cottages	1.32	1.32	2.30	1.53
4	Sussex Inlet	BADGEE VAN PARK					
			Manager	1.20	1.31	2.30	1.53
			Amenities	N.A	1.42	2.30	1.53
			Sites (50)	1.17	1.17	2.30	1.53
5	Sussex Inlet	RIVIERA VAN PARK					
			Manager	1.40	1.44	2.30	1.53
			Amenities	N.A	1.44	2.30	1.53
			Sites (Approx. 50)	1.38	1.38	2.30	1.53
			Cabins	N.A	2.08	2.30	1.53
6	Sussex Inlet	LAGUNA LODGE					
			Manager	1.10	2.31	2.30	1.53
			Amenities	N.A	1.30	2.30	1.53
			Motel (6units)	N.A	1.93	2.30	1.53
			Sites (6)	1.10	1.21	2.30	1.53
7	Sussex Inlet	SIESTA VAN PARK					
			Manager	1.80	1.98	2.30	1.53
			Amenities	N.A	2.33	2.30	1.53
			Sites (Approx. 58)	1.67	1.67	2.30	1.53
8	Sussex Inlet	BENTLEY MOTEL					
			Manager	0.83	2.35	2.30	1.53
			Cabins (Approx. 20)	0.83	1.71	2.30	1.53
9	Sussex Inlet	ALONGA					
			Manager	1.05	2.26	2.30	1.53
			Cabins (Approx. 12)	1.05	1.81	2.30	1.53
10	Sussex Inlet	CARAVAN PARK					
			Manager	1.61	1.76	2.30	1.53
			Amenities	N.A	1.68	2.30	1.53
			Sites (Approx 40)	N.A.	1.76	2.30	1.53
11	Sussex Inlet	TALOFA VAN PARK					
			Manager	1.04	2.09	2.30	1.53
			Amenities	N.A	1.71	2.30	1.53
			Sites (Approx.32)	N.A.	1.76	2.30	1.53
12	Sussex Inlet	ANCHORAGE VAN PARK					
			Manager	1.68	2.25	2.30	1.53
			Amenities	N.A	1.59	2.30	1.53
			Sites	N.A	1.51	2.30	1.53
			Cottage	1.51	1.51	2.30	1.53
13	Sussex Inlet	CEDAR PINES VAN PARK					
			Manager	1.45	2.13	2.30	1.53
			Amenities	N.A	1.69	2.30	1.53
			Sites	N.A	1.51	2.30	1.53
			Cottage	1.45	1.51	2.30	1.53
14	Sussex Inlet	SHANG RI LA VAN PARK					
			Manager	1.75	2.05	2.30	1.53
			Amenities	N.A	2.01	2.30	1.53
			Sites (25)	1.42	1.42	2.30	1.53

NO.	LOCATION	PARK	FACILITY	GROUND RL	FLOOR RL*	FLOOD LEVELS	
						1% AEP	10% AEP
			Cottages	**N.A**	**2.30**	**2.30**	**1.53**
15	**Sussex Inlet**	**RIVERSIDE (SEACREST) VAN PARK**					
			Manager	**1.30**	**2.31**	**2.11**	**1.52**
			Amenities	**N.A**	**1.50**	**2.11**	**1.52**
			Sites (96)	**1.09**	**1.09**	**2.11**	**1.52**
16	**St Georges Basin**	**ALOHA CARAVAN PARK**					
			Sites (18)	**2.23**	**2.23**	**2.35**	**1.54**

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APPENDIX E: POST FLOOD EVALUATION AND REVIEW

APPENDIX E: POST FLOOD EVALUATION AND REVIEW

E1. GENERAL

Design flood levels around the St Georges Basin are provided in the *St Georges Basin Flood Study* - September 2001. Copies of this report are held by Shoalhaven City Council and the Department of Land and Water Conservation. The design levels were determined using computer models of the catchment and lower floodplain which were calibrated to 3 historical floods (February 1971, June 1991 and February 1992).

The accuracy of the design flood levels can be improved with further flood and rainfall data to confirm the calibration of the computer models. The following procedure has been developed to ensure that the information available from future floods is accurately obtained and analysed.

E2. PROCEDURE

Step 1 - Future Flood: Detailed data should be collected if the basin level exceeds (say) 1.2 mAHD at the Island Point Jetty Gauge. The design flood levels for the study area are shown in Table E1.

Step 2 - Collect Peak Levels: Where possible, basin and creek levels and times should be recorded during the event by SES, Council employees or local residents. It is imperative that immediately following the event, the peak height of the flood be marked, either from debris marks or eyewitness reports. Debris marks can be lost within hours of the peak as a result of wind, rain or human interference.

Council should despatch personnel to inspect key locations around the basin and on the tributary creeks to identify, mark and photograph debris. The levels can be picked up later by a surveyor. The data should be recorded in a report showing the photograph, time of recording (if during the flood) and level to AHD. Council should consider if a circular or notice in local papers is warranted to obtain further information.

If possible, flow velocity measurements should be taken (by the DLWC or other suitably qualified authority).

Step 3 - Buildings Inundated: If floodwaters enter buildings, the occupant should be interviewed to obtain any relevant flood information such as a preliminary indication of the damages, peak level and to obtain photographs. The floor level database used in the Floodplain Risk Management Study indicates which buildings are likely to be flooded in a given size event.

Step 4 - Reports from Authorities: Council should obtain written reports on the flood and its implications from various affected sections of Council, the SES and any other relevant public authority on the flood. Data should be obtained from the Manly Hydraulics Laboratory water level recorders and Bureau of Meteorology rain gauges. This data can be obtained at any time although it is better if they are collected soon after the event in order to identify and correct any gross errors in other data.

Steps 5 to 8 only apply to floods estimated to be greater than a 5% AEP.

Step 5 - Major Floods: Flood levels which indicate an AEP of greater than 5% should be used to re-examine the calibration of the hydrologic/hydraulic models. Data from any other floods which have not been previously analysed should be included in this re-examination.

Step 6 - Rainfall Data: Rainfall data from Bureau of Meteorology gauges is continuously recorded and can be readily obtained at any time. If warranted, additional rainfall information can be sought from residents at the same time as flood data are requested.

Step 7 - Hydrologic/Hydraulic Modelling: The new data should be run through the WBNM and RUBICON models. If the models do not produce satisfactory results then all available information (including that from floods used in the Flood Study) needs to be considered to see if the model parameters should be changed. Consideration should be given to upgrading the hydraulic model. This will require a considerable amount of additional survey. Any changes would lead to a revision of design flood levels. A report should be produced documenting the results and any adjustments made to Council's Floodplain Management Plans and S149 Certificates.

Step 8 - Sussex Inlet Channel: The amount of sand that accumulates at the mouth of the Sussex Inlet Channel ocean entrance has a significant influence upon flood levels in the local area. It is essential that as much information as possible is obtained on the topography pre and post flood. Generally this will only be possible from aerial photography but also may include a post flood hydrographic survey. These data should be obtained as soon after the flood as possible.

Table E1: Design Flood Levels (mAHD)

	Location	Creek	Level (mAHD)			
			Ext.	1%	2%	5%
1.	Basin(beginning of channel)	Inlet	5.1	2.35	2.09	1.78
2.	The Haven	Inlet	3.1	1.96	1.86	1.75
3.	200 m D/s Princes Highway	Wandandian	10.2	6.66	6.29	5.81
4.	Wool Rd	Pats	5.1	4.26	4.22	4.18
5.	U/s Wool Rd	Home	5.1	2.54	2.45	2.33
6.	Wool Rd	Tomerong	5.1	3.44	3.26	3.01
7.	Fitzpatrick St	Worrowing	5.1	2.56	2.44	2.32

Note: Refer to Figure 1 for location of model gridpoints.

APPENDIX F: REVIEW OF RELATED PLANNING DOCUMENTS

APPENDIX F: REVIEW OF RELATED PLANNING DOCUMENTS

DISCUSSION OF PLANNING ISSUES

LOWER SHOALHAVEN RIVER FLOODPLAIN RISK MANAGEMENT STUDY AND PLAN

ST GEORGES BASIN FLOODPLAIN RISK MANAGEMENT STUDY AND PLAN

F1. BACKGROUND

The study brief prepared by Shoalhaven City Council required a detailed review of its various Planning related documents as they pertained to flooding issues and/or floodplain management. This review was undertaken by Nexus Planning during the early stages of the project and a summary of the findings is provided within this Appendix.

It should be noted that as an outcome from this review a number of problems or issues were identified and Council have subsequently initiated a number of steps and actions to address the situation. Consequently, much of the following discussion should only be seen as the initial input to an ongoing iterative process and therefore may already be outdated or superseded.

F2. INTRODUCTION

The NSW State Government's Flood Policy ("the 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 and does not create additional flooding problems in other areas.

Under the Policy, the management of flood prone land remains the responsibility of local government. The Policy provides for technical and financial support by the State Government through the following four sequential stages:

Flood Study

- determines the nature and extent of the flood problem.

Floodplain Risk Management Study

- evaluates management options for the floodplain in respect of both existing and proposed development. Considers social, ecological and economic factors relating to flood risk.

Floodplain Risk Management Plan

- involves determining the floodplain management measures that are preferred by Council and the community. This then forms a plan of management for the floodplain, which is formally adopted by Council.

Implementation of the Plan

- construction of flood mitigation works to protect existing development,
- use of Local Environmental Plans and/or Development Control Plans to ensure new development is compatible with the flood hazard.

The Lower Shoalhaven River and St Georges Basin Floodplain Risk Management Studies and Plans constitute the second and third stages of the management process. Although the catchments of the Lower Shoalhaven River and St Georges Basin are distinctly different, for the purpose of discussing planning issues which relate to flooding, both catchments are collectively termed the "Study Area".

The NSW Government Floodplain Management Manual states that:

> *"Management options investigated in a floodplain risk management study may include modification measures for property, the flood, and community response ... These measures are aimed at*
>
> - *modifying development of flood prone properties (property modification measures); or*
> - *achieving more effective community response to the onset and aftermath of floods (response modifications measures). This response is to consider the need for excavation and expected operational limitations; or*
> - *modifying flood behaviour (flood modification measures).*
>
> *.... Options considered should include land use and development controls."*

As part of the preparation of a Floodplain Risk Management Plan, there is a requirement that the existing planning controls which relate to the catchment be reviewed, and suggestions made regarding the means by which those controls could be amended and/or supplemented with regard to land potentially impacted by floodwaters.

This Discussion Paper provides information from the NSW Government Floodplain Management Manual as it applies to the development of planning controls for flood affected land, summarises the land use controls which currently apply to land affected by floodwaters within the Study Area, and provides a series of options for the consideration of Shoalhaven City Council for amendment of the existing controls.

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F2. NEW SOUTH WALES GOVERNMENT FLOODPLAIN MANAGEMENT MANUAL

As stated in the Floodplain Management Manual ("the Manual"):

> *"The primary objective of the* [NSW Government flood prone land] *policy is to reduce the impact of flooding and flood liability on individual owners and occupiers of flood prone property, and to reduce private and public losses resulting from floods, utilising ecologically positive methods wherever possible."*

The Manual contains a number of definitions which are relevant to any discussion of the planning measures which could be adopted to assist in the management of development in the floodplain. These definitions include:

flood	relatively high stream flow which overtops the natural or artificial banks in any part of a stream, river, estuary, lake or dam, and/or overland runoff before entering a watercourse and/or coastal inundation resulting from super elevated sea levels and/or waves overtopping coastline defences.
floodplain	area of land which is subject to inundation by floods up to the probable maximum flood event, i.e. flood prone land.
flood planning levels	are the combination of flood levels and freeboards selected for planning purposes, as determined in floodplain risk management studies and incorporated in floodplain risk management plans. The concept of flood planning levels supersedes the "standard flood event" of the first edition of this Manual.
flood planning area	the area of land below the flood planning level and thus subject to flood related development controls. The concept of flood planning area supersedes the "flood liable land" concept of the 1986 Floodplain Development Manual.
flood prone land	is land susceptible to flooding by the probable maximum flood ("PMF") event. Flood prone land is synonymous with flood liable land.

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F3. EXISTING LAND USE PLANNING CONTROLS

F3.1 City of Shoalhaven Local Environmental Plan, 1985

Land use within the Study Area is generally regulated by the City of Shoalhaven Local Environmental Plan, 1985 ("LEP, 1985").

LEP, 1985 was gazetted on 17 May, 1985 and it is an aims and objectives based planning instrument. With regard to the aims of the plan relating to natural hazards such as flooding, LEP, 1985, at its sub-clause (2) (1) (e), states:

> *"2. (1) The Aims of this plan are:*
>
> *.....*
>
> *(e) to ensure that the council gives due regard to the effect of natural hazards upon development;"*

LEP, 1985 contains general reference to the management of development on flood affected land, however, it does provide some specific controls relating to the control of development on land which is subject to flooding.

Sub-clause 6 (1) of LEP, 1985 provides a series of definitions of terms contained within the LEP. There are no definitions contained within sub-clause 6 (1) specifically relating to flooding.

Zone Objectives

The maps which accompany LEP, 1985 indicate that a number of zones apply to the control of land use within the City of Shoalhaven. Two of the zones relate directly to land which is flood affected, those being:

- Zone No. 1 (g) (Rural "G" (Flood Liable) Zone), and
- Zone No. 9 (a) (Natural Hazards "A" (Urban Flooding) Zone).

Sub-clause 9 (3) of LEP, 1985 states that:

> *"(3) In determining a development application, the Council must take into account the aims and objectives of this plan and the objectives of the zone within which the development is proposed."*

With regard to flooding, the following zone objectives apply:

Zone No. 1 (c) (Rural "C" (Rural Lifestyle) Zone) has as its objective (b):

> *"(b) to meet the reasonable lifestyle needs of residents and provide adequate public safety in relation to bushfire, flooding, landslip and traffic while promoting and sustaining a high level of environmental quality in the zone."*

Zone 1 (g) (Rural "G" (Flood Liable) Zone) has the following objectives:

> *"(a) to limit the erection of structures on land subject to periodic inundation;*
>
> *(b) to ensure that dwelling-houses are erected on land subject to periodic inundation only in conjunction with agricultural use;*
>
> *(c) to ensure that the effect of innundation is not increased through development;*
>
> *(d) ....;*
>
> *(e) ...."*

Zone 2(a4) (Residential "A4" (Restricted Development) Zone) has as its objective:

> *"The objectives are to identify locations in existing urban areas with development problems where special consideration will be required before development can be approved."*

Zone 3(h) (Business "H" (Restricted Development) Zone) has as its objective:

> *"The objectives are to identify locations in existing business areas with development problems where special consideration will be required before development can be approved."*

Zone 4(e) (Industrial "E" (Restricted Development) Zone) has as its objective:

> *"The objectives are to identify locations in existing industrial areas with development problems where special consideration will be required before development can be approved."*

Clause 30 of LEP, 1985 (discussed below) relates to land within the 2(a4), 3(h) and 4(e) zones and refers specifically to land which is likely to be flood affected.

Certain land uses which are permissible with consent in the 1(g) and 2(a4) zones are inconsistent with the stated objectives of the zone, these include bed and breakfast accommodation and community facilities in the 1(g) zone and bed and breakfast accommodation in the 2(a4) zone. As stated in the Manual:

> *"One of the most critical aspects of a floodplain risk management plan is the selection of appropriate land uses in flood prone areas. A balance needs to be struck. On one hand flood prone land should not be unnecessarily sterilised, but on the other, proposed land uses need to be appropriate to the hazards and hydraulics of flood behaviour."*

The Manual describes several factors which determine flood hazard, including evacuation problems. In this regard, the Manual states:

> *"The level of damage and disruption caused by a flood are influenced by the difficulty of evacuating flood affected people and property. Evacuation may be difficult because of:*
>
> - *the number of people requiring assistance;*
> - *the depth and velocity of floodwaters;*
> - *mobility of people;*
> - *the distance to flood free ground;*
> - *the inability to contact emergency services;*
> - *bottlenecks, i.e. large numbers of people and great volumes of goods that have to be moved over roads which cannot cope with the increased volume;*
> - *the time of day and weather conditions; and*
> - *the lack of suitable evacuation equipment such as boats, heavy trucks etc.*
>
> *Consideration of the impact on evacuation strategies of increased occupation of the floodplain is one of the key tests of cumulative impact in preparing floodplain risk management plans."*
>
> *"Generally in lowering the density of development the evacuation assistance required is also reduced due to the lower number of people at risk. However, in the instance of rural residential developments proposed a reasonable distance inside the floodplain, the location generates spacial evacuation needs due to the length and uncertainty of the evacuation route."*

The use of flood affected land for bed and breakfast accommodation is potentially in conflict with the above stated aims of floodplain risk management. Careful consideration must be given by the Council as to the appropriateness of such development on such land where the effect of innundation may be increased through development of such land uses in the floodplain.

With regard to community uses, these can often include hospitals, schools, police stations, Council buildings, churches, telephone exchanges, electricity sub-stations water and sewerage works, fire stations and the like. It is generally considered that any development or redevelopment of land for Community/Special Use purposes should be undertaken on land that is flood free, however, the management of the floodplain must allow for minor development and minor additions to existing development as the need arises. It is recommended, however, that no new lands be set aside for Community/Special Use purposes within the floodplain. The permissibility of Community Uses in the 1(g) zoned land is considered to be inconsistent with this generally held floodplain risk management principle.

Zone No. 9 (a) (Natural Hazards "A" (Urban Flooding) Zone) has as its objective:

> *"The objectives are to identify land within a floodway in urban areas and because of the potential hazard to restrict the use thereof."*

Flood Mapping

It is noted that *"the flood line"* is indicated on the maps which accompany LEP, 1985 and that it generally corresponds with the boundary of the 1(g) zone. The notation on the maps states:

> *"FLOOD LINE AND FLOOD ZONE NOTES*
>
> - *The areas indicated as flooding on this map have been delineated using the most reliable information available to council at the time. This information should be checked by survey.*
>
> - *The areas delineated as flood zones should not be taken as the only areas that flood. The flood zones generally approximate the 1:100 year flood from the best information available at the time of zoning. You are advised to check with council."*

Flood Related Clauses

Clause 12 of LEP, 1985 relates to subdivision in zone No. 1(c). Sub-clause 12 (2) states that:

> *"(2) For the purposes of this clause "environmentally constrained area" includes:*
>
> *(a) ....;*
>
> *(b) ....;*
>
> *(c) flood liable land;*
>
> *(d) ....;*
>
> *(e) ....;"*

Sub-clause 12 (3) provides the matters which the Council must consider when determining an application to subdivide land to which the clause applies. There is no direct reference in sub-clause 12 (3) to the issue of flooding.

Clause 14 of LEP, 1985 provides details of the requirements of the Council for the development of a dwelling house in the 1(a), 1(b), 1(d) and 1(g) zones. Sub-clauses 14 (3), 14 (4) and 14 (5) relate to development of a dwelling house on land within the 1(g) zone as follows:

> *"(3) Subject to subclause (4), the Council may consent to the erection of a dwelling-house in Zone No. 1(g) if the allotment:*
>
> *(a) has an area of not less than 40 hectares;*
>
> *(b) is a 1964 holding;*
>
> *(c) is a concessional allotment described in paragraph (a) of the definition of "concessional allotment" in clause 6(1); or*
>
> *(d) comprises an allotment created under clause 11(1) of Interim Development Order No.1 - Shire of Shoalhaven before 20 September 1974.*

(4) Subject to clause 29, the Council must not grant consent in accordance with this clause to the erection of a dwelling-house on any parcel of land within Zone No. 1(g) unless:

(a) the parcel is predominantly prime crop and pasture land; and

(b) the Council is satisfied that the dwelling-house is essential for the proper and efficient use of the land for agriculture or turf farming.

(5) Notwithstanding subclauses (3) and (4), the Council may consent to the erection of a dwelling-house on land within Zone No. 1(g) that is a concessional allotment described in paragraph (b), (c) or (d) of the definition of "concessional allotment" in clause 6(1) or is the residue of land remaining after the creation of allotments referred to in clause 11(4), or the residue created under clause 11(5), as in force immediately before the commencement of City of Shoalhaven Local Environmental Plan 1985 (Amendment No.127), subject to the assessment specified in clause 29(3) and may impose conditions of the same kind as specified in clause 29(4)."

Clause 29 of LEP, 1985 provides for the objectives for development on flood liable land as follows:

"Development of flood liable land

29. (1) Subject to subclause (2), the Council must not consent to the carrying out of development on land which, in its opinion, is flood liable.

(2) the Council may consent to the carrying out of development on flood liable land if:

(a) the development is for a purpose ancillary or incidental to the use of the land for the purpose of agriculture; or

(b) the development comprises the extension or alteration of an existing dwelling-house; or

(c) the land is in any urban zone under this plan; or

(d) the Council has received a flood assessment report, in relation to the land, that addresses each of the matters referred to in subclause (3), and the Council is of the opinion that the development is feasible despite the land being flood liable.

(3) In considering an application to which subclause (2) applies, the Council must make an assessment of:

(a) the likely levels, velocity, sedimentation and debris carrying effects of flooding;

(b) the structural sufficiency of any building the subject of the application and its ability to withstand flooding;

(c) the effect which the development, if carried out, will or is likely to have on the flow characteristics of floodwaters;

(d) whether or not access to the site will be possible during a flood; and

(e) the likely demand for assistance from emergency services during a flood.

(4) In granting consent to a development application made pursuant to subclause (2), the Council may impose conditions that set floor levels, require filling, structural changes or additions or require other measures to mitigate the effects of flooding or assist in emergency situations."

Although clause 29 relates to "flood liable land", as indicated in the above discussion of clause 6 of LEP, 1985, there is no definition of Flood Liable Land in LEP, 1985. If the reader of LEP, 1985 is to understand the nature of the controls Council has placed on development in the floodplain, the term "Flood Liable Land", or its current equivalent term must be defined in the LEP. This aspect is discussed further in Section 4 of this Discussion Paper.

Clause 30 of LEP, 1985 relates to structures in the 2(a4), 3(h) and 4(e) zones as follows:

> *"Structures in Zones Nos. 2(a4), 3(h) and 4(e)*
>
> *30. In respect of an application for consent to erect a structure on land within Zone No.2(a4), 3(h) or 4(e), the Council must make an assessment of:*
>
> *(a) the likelihood of floodwaters entering the structure;*
>
> *(b) the effect of soil instability; and*
>
> *(c) the likelihood of damage due to coastal erosion,*
>
> *and may attach to any consent conditions which, in the opinion of the Council, will prevent or reduce the incidence of flooding or instability."*

Sub-clauses 40 H (2) & (3) relate specifically to the expansion of the Bomaderry urban area as follows:

> *"Special requirements in respect of expansion of Bomaderry urban area*
>
> *40 H (1) .....*
>
> *(2) The Council shall not consent to a subdivision of land to which this clause applies unless the Council has taken into consideration whether adequate flood free access will be provided from that land to the adjoining urban area.*
>
> *(3) In this clause "flood free access" means access by use of land that is above the 1 in 100 year flood level."*

F3.2 Development Control Plans

Shoalhaven City Council has prepared a number of Development Control Plans ("DCPs") to complement its LEP, 1985. The DCPs which are relevant to the Study Area are:

- Development Control Plan No.63 - Tourist Development in Rural Areas.
- Development Control Plan No.71 - Medium Density Housing.
- Development Control Plan No.98 - Exempt & Complying Development.

- Development Control Plan No.57 - Dual Occupancy Guidelines.

- Development Control Plan No.43 - East Nowra.

Development Control Plan No.63 - Tourist Development in Rural Areas.

The introduction to this DCP states that:

> *"Tourism is one of the main industries within the Shoalhaven City area. It provides significant input into the local economy and provides local employment opportunities.*
>
> *It is therefore important to preserve and enhance the many aspects of the area to ensure that this important industry is not adversely affected."*

With regard to flooding, the DCP states that:

> *"The house may be damaged in times of flood and the septic tank will be swamped.*
>
> *Effluent contaminates ground water and passes directly to creeks and streams.*
>
> *Buildings and septic tanks should be located on high, safe ground above flood level."*

Control Element (E) Natural Hazards of the DCP deals with flooding and has as its aim:

> *"To ensure that developments take into consideration local flooding."*

In this regard the "Standard" adopted by the DCP is as follows:

> *"Where developments propose access over creeks and other water courses consideration should be given to the level of crossing that will be proposed. Flood free access is required to be provided, to a minimum 1 in 20 year recurrent level. In some instances Council may require a separate flood assessment to be prepared for any crossings. The extent of this assessment will depend largely on the individual risks associated with each crossing."*

The DCP also requires that the Applicant for development provide information on the implication of flooding for the development and access.

Development Control Plan 71 - Medium Density Housing

The purpose of the DCP is to encourage high quality medium density housing in the Shoalhaven Local Government Area. The only reference to flooding in the DCP is at Section 4.0 Advice, Procedures and Checklists which details the information required by the Council as part of the Development Application as follows:

> *"Flooding*
>
> *Where a site is likely to be affected by flooding, information on the flooding of the site, public road access, the proposed treatment of the site and source of data on flooding"*

Development Control Plan No.89 - Exempt & Complying Development

This DCP has been developed:

- to detail circumstances when Council's approval is not required (exempt development), and
- to detail circumstances when routine developments requiring Council's approval may be dealt with quickly when they meet predetermined standards (complying development).

The DCP, at its Table 3, provides a list of the locations where, if development is proposed, it is not complying development. In this regard, one such area is land that:

> *"is identified as bush fire prone, flood prone or contaminated land, or land subject to subsidence, slip or erosion;"*

Development Control Plan No.57 - Dual Occupancy Guidelines

The purpose of the DCP is to provide dual occupancy development whilst maintaining and enhancing the amenity and environmental character of the area. With regard to flooding, the only reference in the DCP is to land in the vicinity of Riverview Road, Nowra as follows:

> *"2.4.2 Land in the Vicinity of Riverview Road, Nowra*
>
> *The Riverview Road area has been identified as subject to high hazard flooding. Generally, Council does not favour any increase in population density in this area but a limited form of Dual Occupancy Development will be considered for the purpose of accommodating relatives of the owner, subject to the following provisions -*

a) ....

b) Compliance with the construction standards for this area contained in Council's Interim Flood Policy ....

c) ...."

Since the coming into force of sub-clause 2.4.2 of DCP 57, the Council has prepared and exhibited a draft Local Environmental Plan (Amendment No.311 to LEP, 1985) essentially rezoning the land in the vicinity of Riverview Road, Nowra in accordance with the recommendation contained in the Riverview Road Area - Nowra Floodplain Management Plan.

Development Control Plan No.50 - Sussex Inlet Town Centre

This DCP generally applies to the commercial zoned land within the Sussex Inlet Town Centre. There are a number of objectives attached to the DCP of which objective 4 (d) relates to flooding as follows:

"4. (d) Establishing footpath levels which provide total access to buildings and account for flood heights required on new developments."

The only other reference to flood issues within the DCP is at Section 5 (c) which deals with height restrictions as follows:

"(c) Height Restrictions

Height restrictions apply to all development within the Development Control Plan area to ensure that the scale of urban development relates to existing buildings and is in keeping with the scale of the natural surroundings. As the land is relatively flat the height limit is 8 metres above the flood level of 2 metres, however, non habitable architectural elements may be permitted to exceed this restriction."

F3.3 Development Guidelines for Permanent Occupancy of Caravan Parks

The introduction to this document states that:

"These development guidelines have been prepared to support the provisions of State Environmental Planning Policy No.21 - Caravan Parks and to provide development guidelines where permanent occupancy is being considered within caravan parks."

The "Locational Requirements" of the Guidelines have as one performance criteria:

> *"Development is not located in areas which are affected by flooding, bush fire or any other environmental hazard."*

The "Acceptable Solutions" section of this control element states, inter alia:

> *"Where sites are affected by flooding, compliance with Council's interim policy for "Caravan parks on Floodprone Land" is demonstrated."*

Section 3.5 of the Guidelines, when dealing with the information to be submitted with a development application, states:

> *"Floodin*g
>
> *Where the site is subject to flooding, information on the flooding of the site, public road access, proposed treatment of the site and source of data on flooding must be submitted with the application."*

F3.4 Flood Policies

F3.4.1 Interim Flood Policy General Conditions for the Whole of City and Specific Areas

Council has adopted the "Interim Flood Policy General Conditions for the Whole of City and Specific Areas" ("the Policy") which:

> *"... applies to all land within the City of Shoalhaven identified as being within area affected by a standard flood on any river, lake or stream."*

The primary objective of the Policy is:

> *" ... to reduce the impact of flooding and flood liability on individual property owners and occupies, and to reduce private and public losses resulting from flooding."*

The Policy objectives are:

> "• *To bring to the attention of the community Council's Policy in relation to building on flood liable land within the City.*

- *To ensure that buildings and other development in flood liable areas are designed and constructed to withstand the likely stresses of the standard flood or appropriate higher flood where overtopping occurs.*

- *To limit development which may reduce the ability of the floodplain and, in particular, the floodway, to carry water and subsequently add to the height of floods.*

- *To reduce flood losses by restricting and controlling development in order that it is less susceptible to flood damage and minimises risks to residents and those involved in rescue operations during floods.*

- *To minimise the financial burden to owners of flood liable land and to the general public."*

Section 8 of the Policy states that:

"The standard flood shall be nominally 1:100 year for the interim period, based on the following considerations:

- *In most areas, it is not practicable to define any other flood return period, such as 1:50 etc.*

- *Council's previous Development application assessments were based on the nominal 1:100 year flood standard.*

- *This is in agreement with the advice of the Executive of Flood Mitigation Authorities of NSW.*

- *This is a widely accepted standard in Australia and overseas.*

- *The Courts have recognised 1 in 100 years as the current community standard.*

- *1 in 100 years is the standard adopted by lending authorities."*

The Policy contains numerous controls on development on land to which the Policy applies, for example:

"For residential development, the freeboard to the floor level of habitable rooms shall be 0.5 metres in floodways and 0.3 metres in flood storage and flood fringe areas. For commercial and industrial development in newly created lots, the freeboard shall, likewise, be 0.5 metres in floodways and adjacent to major streams, and 0.3 metres in flood storage and flood fringe areas.

In existing subdivided areas, other local rules may apply – see specific areas eg Sussex Inlet commercial area (flood storage) a 0.0 metres freeboard is adopted."

"The floor level of habitable rooms must be no lower than the Minimum Floor Level. For proposed dwelling extensions where it is impractical to raise the floor level, applications for extensions of the building at the existing level will be treated on their individual merits up to a maximum cumulative total increase in habitable floor area of:

- *50 m^2 for residential and rural residential dwellings.*
- *100 m^2 for dwellings associated with bona fide large area rural enterprises such as dairying.*

Materials used in construction below Minimum Floor Level are to be compatible with immersion as stated in Appendix F of the NSW Floodplain Development Manual. It is recommended that the construction methods and materials of the "suitable" class be utilised and that those in the "marked effects" and "severe effects" be not utilised."

F3.4.2 Flood Policy Interim - Caravan Parks on Flood Prone Land

Council has adopted the "Flood Policy Interim - Caravan Parks on Flood Prone Land" ("the Caravan Policy") which states:

"For a Council to obtain indemnity under the New South Wales Flood Policy, it is obliged to follow the steps set out in the diagram below. In the interval, until all of the required final steps have been carried out and a Floodplain Management Plan prepared for each area, an interim local policy is required and this has been determined by the Floodplain Management Committee. This Caravan Parks Code forms part of this interim local policy.

The Floodplain Development Manual divides flood situations into three hydraulic categories, for each of which there are two hazard categories, as shown. For the purposes of Caravan Parks in this document, fringe areas and storage areas have been combined as one.

As part of the overall interim flood policy, Council's City Services Division has determined standard flood levels (nominally 1%) for all localities within the City. Some Parks within, or immediately adjacent to the Shoalhaven River banks, are in high hazard flood storage or flood fringe areas. In these latter areas, where there are new parks or park extensions, Council requires the van sites to be filled, such that the floor of the caravan is at the standard flood level.

This policy has also been prepared to comply with the Local Government Department Technical Bulleting No. 6."

Specific controls are contained within the Caravan Policy, for example:

"Freeboard

Where Unregistered Moveable Dwellings (UMD's) are permitted, the floor level shall have 0.3 metres freeboard above the standard flood level.

Tie Downs

Where high hazard conditions occur, and vans could either float or be swept away, each van and rigid annexe shall be equipped with quick release tie down of a suitable design.

All vans in high hazard areas shall be tied down in case removal becomes impractical.

Rapid Knock Down

All annexes in high hazard floodway situations must be of rapid knock down, flexible design.

In low hazard, flood storage or flood fringe areas (ie low velocity), annexes may be inundatable as an alternative to rapid knock down."

F3.5 Section 149 Planning Certificates

Council currently has a number of notations which it places on s.149 Planning Certificates which alert the purchaser of that certificate that the land the subject of the certificate is affected by flooding. The wording attached to such a s.149 Planning Certificate is dependant upon the zone within which it is located, whether the land is shown on the LEP, 1985 Map as being within the "Flood Line", and the flood controls which apply to the land.

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F4. PLANNING OPTIONS

F4.1 Amendments to City of Shoalhaven Local Environmental Plan, 1985

Whilst it is recognised that LEP, 1985, in its amended format, is a modern planning instrument, as part of the implementation of both the Lower Shoalhaven River and St Georges Basin Floodplain Management Plans and Studies, it is recommended that LEP, 1985 be amended to incorporate generic provisions to better reflect the need for the control of development of flood affected lands within the City of Shoalhaven as a whole. Those provisions would thus relate to both the Study Area and to any other flood affected areas within the City of Shoalhaven and provide a consistent approach to the management of flood affected land.

Definitions

LEP, 1985 contains a number of definitions. Any Floodplain Risk Management Plan ("FRMP") adopted by Council for each of the study areas will rely on precise definitions of terms which relate to floodplain risk management. Indeed, Council is likely to prepare FRMPs for other catchments in the Local Government Area, and as such it is suggested that definitions be contained within the LEP such that all planning documents (DCPs and/or FRMPs) are based on up to date and consistent floodplain risk management definitions within LEP, 1985.

The adoption of a standard set of definitions which relate to the control of the floodplain will ensure that Council is consistent in its preparation of DCPs and FRMPs for both the Study Area and other flood affected areas. It is recommended that the following definitions, which are consistent with the NSW Floodplain Management Manual, be considered for inclusion in LEP, 1985:

Floodplain	means the area of land which is subject to inundation by floods up to and including the probable maximum flood event, that is, flood prone land.
Flood planning level	means the combination of flood level and freeboard selected for planning purposes, as determined in floodplain risk management studies and incorporated in floodplain risk management plans.
Flood planning area	means the area of land below the flood planning level and thus subject to flood related development controls.
Flood prone land	means the land susceptible to flooding by the probable maximum flood event (that is, land within the floodplain) as indicated on the map marked "Flood Prone Land" deposited in the office of the Council as amended from time to time.

The incorporation of the above definitions into LEP, 1985 will allow consistency in the interpretation of any planning controls which relate to a parcel of land and allow the LEP to accord with the thinking of the NSW government for control of development on land affected by flood waters. All subsequent planning documents, be they DCPs or FRMPs, will be required to be drafted having regard to the above definitions and thus avoid confusion which has often occurred in the past where planning documents have contained conflicting definitions.

The adoption of the above definitions will recognise that flood prone land is not restricted to land affected by the 1 in 100 year or 1% AEP flood event, but the entire floodplain. These definitions also recognise that, unlike Flood Studies and Floodplain Risk Management Plans, planning controls do not necessarily need to relate to the entire floodplain. Rather, they should relate to that part of the floodplain contained within a selected Flood Planning Level i.e. the Flood Planning Area.

It will also be necessary for Council to amend existing DCPs to reflect the above definitions such that those documents accord with the parent LEP. As indicated in the above Section 3 of this Discussion Paper, the existing DCPs and Policies are not consistent in their definitions nor are they predicated on current floodplain risk management practices.

Restrictions on certain development

The existing clauses within LEP, 1985 contain terminology which is inconsistent with the current floodplain risk management terminology. Indeed, if the above recommended definitions are inserted into LEP, 1985, amendments will also be required to the existing clauses to maintain consistency within the LEP. As noted in Section 3 of this report, clauses 12, 14, 29 & 30 of LEP, 1985 are the relevant clauses.

In the case of clause 12 of LEP, 1985, reference is made to "flood liable land" which is not defined in the LEP. Flood liable land is, however, defined in the Council Interim Flood Policy as:

> *"Flood Liable Land - Land which will be inundated by the standard flood."*

The Standard Flood is defined in the Interim Flood Policy as:

> *"The Standard Flood - The flood selected for planning purposes - based on an understanding of flood behaviour and associated flood risk."*

The Policy continues that:

> *"The standard flood shall be nominally 1:100 year for the interim period, ..."*

The terms “Flood Liable Land” and “Standard Flood” no longer exist in modern floodplain risk management parlance and have been replaced by the terms “Flood Planning Area” and “Flood Planning Level” respectively as defined above. It is recommended that sub-clause 12 (2) be amended to reflect the above definitions.

With regard to sub-clause 12 (3), as noted in Section 3 of this Discussion Paper, there is no direct reference to flooding in the matters for consideration of Council when it determines a development application for subdivision in the 1(c) zone. In order to reflect the need to address floodplain risk management techniques in the determination of development applications on land which is flood affected, it is recommended that a further sub-clause be inserted into clause 12 of LEP, 1985 to ensure that flooding of land is considered by the Council. In this regard, because the Council has embarked on a program of preparation of Floodplain Risk Management Plans, it is suggested that reference to those FRMPs be inserted into the clause as follows:

> *“12. (3) In determining an application to subdivide land to which this clause applies, the Council must ensure that:*
>
> *(a) ....*
>
> *(b) ....*
>
> *(c) ....*
>
> *(d) it has taken into account the potential for flooding of the land and any Floodplain Risk Management Plan or development control plan adopted by the Council applying to the land.”*

Subject to amendments made to Clause 29 as discussed below, clause 14 of LEP, 1985 will also require amendment to ensure continuity of assessment of development applications for dwelling houses in the 1(g) zone.

Clause 29 of LEP, 1985 provides a number of matters for consideration by the Council when assessing a development application on land which is “Flood Liable”. From reading clause 29, it is unclear as to what the term “flood liable land” refers as it is not defined in the LEP. Again, this clause requires amendment to ensure that the term “Flood Liable” is replaced by the recommended terminology i.e. “Flood Prone Land” and “Flood Planning Area”. As indicated above, the term Flood Prone Land refers to all land which is likely to be inundated up to and including the Probable Maximum Flood while the Flood Planning Area is the land which falls within the Flood Planning Level and is thus land which is subject to planning controls. As such, sub-clause 29 (1) should be amended to reflect the fact that the Council only wishes to receive development applications over land which is the subject of development controls, i.e. the land within the Flood Planning Area. The amended clause could read:

"Development of flood prone land

29. (1) Subject to subclause (2), the Council must not consent to the carrying out of development on land which, in its opinion, is within the flood planning area."

Existing sub-clauses 29 (2), (3) & (4) provide the matters which the Council will consider when assessing an application on "flood liable land". If the above recommendation is adopted these sub-clauses will need to be altered to reflect correct floodplain risk management terminology i.e. remove the use of the term "flood liable" as this refers to land inundated up to and including the Probable Maximum Flood.

An alternative to the above recommended amendment to clause 29 would be to replace the entire clause with one which better reflects modern floodplain risk management practices. The following special provisions are recommended for the consideration of Council:

"Development within the flood planning area

(1) A person shall not carry out development for any purpose on land that is in the Flood Planning Area except with the consent of the council.

(2) Before granting consent to development in the Flood Planning Area, the council must consider the following:

(a) the extent and nature of the flooding or inundation hazard affecting the land, and

(b) whether or not the proposed development would increase the risk of flooding or inundation affecting other land, buildings, works or land uses in the vicinity, and

(c) whether the risk of flooding or inundation affecting the proposed development could be reasonably mitigated, and

(d) the social impact of flooding, including the ability of emergency services to access, evacuate, rescue and support residents of flood prone areas, and

(e) the characteristics of floodwaters as provided by any Floodplain Risk Management Plan applying to the land, and the requirements of that Floodplain Risk Management Plan.

(3) The council shall not grant consent to the carrying out of any development or works for any purpose on land within the Flood Planning Area unless it is satisfied that:

(a) the development or work would not unduly restrict the flow characteristics of flood waters, and

(b) the development or work would not unduly increase the level of flow of floodwaters on land in the vicinity, and

(c) the development or work would not exacerbate the adverse consequences of floodwaters flowing on the land with regard to erosion, siltation and destruction of vegetation, and

(d) all habitable floor levels shall be above the FPL, and

(e) the structural characteristics of any building or work, the subject of the application, are capable of withstanding flooding in accordance with the requirements of the Council, and

(f) any proposed building is adequately flood proofed, and

(g) the development would not imperil the safety of persons on land inundated by floodwaters, and

(h) flood evacuation access to the development or work is available at the appropriate Flood Planning Level, and

(i) the development would not increase dependency on emergency services.

(4) The council may grant consent to facilities which, in its opinion, are considered to be essential in times of major flooding only in locations where it can be shown that they will be fully operational during a Probable Maximum Flood."

The above clauses allow flexibility in land use planning in that they relate to Flood Prone Land i.e. the entire floodplain, while applying development controls only to that land which has been identified as falling within the Flood Planning Area. This approach will also allow the Council flexibility in the adoption of flood planning levels should the circumstances of a particular floodplain demand that a level other than the 1 in 100 year event should apply.

It is recognised, however, that the adoption of the above recommendations will result in controls contained within the LEP being tied to Flood Planning Levels which, by definition, have been established during the preparation of floodplain risk management studies and incorporated into floodplain risk management plans. The question remains as to how development on those flood affected areas which have not been the subject of floodplain risk management studies/plans can be controlled through the planning process. In this regard, it is recommended that the Council considers an alternative definition of "Flood planning level" as follows:

Flood planning level means the combination of flood levels and freeboards selected for planning purposes, as determined in floodplain risk management studies and incorporated in floodplain risk management plans or where no floodplain risk management studies or plans have been prepared, the flood level determined by the Council for that area.

The above alternative definition will allow the Council to adopt modern planning definitions to control development on the floodplain while at the same time allowing existing flood policies/restrictions to remain in place for areas where Floodplain Risk Management Studies and Floodplain Risk Management Plans have not been prepared.

In order for the above regime to be effective, however, the Council will need to revise existing policies to ensure that they are consistent with the above recommended changes to LEP, 1985 and indeed are consistent with modern floodplain risk management practices.

As noted above, Council has prepared mapping which delineates the flood line, which is generally the 1 in 100 year flood level. At present, the flood line is shown on the Map; i.e. the LEP, 1985 Map.

As Council will appreciate, the map attached to the LEP forms part of the legislation of NSW and any amendment to that map requires an amendment to the legislation. To effect such a change, an amending LEP must be prepared, exhibited and then made by the Minister for Urban Affairs and Planning.

It is apparent that land which is flood affected, and hence flood prone land, is dynamic, and changes to the delineation of that land will occur as flood experience and refinement of flood models are attained. Because of the dynamics involved in flood prediction, it is recommended that Council adopt a similarly dynamic means of noting flood prone land and/or the flood planning area in graphic format.

It is recommended, rather than have the flood mapping tied to the LEP map, that there be a separate series of maps held by Council which delineate land which has been determined as flood prone and/or within the flood planning area. Such an approach will accord with the above recommended definition of Flood Prone Land, while at the same time allowing Council to amend its flood mapping without the need for a formal amendment to the LEP.

Such an approach has been adopted by other Councils in recent time, notably Port Stephens Council in its Local Environmental Plan, 2000 which contains the following definition of Flood Prone Land:

> *"flood prone land means land indicated on the map marked "Flood Prone Land" as amended from time to time."*

Similarly, Hastings Local Environmental Plan, 2001, at its clause 25 which relates to flood liable land, states

> *"For the purposes of this clause, flood liable land is:*
>
> *(a) land likely to be inundated in the 1 in 100 year flood, as identified on mapping held in the office of the Council, or ..."*

Although neither the Hastings LEP, 2001 nor the Port Stephens LEP, 2000 have been drafted having regard to the current terminology relating to floodplain risk management, they have adopted the approach of not having the dynamic flood mapping tied to the mapping of the LEP.

F4.2 Floodplain Management Plan

The Floodplain Risk Management Plans ("FRMPs") being prepared by Council will provide a set of specific development and flood protection guidelines which will assist in the control of development on Flood Prone Land and in particular the land within the Flood Planning Area. The planning controls which apply to the land within the Flood Planning Area should not only be specifically related to the particular area but should also be in accordance with the guidelines contained in the draft Floodplain Management Manual.

As stated in the Manual:

> *"One of the most critical aspects of a floodplain risk management plan is the selection of appropriate land uses in flood prone areas. A balance needs to be struck. On one hand flood prone land should not be unnecessarily sterilised, but on the other, proposed land uses need to be appropriate to the hazards and hydraulics of flood behaviour."*

There is currently a mix of land uses located within the Study Area. There is potential for development and redevelopment, particularly in the residential areas. It is generally considered that any development or redevelopment of land for Special Use purposes including hospitals, schools, police stations, Council buildings, churches, telephone exchanges, electricity sub-stations water and sewerage works, fire stations and the like should be undertaken on land that is flood free, however, the management of the floodplain must allow for minor development and minor additions to existing development as the need arises. It is recommended, however, that no new lands be set aside for Special Use purposes within the floodplain of the Study Area.

This approach is reflected in the above recommended amendment to clause 29 of LEP, 1985.

One option for the control of redevelopment in the Flood Planning Area is to rezone those lands such that redevelopment is restricted to low risk land uses. Such an approach would necessitate the removal of some existing zones from that area. The NSW Flood Prone Land Policy does not support the use of zoning to unjustifiably restrict development simply because the land is flood prone. As such, the option of generic rezoning of land is considered inappropriate and is not considered further. This is not to say that spot rezoning should not be employed as a means of implementing floodplain management techniques.

With regard to the land identified as being within zone 1(g) Flood Liable, if the Council adopts the recommended definitions, it will also have to amend the title of this zone. The term Flood Liable Land has always been synonymous with Flood Prone Land, however, the current definition of Flood Prone Land incorporates all land with the potential to be inundated up to and including the Probable Maximum Flood. As such, the "Flood Liable" zone will be inappropriately named.

It is also recommended that the Council give consideration to the total removal of the 1(g) zone as it relies on generally inaccurate flood data for the establishment of its boundaries and relates only to the 1 in 100 year flood event. In addition, as per the above discussion of attachment of flood mapping to the LEP, the boundaries of the 1(g) zone are tied to flood data held by the Council. If, as the Council pursues the undertaking of floodplain risk management studies/plans, it is determined that the 1 in 100 year event is not appropriate or indeed that the *"flood line"* is inaccurate, then an amendment to LEP, 1985 will be required to reflect the findings of that updated data such that the Council is seen to be providing correct flooding advice to the general public.

The recommended changes to clause 29, together with floodplain risk management plans prepared by the Council, should ensure that any development proposed on land that is currently within the 1(g) zone would be suitably assessed in the development application stage such that inappropriate development is excluded from those flood affected lands.

If, however, the Council is of the opinion that the 1(g) zone should remain, it is recommended that a comprehensive strategic planning exercise be undertaken to determine more accurately the land which is flood affected and indeed the land which falls within the Flood Planning Area. It is that land which, following the implementation of changes to LEP, 1985 definitions, will be the subject of development control and indeed to which clause 29 will apply. As such, the delineation of the Flood Planning Area will delineate the boundaries of the renamed 1(g) zone.

A strategic planning exercise such as this will require a considerable amount of time to complete and should not stall the updating of the remaining sections of LEP, 1985. As noted in the suggested definition of Flood Planning Level, which determines the Flood Planning Area, the Flood Planning Level can be determined either through the floodplain risk management study/plan process or by the Council where no such plans have been completed. As such, the renamed 1(g) zone could include a combination of Flood Planning Areas determined by floodplain risk management studies/plans or the 1 in 100 year flood level for areas not subject to floodplain risk management plans.

If the 1(g) zone is to remain, it is recommended that the change to its name be made as part of any initial amendment to LEP, 1985 with the results of the strategic planning exercise (changes to mapping boundaries) implemented in a subsequent amending LEP.

The FRMPs will contain a series of guidelines for the redevelopment of the Study Area. The FRMPs will also account for the requirements of some landowners for both major and minor additions to existing development within the Study Area.

Control guidelines which should be contained in the FRMP will differ according to the level of hazard identified in the Floodplain Risk Management Study which precedes the FRMP.

Assessment of hazard for both study areas will provide the basis upon which the development of planning controls can be formulated. It is envisaged that the next stage of the floodplain risk management process will provide a series of suggested controls for the consideration of the Council.

F4.3 Section 149 Planning Certificates

Planning Certificates issued under s.149 of the Environmental Planning and Assessment Act, 1979 are a major source of planning related information about the development potential of a parcel of land.

Schedule 4 of the Environmental Planning and Assessment Regulation, 2000 prescribes matters which must be included in a s.149 Planning Certificate. With regard to flood affected land, Items 1 (1) (c) and 7 of the Regulation are relevant, those being:

> *"1 (1) (c) each development control plan applying to the land that has been prepared by the council under section 72 of the Act."*
>
> *"7 Whether or not the land is affected by a policy:*
>
> *(a) adopted by the council, or*

(b) adopted by any other public authority and notified to the council for the express purpose of its adoption by that authority being referred to in planning certificates issued by the council,

that restricts the development of the land because of the likelihood of land slip, bushfire, flooding, tidal inundation, subsidence, acid sulphate soils or any other risk."

Shoalhaven City Council has a series of notations which it places on s.149 Planning Certificates detailing that it has a policy to restrict development of land due to the land being flood affected. With regard to land affected by the FRMPs for the Study Area, it is recommended that the Planning Certificate also include advice that the FRMP applies to that land.

In this regard, it is recommended that:

- Pursuant to the Environmental Planning and Assessment Regulation, 2000, the Council prepare a notation to the effect that it has adopted a policy to restrict development on land due to it being flood affected; that notation being a generic statement of fact which would appear on all s.149 Planning Certificates.

- Where the Council has evidence that the land which is the subject of a particular s.149 Planning Certificate is indeed within the Flood Planning Area, it should provide a further notification on the certificate to that effect. Such a notification should also include advice that a Floodplain Risk Management Plan has also been prepared if appropriate.

- Where the Council has evidence that the land which is the subject of the s.149 Planning Certificate is outside the Flood Planning Area, but is still Flood Prone Land, a separate notation should be provided which indicates that the Council considers the land in question to be above the Flood Planning Level but could be flooded in rarer events than that adopted as the basis for determination of the Flood Planning Level. This notification could also state that for this reason the Council's local floodplain risk management policy does not impose flood related development controls on the land in question.

In addition, Council could elect to adopt FRMPs as DCPs. Such an approach would allow land to which the DCPs apply to be further notified on the planning certificate in addition to the individual notification described above.

F4.4 Flood Policy

As part of the implementation of the FRMPs for the Study Areas, it is recommended that the Council also review the content of its flood policies to ensure that terminology contained within those documents accords with definitions and terminology contained within an amended LEP, 1985 and any adopted DCP for the Study Area and the Local Government Area in general. It is recommended that the Council consider the preparation of a DCP which would contain both the updated Flood Policy provisions and the generic planning controls which would relate to the control of development on flood affected land. Such a DCP would replace the Interim Flood Policy and be notified on s.149 Planning Certificates.

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APPENDIX G: STAKEHOLDER OPTIONS WORKSHOP - SUMMARY OF MEASURES

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FLOOD MODIFICATION MEASURES		
Action	Management Option	Comments
F1	Improve Hydraulic efficiency of Sussex Inlet Channel	Environmental issues high and benefits low, an education program is needed to make residents aware of the data and the facts.
F2	Local Drainage	Maintenance program, needs resources for Stormwater Management Plan, not really a big flooding issue. The areas are very low and flat.
F3	Levees	Not applicable generally but may have some benefit in isolated areas.
F4	Undertake catchment treatment works to control the effects of urban development on water quality and siltation.	Not really a flooding issue. Needs more attention and is a catchment management issue.
PROPERTY MODIFICATION MEASURES		
Action	Management Option	Comments
P1	Voluntary Purchase	Not really viable except for high hazard floodway areas. Not generally supported but may be applicable with outside funding. Seen as a last resort measure.
P2	House raising.	Individual owners decision and at their expense. May be expensive.
P3	Flood proofing - Seal entrances to buildings.	Owner induced. May only be viable for commercial properties.
RESPONSE MODIFICATION MEASURES		
Action	Management Option	Comments
R1	Develop a flood warning system which links rainfall to river conditions.	Establish reference gauges, investigate potential, not much lead time, require improved information from BoM.
R2	Update the SES Flood Plan to incorporate findings of the Floodplain Management Study.	Include floor level survey results, improvements in format required.
R3	Undertake a workshop to update the SES, Police and other authorities.	Process already exists. Access to GIS for SES. Rely on Police and local emergency management committees. Hold public meetings in Sussex Inlet.
R4	Develop a flood evacuation/damage minimisation strategy for caravan parks identified as medium to high hazard.	Yearly licence renewals take place and should include conditions with respect to information and action plans. Need to regulate tie-down and free vans and include other forms of tourist accommodation.
R5	Update the flood awareness and readiness program and implement to educate people about flooding.	Develop a package for residents. Many absent owners. Need to be aware of who is in residence and when.
R6	Formalise a post flood evaluation program to ensure future events are well	Recommended to help improve flood information.

	documented.	
R7	Issue advice or notification to flood liable properties informing them of their particular circumstances	Should happen as a duty of care. There will be legal liability issues and property value changes.
PLANNING AND FUTURE DEVELOPMENT CONTROL MEASURES		
Action	Management Option	Comments
PL1	Review and formalise the current Flood Policy.	Recommended. Review of local flood policies is currently being done.
PL2	Review Section 149 Certificate, the Development Restrictions Certificate and the Flood Prone Land Advisory Letter.	Certificate only valid for day of issue but should be undertaken.
PL3	Council to obtain advice on the Greenhouse Effect and reassess the Flood Policy (if appropriate).	Must consider. Check sensitivity of floodplain to sea level rises.
PL4	Ensure Council''s development controls adequately address the effects of further development in the study area on flood hazard.	refer to PL6
PL5	Council to monitor the extent and location of fill to ensure that local drainage is not adversely affected.	Cumulative effects need to be considered. Depends on nature of flooding in the area.
PL6	Review and update LEP and DCP's in line with current information and FPM Manual	Also consider Coastal Management Manual. Recommend as new information becomes available.

APPENDIX H: UPDATES TO STUDY SINCE COMMENCEMENT

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H1. BACKGROUND

The St Georges Basin Floodplain Risk Management Study and Plan were commenced in 2000 and as part of the process all available information was collected at that time. However, Floodplain Risk Management is a dynamic process which is continually evolving both at a State and Council level.

Since 2000 there has been a number of changes to both State and Council policy which may influence the outcomes of the Study and Plan.

This Appendix documents the major changes that have occurred. The approach of documenting the changes, rather than updating the words in the text to reflect the changes, was undertaken as the latter approach would require a complete reworking of the study and would further delay publication of the final reports.

H2. UPDATED STATE GOVERNMENT POLICY

The NSW Government's policy on floodplain management since 1986 has been documented in the following reports:

- Floodplain Development Manual, December 1986 (Reference 14),
- Floodplain Management Manual, January 2001 (Reference 2),
- Floodplain Development Manual, April 2005 (Reference 15).

The St Georges Basin Floodplain Risk Management Study and Plan was undertaken under the auspices of the January 2001 manual. The April 2005 edition was produced to replace the 1986 manual relating to the management of flood liable land in accordance with Section 733 of the Local Government Act 1993 (the January 2001 edition was never gazetted). This provided Councils and their staff, with indemnity for decisions made and information provided in good faith from the outcome of the management process.

There is no listing of the various changes between the 2001 and the 2005 manuals. The foreword of the 2005 manual states:

> *"In 2003 major changes were made to the composition of agencies with responsibilities for floodplain risk management. In particular the creation of the Department of Infrastructure, Planning and Natural Resources means that one agency now has responsibility for both land use planning and natural resource functions on the floodplain.*

This necessitated changes to the 2001 Manual and provided an opportunity, in light of experience with the 2001 Manual, to further clarify the intent of the policy. In particular, this clarification will reduce the potential for inconsistent interpretation by consent authorities, particularly with respect to the interaction between the determination of flood planning levels and the consideration of rare floods up to the PMF."

H3. SHOALHAVEN CITY LOCAL FLOOD PLAN

The October 1999 version of the above was reviewed as part of this report. Subsequently this report was updated in a February 2004 version. This Plan is due for further review within a 5 year timeframe (2009) or following the next significant flood

H4. COUNCIL'S PLANNING DOCUMENTS

A review was undertaken of the Shoalhaven City 1985 Local Environmental Plan (LEP) and various DCP's. In late 2005 the State Government has advised Councils that a single LEP is now required and must be completed within three years. This program will also affect other planning instruments such as DCPs.

The proposed planning template introduces many new concepts which require further investigation by Council.

H5. FLOOD WARNING SYSTEM - ALERT

Appendix I provides final details of the proposed scheme.

H6. CARAVAN PARKS - GRANT FUNDING

Shoalhaven City Council has accepted a grant and prepared a consultant brief for a caravan park risk assessment study within its local government area. This study should be completed in 2006.

APPENDIX I: ST GEORGES BASIN FLOOD ALERT SYSTEM UPGRADE

Shoalhaven City Council

2004-05 Natural Disaster Mitigation Programme Funding

St Georges Basin Flood Alert Upgrade

Final Report - December 2005

Background:

Flood warning and the implementation of evacuation procedures by the State Emergency Services (SES) are widely used throughout NSW to reduce flood damages and protect lives. A flood warning system is usually based on a series of stations or gauges which automatically record rainfall or river levels at upstream locations and telemeter the information to a central location. The Bureau of Meteorology (BOM) is responsible for storm/rainfall predictions for St Georges Basin but a formal flood warning system for St Georges Basin did not exist prior to this project. Shoalhaven Council has an existing Flood ALERT system including a number of rain and stream gauges which link into a remote data viewing system (Enviromon), which is jointly run by BOM and SCC) via telemetry. As such, the St Georges Basin Floodplain Risk Management Plan recommended the installation of additional gauges to connect into the existing system to benefit the Basin foreshore areas, Sussex Inlet and local SES preparedness. Gauges are generally maintained by SCC.

Selection of Suitable Gauging Sites:

Webb McKeown, the engineering consultant in charge of the preparation of the St Georges Basin Floodplain Risk Management Study and Plan provided a provisional plan showing suggested locations for new rain and stream gauges for the St Georges Basin Area (see Attachment 1). This proposal was discussed with representatives from Council, SES and BOM and it was decided to use the Natural Disaster Mitigation Program funding of $40,000 to install a stream gauge at Tomerong (proposed site 2) and rain gauges at Jerrawangala Valley (proposed site B), at Island Point Road (proposed site C) as well as Glennelly Creek (proposed site D). It was also necessary to upgrade the existing repeater station at Vincentia in order to achieve satisfactory transmission of data to Council's existing Flood ALERT system computer in the Shoalhaven City Administrative Building in Nowra.

While the Webb McKeown map showed an existing stream gauge at Wandandian, this gauge could not be located. However it was seen to be important for the overall system and BOM suggested for SCC to write to the NSW Flood Warning Consultative Committee to request a new gauge to be installed in this location by BOM. A request was consequently sent to the

committee and has been approved. BOM will be installing this gauge in 2006 (see Attachment 2).

System Installation:

All gauging equipment and telemetry systems were installed by Shoalcom, Council's internal service provider for communication systems and with the assistance and advice from BOM. Consultation with land owners was also undertaken by both parties where gauges needed to be installed on private properties. Ongoing maintenance of the system will be the responsibility of Shoalhaven City Council and has been included in the annual maintenance service agreement with Shoalcom as well as the annual budget allocations for the overall flood ALERT system within the Shoalhaven.

Description of new Gauges and Sites:

The following paragraphs provide a description of the new gauges that were installed for the St Georges Basin ALERT system. A map showing all existing and new gauges that comprise the overall ALERT system is shown in Attachment 3.

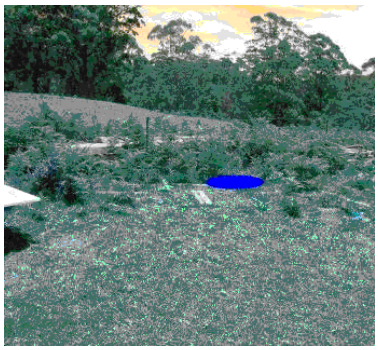
Tomerong Creek – rain and stream gauge
The Tomerong creek site is located on the northern side of the Tomerong Creek Bridge on Hawken Road. There was no existing equipment at this site. A hardwood log was installed into the ground with a galvanised platform and a fibreglass cabinet to house the bubble unit, gas regulator, canister, tipping bucket and solar panel. A galvanised pipe with a plastic gas line inside was run down to the creek. The bridge height was surveyed back to a State Survey Marker and is at AHD levels. The data is transmitted back via the BOM Flood Alert radio network through the Vincentia repeater.

Island Point Rd – Existing Stream and New Rain Gauge

The Island Point Road site is located on the end of a jetty at 41 Island Point Road. This is an existing Manly Hydraulic laboratories (MHL) site with water level data being sent back via GSM phone. The existing cabinet was upgraded to fit the new canister, tipping bucket and solar panel. The druck water level sensor is located in a plastic pipe which is submerged in the lake. The data is transmitted back via the BOM Flood Alert radio network through the Vincentia repeater.

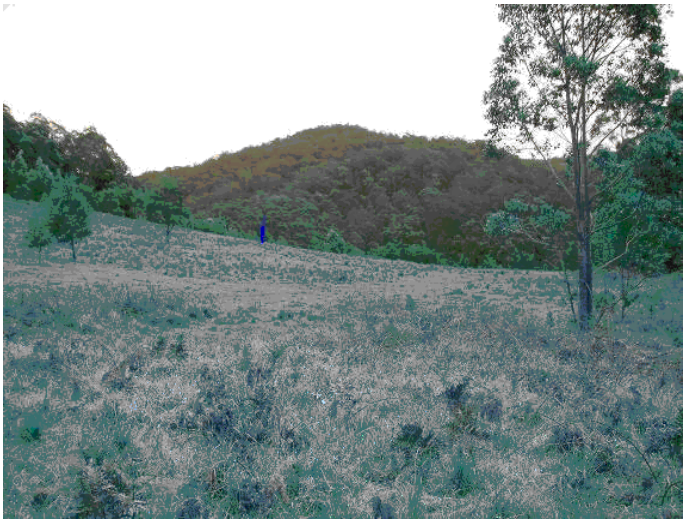
Jerrawangala Valley – Rain Gauge

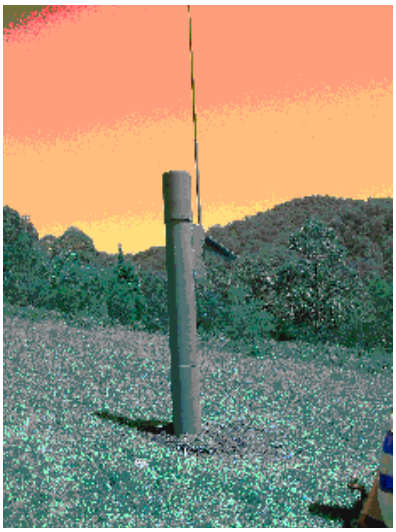
The Jerrawangala Valley site is located 2km west of the Princess Highway on a private property and is a new site. A standard field station was installed which comprises of a canister, tipping bucket, solar panel, collinear antenna, all housed in an aluminium tube. The data is transmitted back via the BOM Flood Alert radio network through the Vincentia repeater. The photos indicate the site of the install and the completed installation.



Glennelly Creek – Rain Gauge

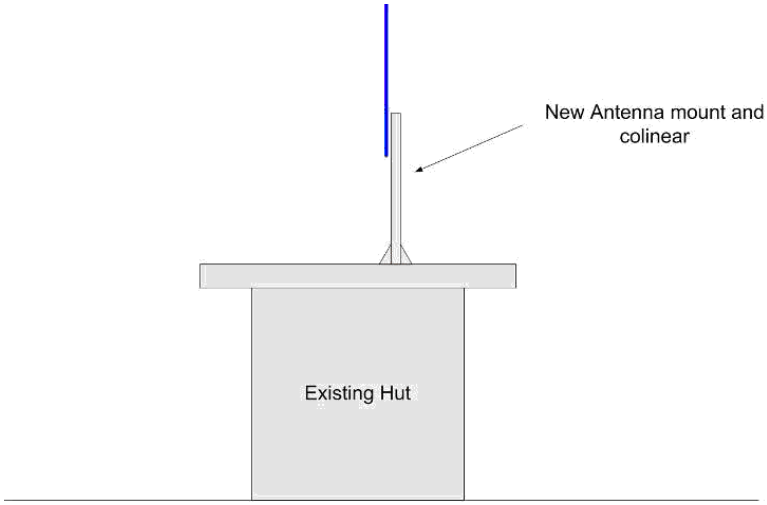
The Glennelly Creek site is located 5km west of Wandandean Road on a private property and is a new site. A standard field station was installed which comprises of a canister, tipping bucket, solar panel, collinear antenna, all housed in an aluminium tube. The data is transmitted back via the BOM Flood Alert radio network through the Vincentia repeater. The photos indicate the site of the installation and the completed installation.





Vincentia Repeater

The Vincentia repeater is an existing site located at the Vincentia Water reservoir. The pass-band was increased to allow the data from the new sites to pass through to Red Rocks. The existing antenna and mount located on the hut were upgraded to a 3dB collinear to help improve weak signals from the new sites.



Vincentia Flood Alert Site

Costs:

The overall costs for the project amounted to $39,780.16. An itemised cost report can be found in Attachment 4.