Myall River

Floodplain Risk Management Plan for Bulahdelah

Prepared for:
Great Lakes Council

August 2003

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EXECUTIVE SUMMARY

Bulahdelah is affected by flooding from both the Myall River and drainage paths transferring water from both east of the urban area and the urban area itself to the Myall River.

This plan concentrates on flooding from the Myall River and its tributaries and draws on the findings of the Bulahdelah Floodplain Risk Management Study. Council has commissioned a separate study into local overland flooding/drainage issues.

The Myall River system has a catchment area of approximately 365km^2 at the Pacific Highway. The Crawford River, its major tributary, has a catchment area of 125km^2.

Flooding at Bulahdelah has not occurred for a number of years. The largest floods in available records occurred in 1897 and 1927. Smaller floods were recorded in 1947 and 1953 with less severe floods again occurring most recently in 1985 and 1987. Therefore the current knowledge of Bulahdelah residents of significant flooding is expected to be low.

Major floods can have a reasonable impact on Bulahdelah township resulting in significant property damage and the need for a number of dwellings to be evacuated. Flooding from the Myall River in the 1% annual exceedance probability (AEP) flood event will inundate around 45 houses and 7 non residential buildings. The potential flood damage in the 1% AEP event is estimated to be in the order of $1,700,000 with the annual average damage for the full range of floods expected to be in the order of $95,200. Therefore flooding can have significant implications to Bulahdelah.

The Bulahdelah Floodplain Risk Management Study investigated the extent of the flood problems from the Myall River and has assessed potential floodplain management measures.

This plan documents the proposed methods of dealing with the three types of flood risk, namely:

- existing flood risk which relates to existing development in the floodplain;
- future flood risk which relates to the risk to future development in the floodplain; and
- continuing flood risk is the flood risk remaining after management measures are implemented.

Each of these risks involves both danger to personal safety and property damage. This study highlights the need for a number of different measures to address these issues and types of flood risk.

The plan and the associated implementation plan, as outlined below, were exhibited by Council and comments were invited from the community. No comments relating to flooding from the Myall River were forthcoming.

This plan recommends the following management measures in priority order:

Priority 1 updating the Council's 1985 Flood Management Policy and associated development controls as outlined in this report to manage future flood risk.

Priority 2 installation of a flood warning system with associated emergency management planning, community education and awareness and data collection to aid in addressing continuing flood risk.

Priority 3 review of this floodplain management plan as necessary.

Priority 4 a voluntary house raising scheme is recommended to reduce existing flood risk.

Priority 5 a voluntary purchase scheme is recommended to reduce existing flood risk.

The implementation plan recommends implementation of Priority 1 immediately, Priority 2 should be progressively undertaken with the flood warning system completed as soon as subsidised funds are available. Priority 3 is recommended at a maximum of every 5 years, upon the completion of the study into major drainage at Bulahdelah to include associated works or development controls, or where developments or works are proposed that will significantly impact on flood risk or potential damages. Subsidised funding should be sought for Priorities 4 and 5 following canvassing of interest in voluntary house raising and voluntary purchase.

The summary table below provides additional detail on the recommended portions of the proposed floodplain management scheme.

Table E1 - Program to Implement the Bulahdelah Floodplain Risk Management Plan

Priority	Description	Indicative Cost	Target Start Time	Benefit Cost Ratio	Eligible for Funding
1	**Development Controls & s149 Certificates**	**Low-Medium, Council resources. Advice provided in Floodplain Management Manual.**	**Year 1**	**N/a**	**No**
2	**Components 2a to 2d**	**As below**	**As below**	**1.7**	**See components**
2a	Flood Response Plan	Medium. Council/SES resources.	Year 2		Part
2b	Flood Warning System	$63,000 Capital, $5,000 per annum maintenance	Year 2/3		Yes
2c	Flood Education and Awareness	$10,000 capital, $2,000 annual maintenance	Year 2/3		No
2d	Ongoing Data Collection		Ongoing		No
3	**Review of this Floodplain Risk Management Plan**		**Maximum 5 years or as required**	**N/a**	**Yes**
4	**Voluntary House Raising of all below 2% AEP flood level that can be raised**	**$690,000**	**Year 4**	**1.42**	**Yes**
5	**Voluntary Purchase of all below 5% flood level that cannot be raised**	**$360,000****	**Year 4**	**0.66**	**Yes**
Overall Scheme	**Integrated Scheme of Items 1 to 5**	**$1,120,000 plus**	**Year 1**	**1.09**	**See components**

* Great Lakes Shire Council has asked for funding under a separate Commonwealth Program for a number of these studies. Works to do with the local flood plan not eligible.

** Based on $120,000 per property.

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1. INTRODUCTION

1.1 Floodplain Management in the Great Lakes Council Area

Council is responsible land use planning, including the management of flood prone land, within its local government area in accordance with the NSW Government's Flood Prone Land Policy.

To support effective floodplain management Council has formed a Floodplain Management Committee and is undertaking the floodplain management process in accordance with the NSW Government's Floodplain Management Manual. The process outlined in the manual aims at addressing the existing, continuing and future flood risks related to human occupation of the floodplain using a process of risk avoidance, minimisation and mitigation. This floodplain management plan is the third of four steps in this process, described in the table below.

Table 1.1 - Steps in the Floodplain Management Process

1	Flood Study	- Determines the nature and extent of the flood problem.
2	Floodplain Management Study	- Evaluates management options for the floodplain with respect to existing, future, and continuing flood risk.
3	Floodplain Management Plan	- Involves formal adoption by Council of a plan of management for the floodplain.
4	Implementation of the Plan	- May involves construction of flood mitigation works, where viable, to protect existing development and reduce existing flood risk. - Uses planning controls to ensure that future development is compatible with flood hazards in controlling future flood risk. - Uses flood warnings to provide the community of information on potential flooding through the local emergency services. - Uses flood education and awareness to promote flood readiness to minimise continuing flood risk

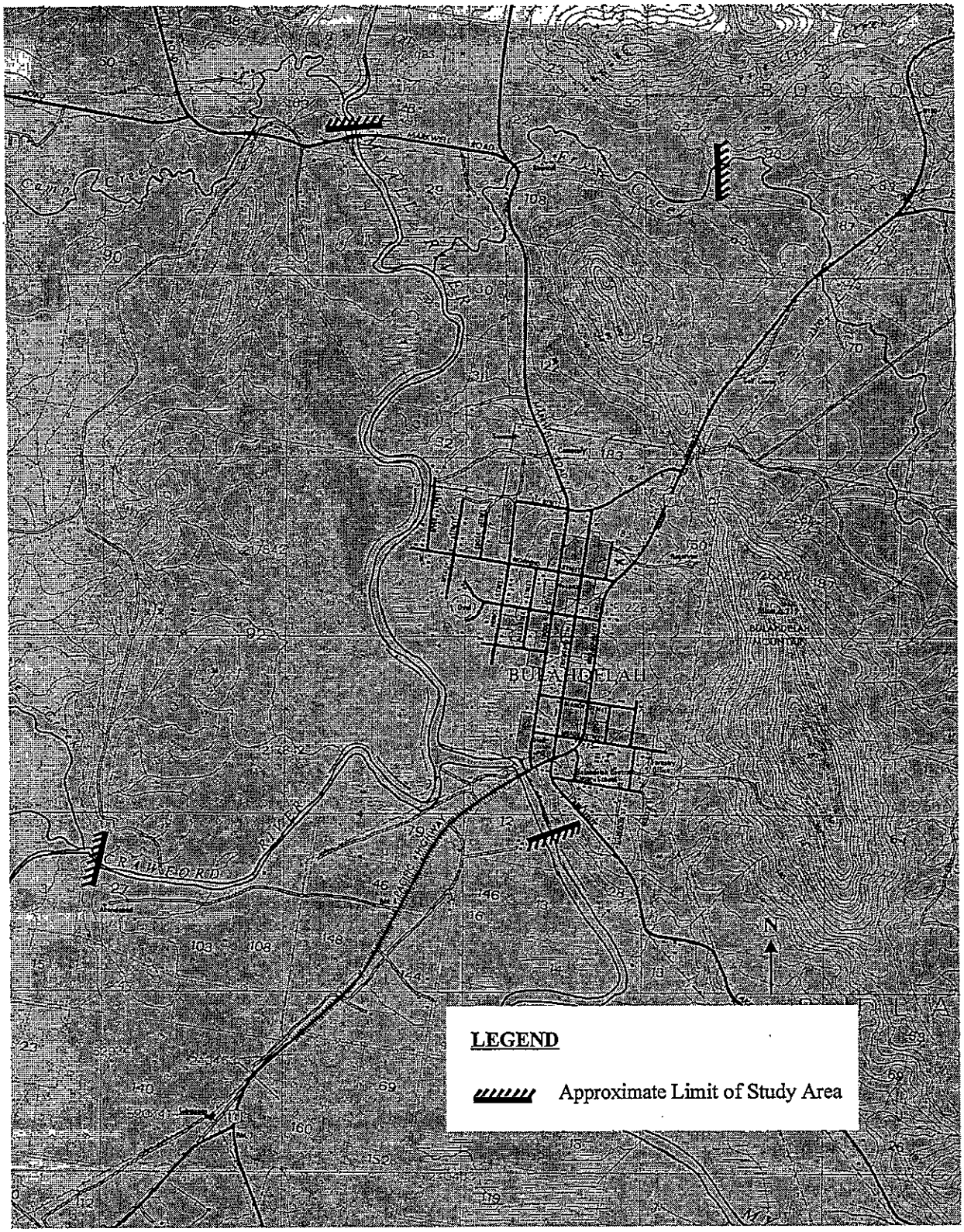
This plan is one of a number that are being undertaken by Council for different locations within its service area. This plan concentrates on the impacts of the Myall River on Bulahdelah township.

1.2 Bulahdelah Floodplain Risk Management Plan

The Department of Infrastructure, Planning and Natural Resources (DIPNR) was engaged by Council to undertake a floodplain management study for Bulahdelah to assess the impacts of the Myall River on the township and associated management options. This role extended to preparing a plan to manage the floodplain in consultation with the Committee and Council.

The township of Bulahdelah is located about 96km north of Newcastle where the Pacific Highway crosses the Myall River (refer Figure 1). The Myall River at Bulahdelah has a history of flooding with the largest floods on record occurring in 1897 and 1927. Smaller floods were recorded in 1947 and 1953, and less severe floods occurred more recently in 1985 and 1987. The area of the study, shown in Figure 1, covers the floodplains of the Myall River and its main tributaries.

Bulahdelah is affected by flooding from both the Myall River and local overland flow from drainage paths transferring water from the urban area to the river. A separate study is being undertaken to examine the local overland flow/drainage issues in the township.



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SCALE

STUDY AREA
Figure 1

The management study indicates that approximately 52 buildings are affected by above floor flooding in Bulahdelah in a 1% AEP flood event which would cause in the order of $1,700,000 damage. The annual average damage (AAD) of the full range of floods would be in the order of $95,000 per annum. The management study involved detailed assessment of the options with recommended management measures. Figure 2 indicates the extent of flooding the 1% AEP event at Bulahdelah.

This management plan has been developed in accordance with the NSW Government's Floodplain Management Manual, 2001. It outlines the Floodplain Management Committee's proposed method of managing flood risk from the Myall River at Bulahdelah. This plan is to be put forward to Great Lakes Council's for their consideration in the adoption of a management plan for this area.

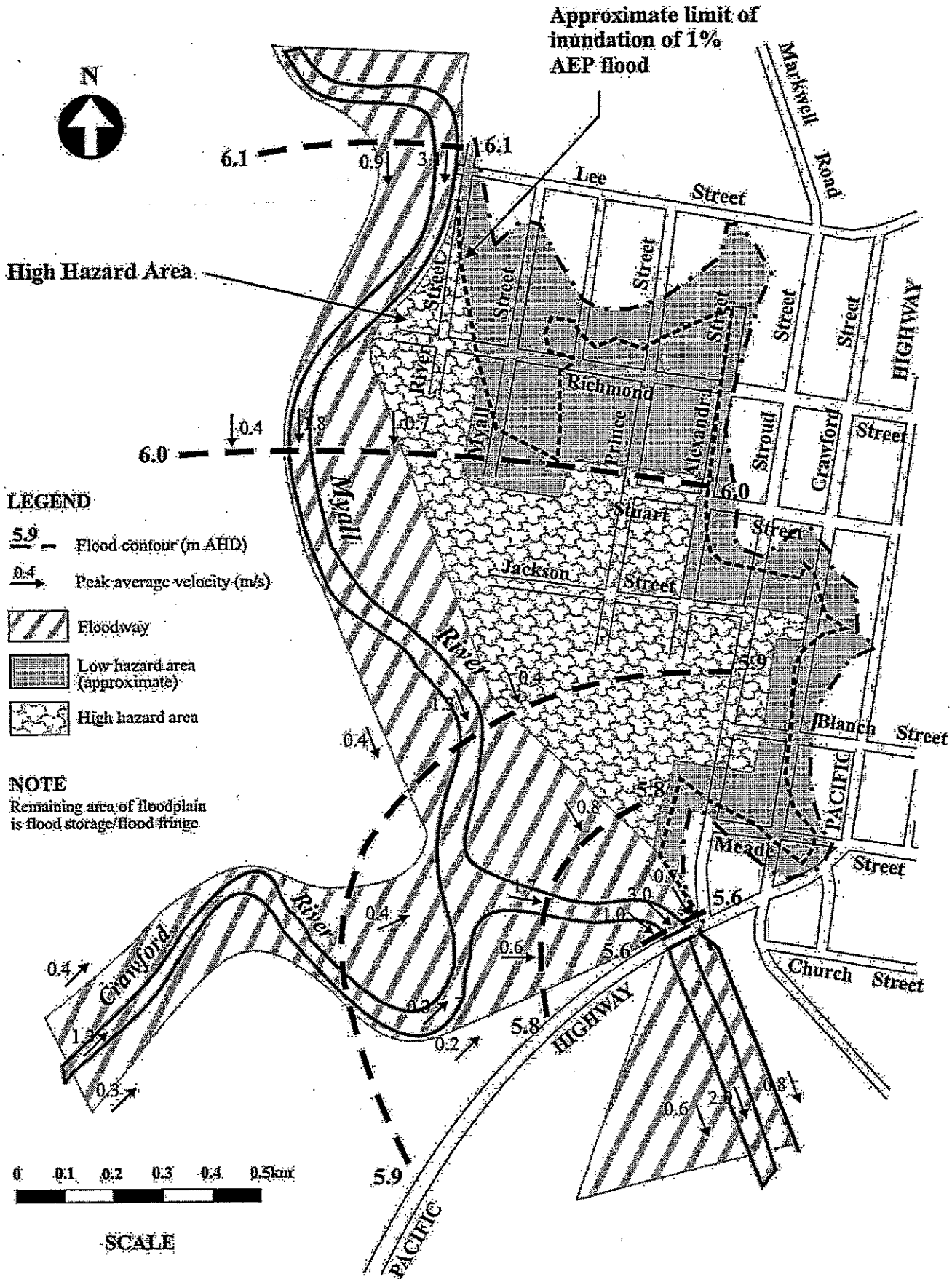
The plan deals with the management of both danger to personal safety and damage to property by addressing the 3 types of flood risk, namely:

- existing flood risk is the risk associated with current development on the floodplain;
- future flood risk is related to new development within the floodplain; and
- continuing flood risk is the risk remaining after floodplain management measures and development controls are in place. This exists in both existing and future development area.

The plan outlines Council's proposal to manage the floodplain at Bulahdelah and provides a program to implement the proposed floodplain management measures. Council exhibited and sought public comment on this plan. However, no comments were received in relation to the plan and flooding issues from the Myall River.

This report is split in the following sections:

Section 2	Floodplain Management Plan, Implementation Program, Further Investigations, and Updating the plan;
Section 3	Potential to Attract Funding Subsidy;
Section 4	Acknowledgments;
Section 5	Glossary. Provides a definition of the terms used in this report; and
Section 6	References.



APPROXIMATE FLOOD EXTENTS & 1% AEP HYDRAULIC & HAZARD CATEGORIES
Figure 2

2. MANAGEMENT PLAN

2.1 MYALL RIVER FLOODPLAIN MANAGEMENT PLAN OVERVIEW

The objectives of floodplain management are aimed at managing the danger to personal safety caused by flooding and managing the damage to property resulting from flooding. The management of these risks can be broken down into three areas:

- management of existing flood risk (the risk faced by existing development in the floodplain);
- management of future flood risk (the risk that would be faced by future development in the floodplain); and
- management of continuing flood risk (the risk remaining after adopted floodplain management options have been implemented). This exists in both existing and future development areas.

The Myall River Floodplain Management Study identified measures to manage the flood risk at Bulahdelah. Options investigated include voluntary house raising, voluntary purchase, levee systems, flood warning, education and awareness, flood proofing and development controls.

Assessment of management options was undertaken relative to their effectiveness in meeting the objectives identified above and the following additional criteria:

- environmental impact in relation to the affects of any proposed works;
- opportunities for environmental enhancement;
- affect on the community and the associated community support and acceptance;
- economic efficiency; and
- ability and capacity to implement measures.

The Great Lakes Floodplain Management Committee allocated the following priorities to floodplain management options recommended in the Myall River Floodplain Management Study. In addition, a drainage study for Bulahdelah and a data collection program are also identified.

Priority 1 Updating Development Controls. To manage future flood risk.

Priority 2 Flood Warning, Planning, Education, Awareness and Data Collection to manage continuing flood risk.

- Priority 2a Updating the Flood Response Plan;
- Priority 2b Instigating a Flood Warning System and associated procedures;
- Priority 2c Flood Education and Awareness; and
- Priority 2d Ongoing Data Collection.

Priority 3 Review of this Floodplain Management Plan.

Priority 4 Voluntary House Raising to manage existing flood risk.

Priority 5 Voluntary Purchase to manage existing flood risk where dwellings cannot be raised.

Priority 2a, 2b and 2c are closely linked, as the objectives of these measures cannot be effectively met without all being implemented.

2.2 PRIORITY 1 - UPDATING DEVELOPMENT CONTROLS

2.2.1 Flood Planning Level (FPL)

As part of the management study the planning level flood was considered and it was recommended that the flood planning level (FPL) remain at 0.5m above the 1% AEP flood for the control of development. All land below this FPL, ie, within the flood planning area, would have a minimum floor level set at the FPL.

The management study highlights that this decision considered:

- The ground level at the fringes of the floodplain increases steadily limiting any additional area of inundation. Therefore variation of the planning level flood (eg raise to the 0.5% AEP flood or lower to the 2% AEP flood) would not have a major effect on the area of land subject to flood related controls.
- There is land below the 1% AEP flood level that is available for development.
  - Development of the available land based upon the current controls related to the 1% AEP flood level, will not significantly increase flood damage, however, it will increase the amount of people in areas at risk of flooding;
  - Developing this land to a reduced flood planning level will be inconsistent with previous development control decisions. In addition it will increase the level of flood risk in Bulahdelah relative to adopting the current development controls; and
  - Developing with a higher flood planning level will have only a minimal effect on flood damage potential.
- The estimated 1% AEP flood levels in Bulahdelah are higher than recorded historical flood levels in the area. However on three occasions (in 1897, 1927 and 1947), the historical flood levels came to within 0.1 to 0.5m of the 1% AEP flood levels. Hence, the 1% AEP event is considered to provide a reasonable planning level flood relative to the experience of flooding in the area.
- There is scope for a flood warning system and associated improvements in emergency management planning (including evacuation) at Bulahdelah to limit the danger to personal safety in future development areas in floods greater than the 1% AEP flood.
- The flood behaviour in the extreme event is very similar to the 1% AEP Flood, though the flood levels are around 1.8m higher, the velocities slightly increased and the warning time shortened due to the quicker rise of the flood.
- The flood levels currently used for development control are very similar to those used to derive the Flood Planning Level. Council had previously adopted a set figure of 5.9m AHD for the 1% AEP flood level for Bulahdelah. This report recommended the use of a variation from 5.6m AHD (near the Pacific Highway Bridge) to 6.1m AHD (near Lee Street). This is unlikely to significantly impact upon existing development with the only potential impact in areas where the new flood level is higher than the previously applied level. If the new level was strictly applied to control the floor levels of extensions in this area it would impact upon the practicality of extensions. However, adopting a merit based approach to extensions (which is recommended), allowing them to be at the same level as the existing floor level, would negate this issue. In addition, given there is only a difference of 0.2m between the old and maximum new control this change should not significantly impact on streetscape issues.

2.2.2 Planning Instruments and Development Controls

The adoption of the FPL does not impact upon the following planning instruments and controls:

- Great Lakes Local Environmental Plan, gazetted December 1996, last amended June 2000;
- Subdivision Development Control Plan, adopted September 1999;
- Residential Development Control Plan for Urban Areas, adopted September 1999; and
- Exempt and Complying Development Control Plan, adopted August 1999.

However, it does impact upon the Council's Flood Management Policy, adopted on 10 December 1985. The policy requires revision to address the following issues:

- revision of definitions to avoid confusion with the new Exempt and Complying Development DCP and to reflect current terminology in the floodplain management field;
- alterations need to indicate that the hazard categorisation methodology recommended in the policy is preliminary only and should be over ridden by assessments in studies for specific areas.
- Deletion of Tables 1 to 6 of the Policy are similar to those in the superseded 1986 Floodplain Development Manual. Reference could be made to the Floodplain Management Manual (2001) which has revised tables that are to only be used in limited situations, where studies are yet to be undertaken and care should be taken in their use. Flood hazards for Bulahdelah for the 1% AEP flood event are indicated on Figure 2.
- The adoption of the 1% AEP plus 0.5m adopted freeboard as the Flood Planning Level (FPL) for minimum floor levels for habitable development.
- Appendix A of the Policy relates to the NSW Government's Flood Prone Land Policy. This should be deleted as much of the background information is not relevant some 16 years after adopted of the policy and can refer to the Floodplain Management Manual: The Management of Flood Liable Land (2001).
- The Policy needs updating to make it consistent with the NSW Government's Floodplain Management Manual (2001) including the need to address issues such as major drainage, and flood awareness and education.
- The Policy should be renamed the Local Flood Risk Management Policy to be consistent with the Floodplain Management Manual.
- Emergency management in the extreme flood event should also be considered. This is particularly important in areas without direct evacuation routes to ground above the extreme flood levels. This is generally not an issue in Bulahdelah but may be for other areas of the Great Lakes Local Government Area.
- The policy should also outline information to be provided on Certificates under s149 of the Environmental Planning and Assessment Act (1979). This is discussed in Sections 3.2.4 and L6 of the NSW Government's Floodplain Management Manual with typical examples provided in Section L6.2 to L6.4.

Changes to the Council's Flood Management Policy should be made as a matter of priority.

In addition to updating the policy it may be effective to centralise flood related development controls into a flood specific Development Control Plan (DCP) to cover all developed areas of the LGA, including Bulahdelah. This would facilitate administration of floodplain management controls, as well as the community's understanding of these controls.

The issue of further development at Bulahdelah needs to be considered. Whilst no development in the floodway areas identified on Figure 2 is recommended, the following recommendations are provided for the high hazard areas outside of the floodway which are also shown on Figure 2. The recommendations consider that installation of an appropriate flood warning system, instigation of an associated emergency management plan, and raising of community awareness will be undertaken. Without these components further restrictions on development would be recommended.

It is recommended that existing high hazard land not be subdivided further and development of properties in high hazard areas remain at the same density as current development, ie, generally single dwelling per lot.

Development or redevelopment of any of the existing sites needs to be aware of the flood situation, consider the flood planning level, and the potential flood and debris forces and evacuation issues. Certification of the structural adequacy for flood forces, including buoyancy, by a registered structural engineer, is recommended.

Where infill development is considered appropriate in high hazard areas closer to the river, but outside of the floodway, the following additional points need consideration. These are particularly relevant to properties to the west of River Street. Any development should meet the criteria outlined above and also be built away from

the riverbank, toward River Street, the least hazardous area in these sites. Consideration should also be given to alignment any new development with existing development, where this is away from the river.

2.3 PRIORITY 2 - FLOOD PLANNING, WARNING, EDUCATION & AWARENESS

Priority 2 is a combination of:

- improved flood response planning;
- a Flood Warning System;
- Data Collection; and
- Public Education and Awareness.

These are dealt with as priorities 2a, 2b, 2c and 2d respectively below.

Flood warning, with an appropriate response plan, and community awareness and education enables a reduction of danger to personal safety and flood damage.

2.3.1 Priority 2a – Flood Response Plan

The Local Flood Plan is central to the effective management of flood risk. It has some shortcomings in relation to Bulahdelah. The proposed methodology to overcome these shortcomings are indicated below:

- Annex A identifies the flood threat but provides little detail in relation to Bulahdelah.

  A detailed evacuation plan should be prepared to establish evacuation procedures for Bulahdelah, including identification of preferred evacuation routes based on the flood hazard.

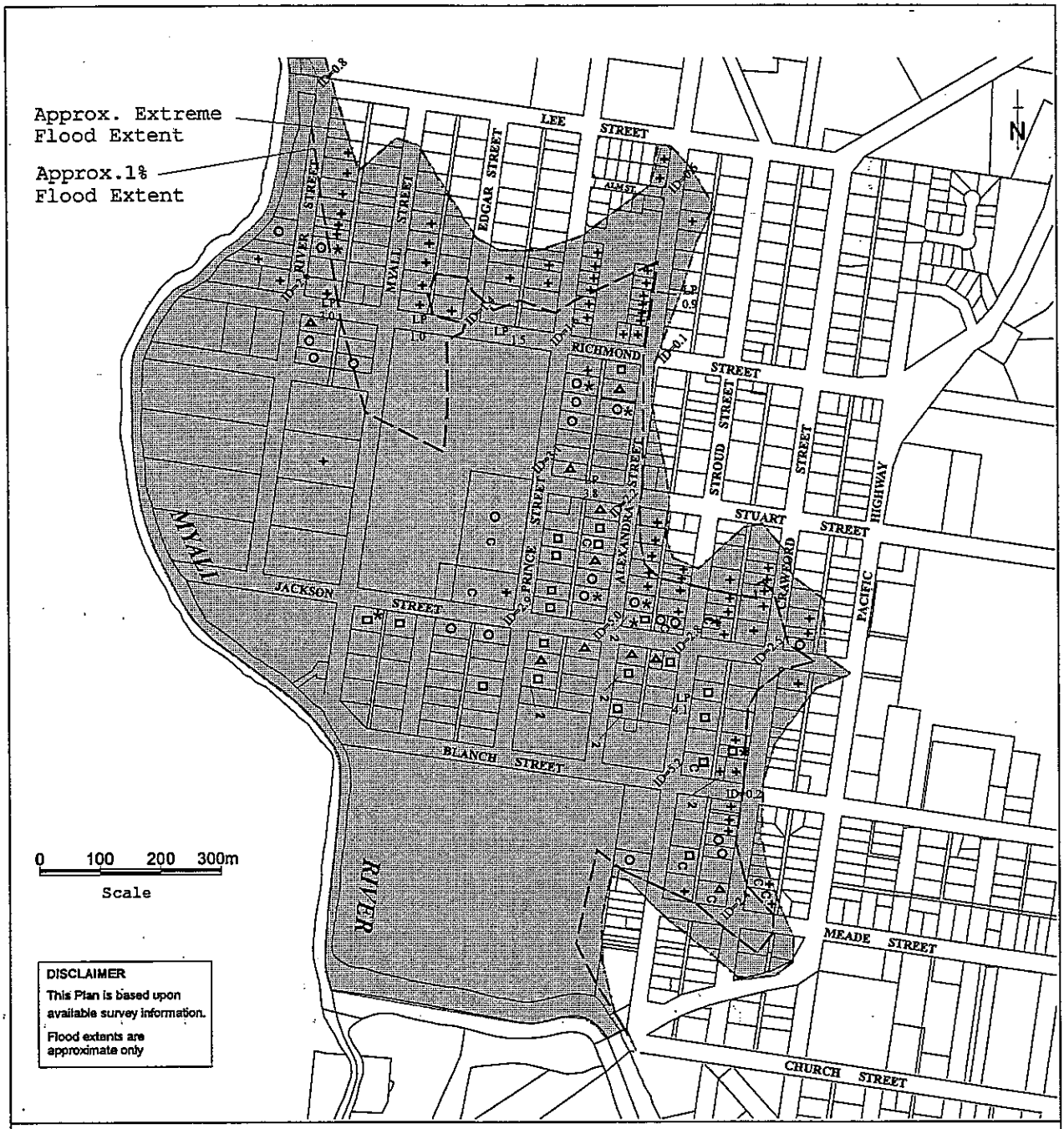
- Annex B indicates specific risk areas. Some additional information could be included for Bulahdelah relating to typical warning times, likely depths of water in some areas, evacuation routes and early road closures. In addition, the provision of depth indicators may improve safety in low points.

- Annex C needs updating to indicate that the Markwell Gauge no longer exists. This should be updated with any change in the flood warning system for Bulahdelah.

- Annex D provides a guide to the content of evacuation warning messages. Map 1 indicates that the Bulahdelah Rescue Squad (Volunteer Rescue Association) is designated as operating in Bulahdelah. It would be useful if maps of townships indicating critical areas such as, evacuation routes and centres likely to be used for evacuation in significant flood events, were included. The plan for Bulahdelah township could be based upon Figure 3 in this report.

  Figure 3 indicates the potential flood extents, the properties likely to be affected above floor level in different flood events, and potential depths at intersections in an extreme event. The houses affected in more frequent events would generally need evacuation earlier in a flood event. The intersections with deeper inundation in the extreme event would generally be closed to traffic earlier in flood events, although location drainage paths may also impact on road closures. Flooding early in a flood event is likely to impact on the following intersections:

  - Stroud Street between Jackson Street and Meade Street,
  - Jackson Street between Prince Street and Alexander Street, and
  - Stuart Street between Prince Street and Alexander Street.



LEGEND

+	above 1% to Extreme Flood Level	◁	above 5% below 2%	*	Below 1% flood level and unsuitable for house raising	ID=	Depth at intersection in/Extreme Event
o	above 2% below 1%	□	below 5%	2	two storey - flooding relates to ground floor if built in	LP	Depth at Low point in Extreme Event
				C	Commercial/Industrial All others are residential		

MYALL RIVER FLOODPLAIN MANAGEMENT STUDY AT BULAHDELAH

PROPERTIES INUNDATED ABOVE FLOOR LEVEL IN VARIOUS FLOOD EVENTS

Figure 3

It is also suggested that Council liaise with the SES in order to advance the development of a detailed local flood evacuation plan. The plan should recognise that floods greater than the 1% AEP event may occur. The local flood plan could use the information on Figure 3 of this report as the basis for considering evacuation logistics. This plan should be referenced in the Local Flood Plan.

- The current flood warning procedures are informal and rely on empirical information and the decisions of individuals based upon general Bureau of Meteorology warnings. These warnings give no prediction of timing or specific severity to enable plans to be enacted. These procedures should be updates as part of the introduction of a flood warning system discussed below.

2.3.2 Priority 2b - Flood Warning System & Procedures

The Bureau of Meteorology does not issue flood warnings for watercourses within the Great Lakes Council area. However, SES personnel and the Bulahdelah Rescue Squad monitor developing floods on rivers, creeks and lakes, including the Myall River at Bulahdelah including monitoring one gauge (Pacific Highway bridge over the Myall River). Information and advice on flood severity to the Lower Hunter SES Division Headquarters for broadcast over local radio stations in SES Flood Bulletins. Given the available information, the accuracy of predictions would have to be questioned.

The potential warning available should be sufficient to warrant implementation of a flood warning system based on real-time monitoring of rainfall and river levels such as the "ALERT" system (Automated Local Evaluation in Real Time). The major components of an ALERT radio telemetry flood warning system for Bulahdelah would include:

- an upgrade of the Bulahdelah DIPNR Rain/River Gauge (maintained by Department of Commerce) with ALERT Communications;
- an automatic rainfall/river height data collection station at Markwell on the Myall River upstream of Bulahdelah;
- a rain repeater station in the Upper Myall catchment and one rain gauge in the Crawford River catchment; and
- software for Council's existing base station.

Flood forecasting models would be required in order to provide predictions of flood heights using the data collected from the ALERT system together with meteorological forecasts. The hydrologic model (and possibly the hydraulic model) developed upgraded as part of the floodplain management study could be of assistance for this purpose. The models could be used to develop general relationships between catchment rainfall, river heights and flood levels at Bulahdelah. These relationships could then be readily applied during actual flood events.

The Bureau of Meteorology has completed a feasibility study for an ALERT based flood warning system for Bulahdelah, which is with council. The capital cost of the system is estimated to be $63,000, with a maintenance cost of $5,000 per annum. The Council and State would need to contribute a total of $43,000, whilst the Bureau of Meteorology would contribute $20,000.

Improvements to the local flood plan, discussed above, will be necessary to make the warning system effective.

2.3.3 Priority 2c - Flood Education and Awareness

Ongoing education is necessary to ensure that the community in the floodplain has a high level of flood awareness (an accurate perception of the flood risk) and flood preparedness (knowledge of the appropriate course of action during a flood). Knowing what may occur and knowing what to do and being ready to do this is considered to be flood readiness.

The most recent severe flood at Bulahdelah occurred in the 1950's. Given the time since the event, the arrival of new residents, and the tendency for the general level of flood awareness to diminish over time after floods in

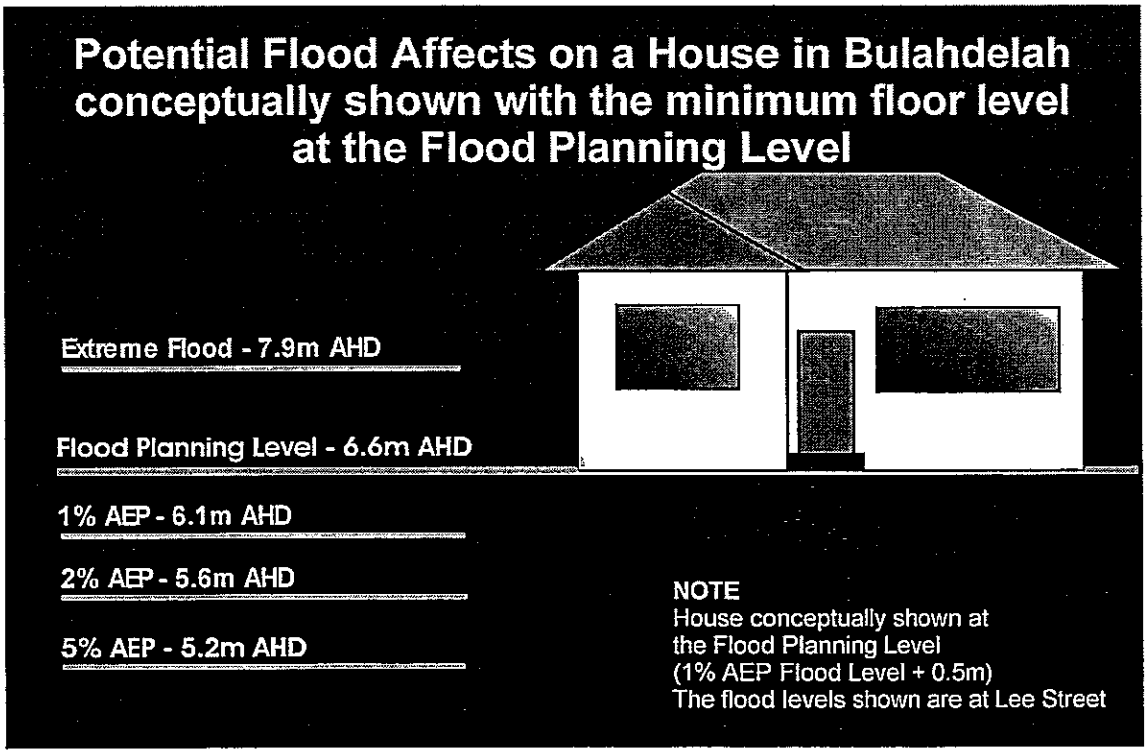
the absence of appropriate education campaigns, the current level of flood awareness is likely to be low. The Council in conjunction with the SES should conduct regular flood awareness campaigns such as:

- installation of permanent marks showing the levels reached by the largest historical floods;
- installation displays of plans indicating the flood situation in the local information centre;
- sending out regular information with rate notices, which could include information indicating that compliance with development controls still leaves a rare flood risk, see Figure 4; and
- SES displays and talks by SES officers to community groups.

Flood preparedness campaigns should educate the flood-affected community on issues such as:

- storage or removal of important items, memorabilia and treasured items as high as practicable and, at least, above the 1% AEP flood level;
- procedures for lifting and evacuation of possessions;
- provide an understanding of any warning system;
- indicating what is expected of individuals;
- indicate the roles of the various players in emergency management locally;
- indicating where to evacuate to and who to report to once you arrive at the evacuation centre; and
- the need to react and listen to direction by the appropriate response agencies.

The estimated cost of an initial flood awareness and public education program would be between $5,000 and $10,000. The cost of ongoing activities to maintain flood readiness would be around $2,000 per annum.



RELATIVE LEVEL OF FLOODS AT BULAHDELAH

Figure 4

2.3.4 Priority 2d - Ongoing Data Collection

Council needs to be committed to the collection, collation and assessment of data from flood events to verify that the flood behaviour documented in the Floodplain Management Study is consistent with actual behaviour in flood events and to enable further calibration of the proposed flood warning system.

2.4 PRIORITY 3 - REVIEW OF THIS FLOODPLAIN MANAGEMENT PLAN

This plan should be reviewed at least once every 5 years and in the following instances:

- completion of investigations into major drainage to incorporate works/development controls in this plan;
- when any significant changes in development are proposed in the floodplain;
- where works or measures significantly alter the level of flood risk; and
- after a significant flood event.

2.5 PRIORITY 4 - VOLUNTARY HOUSE RAISING

Voluntary house raising may be a practical measure to reduce the potential for flood damage to existing houses and their contents. It does not, however, address danger to personal safety. The survey identified 37 houses of timber or fibro-cement construction in the study area which would be inundated above their floor levels by the 1% AEP flood and which could be suitable for house raising. Of these 9 are in low hazard areas and 28 in high hazard areas.

Whilst voluntary house raising is generally restricted to low hazard areas, in the case of Bulahdelah the flood hazard is due to the depth of flooding rather than the low flood velocities. Given the low velocities, the proposed flood warning system and procedures resulting in sufficient warning time and associated early evacuation, adequate community flood awareness and the relative short duration of flooding of the area, voluntary house raising is considered a viable option in this area. On this basis, there are some 37 existing dwellings affected by flooding above floor level that are suitable for raising.

The voluntary raising of these houses would have a negligible effect on flood behaviour nor would it be likely to have significant social impacts on the community, although streetscape issues may need to be considered.

The estimated cost of raising a fibro-cement or weatherboard house is around $30,000. The benefit-cost ratios for individual houses will vary considerably with the regularity and depth of flooding. Table 2.1 indicates the benefits and costs for properties affected by above floor flooding in the 5%, 2% and 1% AEP events. The properties affected above floor level in these events are indicated in Figure 3. The houses below the 1% AEP flood level that cannot be raised are also highlighted.

Table 2.1 Benefits/Costs of House Raising dependant upon Regularity of above floor level flooding

Flooding Above Floor Level in AEP event	Number of Houses	Indicative Cost	Benefit. Reduction in flood damages if houses raised to above 1% AEP level	Benefit to Cost Ratio
Between 2% & 1%	14	$420,000	$56,300	0.13
Between 5% & 2%	8	$240,000	$138,600	0.58
5% or more frequent	15	$450,000	$840,000	1.87

Voluntary house raising is recommended as a management measure. Its implementation needs to consider:

- the make up of the scheme, does it cover all houses below the 1% AEP flood level or just those below the 5% flood level. It is recommended that a scheme raising all houses below the 2% event be adopted but that preference is given to houses that have the highest depth of inundation. The benefit cost ratio of raising all 23 below the 2% would be 1.42, giving a reasonable return on investment.

- determine a procedure for its implementation. Implementing the scheme could involve calling for expressions of interest from the affected public and offering funds to those interested in house raising in a priority order based upon depth of inundation.
- given the current level of community flood awareness there maybe little interest in house raising. This could change significantly if a significant flood event were to occur on the catchment.
- floodplain management funding (discussed in Section 3) and particularly how the local component is funded. House raising schemes vary between councils with some Councils contributing toward the cost of damage reduction works in part or full and others not. The ability to implement the scheme may depend upon the option selected by Council and therefore the ability of the individual owners to contribute toward house raising. A part payment by Council may make house raising more affordable and implementation easier or more feasible.

Appropriate building standards. Ensuring buildings being raised can withstand flood forces is an essential part of any house raising scheme. This may require special conditions in the Flood Risk Management Policy in relation to house raising and should incorporate the requirement for structural certification. A typical clause could be as follows:

> *House raising requires the raising of floor levels to a minimum of 0.5m above the 1% AEP flood level. In raising the house, all the materials used should be flood resistant and structurally sound in accordance with Council's Flood Risk Management Policy and considering the likely flow velocities in the floodplain. In determining design flood loadings consideration should be given to the additional loadings caused by flood debris. Information on flood levels and flow velocities in the area based upon current studies is available from Council. A certificate from a NPER registered Structural Engineer as to structural adequacy and appropriateness of material will be required prior to approval being given to raise the house.*

2.6 PRIORITY 5 - VOLUNTARY PURCHASE

Voluntary purchase of houses needs to be considered when it would be impractical or uneconomic to mitigate the effects of flooding in high hazard areas. The intent is to cease occupation of properties in high hazard areas, in order to free both the residents and potential rescuers from danger to personal safety and to reduce damage costs in future floods. The inclusion of properties in such a scheme is based on the level of hazard to each property such as remoteness from high ground and the combination of depth and velocity of floodwaters and the depth of inundation over floor level. Recommendations on restriction on development in high hazard areas are discussed in section 2.2.2.

Voluntary purchase of the 3 properties below the 5% flood level, with flood depths of greater than 1m above floor level in the 1% AEP event has an indicative cost of $360,000, a benefit of $237,000, and a benefit-cost ratio of 0.66. It is recommended that these 3 houses be purchased. The sites, once cleared, could then be considered for more flood compatible development. This could include elevated dwellings on the properties where evacuation time and routes and flood warning is considered appropriate.

2.7 INTEGRATED SCHEME

The recommended integrated scheme is as follows:

- Updating Development Controls. To manage future flood risk.
- Flood Warning, Planning, Education and Awareness to manage continuing flood risk.
  - Updating the Flood Response Plan;
  - Instigating a Flood Warning System and associated procedures;
  - Data Collection; and

- Flood Education and Awareness.

- Voluntary House Raising for all 23 suitable houses with floor levels below the 2% flood event to 0.5m above the 1% flood event.
- Voluntary Purchase of 3 houses not suitable for house raising and with floor levels below the 5% flood event.

The total cost of this scheme would be around $1,120,000. The potential benefit of the overall scheme, $1,220,000, with a benefit cost ratio of 1.09.

2.8 IMPLEMENTATION PROGRAM

The implementation program is provided in Table E1 (page ii) for the recommended integrated scheme discussed above. This program is subject to funding availability as discussed in Section 3.

2.9 FURTHER INVESTIGATIONS

Existing investigations are ongoing into major drainage problems at Bulahdelah. Once these investigations are complete their findings should be considered in relation to development controls, and potential upgrading works and how these should be incorporated into the management plan.

No other investigations are considered warranted at this time. However, a review of the floodplain management study and associated modelling should be undertaken following any significant flood event.

3. POTENTIAL TO ATTRACT FUNDING SUBSIDY

Funding through the NSW Government's Floodplain Management Program in the last few financial years has seen projects with a priority in the lower to mid 30's or more using the Floodplain Management Authorities (FMA) assessment system receiving financial assistance. Based upon the available funds and the volume of projects ranked in this region this is not expected to change in the near future.

This assessment system was used to check the potential for subsidised assistance for the proposed management options. The outcomes given in Table 3.1 indicate that there would be a reasonable potential for subsidised assistance for the flood warning system, voluntary house raising and voluntary purchase and the overall integrated scheme.

Table 3.1 Indicative FMA Assessment Scores for Recommended Works

Priority	Description	Indication of Cost	Approximate FMA System Score
1 ##	**Development Controls S 149 Certificates**	**Low-Medium, Council resources. Advice provided in Floodplain Management Manual.**	**Ineligible**
2a ##	**Flood Response Plan**	**Medium. Council/SES resources.**	**30 ***
2b ##	**Flood Warning System**	**$63,000 Capital, $5,000 per annum maintenance**	**34**
2c ##	**Flood Education and Awareness**	**$10,000 capital, $2,000 annual maintenance**	**Ineligible**
2d ##	**Ongoing Data Collection**		**Ineligible**
3	**Review of this Floodplain Risk Management Plan**		Not an implementation work therefore not scored
3	**Voluntary House Raising**		
	All below 1% that can be raised	$1,110,000	35
##	**All below 2% that can be raised**	**$690,000**	**35**
	All below 5% that can be raised	$450,000	36
	Below 2% above 5% that can be raised	$240,000	33
	Below 1% above 2% that can be raised	$420,000	32
4	**Voluntary Purchase**		
	All below 1%	$960,000**	33
##	**All below 5%**	**$360,000****	**35**
Recommended Eligible 2-4 items ##	**Integrated Scheme of Recommended Eligible Items marked ##**	**$1,120,000 plus**	**33**

* Great Lakes Shire Council has asked for funding under a separate Commonwealth Program for a number of these studies. Works to do with the local flood plan are not eligible.

** Based on $120,000 per property.

4. ACKNOWLEDGEMENTS

This study is being financed under a State, Commonwealth and Council partnership through the New South Wales Government's Floodplain Management Program administered by the Department of Infrastructure, Planning and Natural Resources (DIPNR).

This plan has been prepared by the Flood Unit of the Ecosystems Branch in DIPNR with the assistance of Great Lakes Council and Council's Floodplain Management Committee.

5. GLOSSARY

Following is a glossary of the terms used in this management plan.

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.
Australian Height Datum (AHD)	a common national surface level datum approximate to mean sea level.
development	defined in Part 4 of the Environmental Planning & Assessment 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.
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.
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 & 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 and 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.
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 management options	the measures that might be feasible for the management of a particular area of the floodplain. Preparation of a floodplain management plan requires a detailed evaluation of floodplain management options.
floodplain management plan	a management plan developed in accordance with the principles and guidelines in this manual. Usually includes both written and diagrammatic 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 levels (FPLs)	are the combinations of flood levels and freeboards selected for planning purposes, as determined in floodplain management studies and incorporated in floodplain management plans. The concept of flood planning levels supersedes the "standard flood event" of the first edition of this manual.
flood prone land	is land susceptible to flooding by the probable maximum flood 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 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 management measures, the continuing flood risk is simply the existence of its flood exposure.

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 flow, 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 and 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.

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.

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