Johnstone River Floodplain Management Plan

Final Report

Prepared For:	Johnstone Shire River Improvement Trust
Prepared By:	WBM Oceanics Australia

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Synopsis:	This document details the Johnstone River Floodplain Management Plan. The document summarises the recommended flood management measures, their costs, funding sources and implementation plans. The Flood Study exists as a separate document.

REVISION/CHECKING HISTORY

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FOREWORD

The Queensland Department of Emergency Services is administrating the Queensland natural disaster studies under the Federal Department of Transport and Regional Services' "Natural Disaster Risk Management Studies Program." The aim of the program is to identify, analyse and evaluate the risks from natural disasters and to identify risk management measures to reduce the risk to life and property.

Flooding was identified as a major risk on the floodplains of the North and South Johnstone Rivers and funding for the study was obtained through this program to develop a Floodplain Management Plan. The Natural Disaster Risk Management Studies Program contributed 2/3 of the funding (1/3 from both Federal and State Governments) and 1/3 of the funding for the study was provided by the Johnstone Shire Council through the Johnstone Shire River Improvement Trust. During the study, the Queensland Department of Main Roads contributed funds in recognition of the future value of the flood model.

The publication "Floodplain Management in Australia – Best Practice Principles and Guidelines" (CSIRO, 2000) provides the framework for the development and implementation of a Floodplain Management Plan. The process outlined in CSIRO (2000) is described below.

Floodplain Management Process

Stage	Description
1. Flood Behaviour Definition	The nature and extent of the flood problem are determined.
2. Floodplain Management Measures Investigation	Management measures for the floodplain are investigated in respect of both existing and proposed developments. These options are evaluated based on the impact on flood risk, while considering social, ecological and economic factors.
3. Floodplain Management Plan	Following acceptance of Stage 2 recommendations, the preferred management options are documented in a plan.
4. Implementation of the Plan	Involves formal adoption by Council of the floodplain risk management plan and a process of implementation for the selected flood, response and property modification options.

This document comprises stage 3 of the process for the Johnstone Rivers. The Plan defines a series of actions which, if implemented, help to reduce the impact of flooding in the lower Johnstone River area by controlling the flood risk and reducing flood damages.

The Plan is designed to be a 'stand alone' document, which briefly outlines the issues and details the recommended management actions to be implemented if adopted by the Johnstone Shire Council. More detailed discussion of the floodplain management options is contained in the Johnstone River Flood Study (WBM Oceanics Australia, 2003). The timetables presented assume that the measures are adopted by Johnstone Shire Council.

WBM Oceanics Australia was commissioned by the Johnstone Shire River Improvement Trust (JSRIT) to carry out this study.

A NOTE FROM YOUR PROJECT STEERING COMMITTEE

At the start of this critical study of the Johnstone Rivers the steering committee took great care in selecting its preferred consultant. WBM Oceanics Australia undertook the study with energy and professionalism and met all our requirements as defined in the project schedule. They identified the community's needs and concerns and addressed all issues raised. The community steering committee makes the following observations at the conclusion of the study and reporting.

- Reports will now be sent to the Johnstone Shire Council. Council will consider recommendations and implement those they see as appropriate in the period they determine. The Johnstone Shire River Improvement Trust and the local Counter Disaster Committee will also consider the reports and may choose to implement actions as a result.

- Residents are strongly urged to read the two reports provided and to take advantage of the useful information these offer for the future of our floodplain. Everyone in the community can be involved in the implementation of the Plan;

- Many options and ideas were considered not just the few that made it to the final summary. Comments on the full spectrum of options are outlined in the Floodplain Study Report.

- The models produced and calibrated in this study are of high quality and accuracy and will benefit the community in many ways right now and well into the future.

- Whilst structural flood mitigation measures were the initial focus of most people, the study has shown that most structural options are not very cost effective, and the few that are provide protection from smaller floods only.

- The Flood Management Plan offers us most potential benefit in the areas of community awareness, flood warning and emergency management.

- The Steering Committee wishes to stress the importance of being well prepared for big floods. Our memories tend to see the 1967 flood as being the big one. However, history and the study clearly show that there can be floods much larger than the 1967 event, so we need to focus carefully on the consequences of these and how to respond when they do inevitably arrive.

The community steering committee comprised: Stephen Bertocchi (DNR&M), Cr Tony Buzolich (JSC), Alan Cole (River Trust), Alan Dunne (River Trust), Rob Hart (Chamber of Commerce), Will Higgins (River Trust/JSC), Cr Dave McCarthy (JSC), Murray McKenzie (Community) and Chairperson, Elaine Ridd (River Trust). In the latter stages, Bob Devine then Greg Underwood replaced Will Higgins in their role as River Improvement Trust Engineer. Ken Gray managed the project on behalf of the River Improvement Trust.

The committee would like to thank all those people who attended public meetings and helped during the study. Thanks also to Maralyn Bonner and Steve Wilton for their unending support for the committee. Special thanks go to the farmers who provided access to their land and history and to our many well-informed long-term residents who generously donated past flood information, so vital to the accuracy of the models and the outcomes of the study.

EXECUTIVE SUMMARY

The Johnstone River system comprises the North Johnstone River and the South Johnstone River with their confluence being at the town of Innisfail. From the confluence, the river flows about 5 km to the ocean. The rivers have a combined catchment of about 1600 km^2 with the North Johnstone being the larger of the two with a catchment of about 1030 km^2. The locality of the river system is shown in Figure 1and the key features in Figure 2.

The headwaters of the rivers are in the high rainfall area of the Cardwell Ranges. The rivers flow from the range down through gorges to the lower fertile floodplains that are predominantly utilised for agricultural purposes including sugarcane and banana farming. There are a number of townships on the floodplains including the major centre of Innisfail and the smaller townships of South Johnstone, Mourilyan, Wangan and Mundoo.

There is a history of severe flooding on the floodplain with considerable damage to property, agriculture and public infrastructure. Innisfail is most affected being at the confluence of the rivers and with development on flood prone land. Flooding in and around Innisfail town occurs initially through backup of Saltwater and Sweeneys Creeks and then through overtopping of the banks around Innisfail and further to the north in larger floods. The construction of floodgates on Sweeneys and Saltwater Creeks has helped to reduce the frequency of flooding in Innisfail, although the floodgates are overtopped in larger floods.

The suburbs of Webb, East Innisfail and South Innisfail are affected by overtopping of the river banks and by back up from the Johnstone River through the Ninds Creek catchment. Parts of Innisfail Estate are affected in larger floods through overtopping of the river bank. Mourilyan is affected in larger floods when the South Johnstone River overtops its banks. These floodwaters pass through Mourilyan and into the Ninds Creek catchment before rejoining the Johnstone River at the confluence with Ninds Creek.

Consideration of options to reduce flooding impacts, and planning for future development requires an understanding of the flood behaviour. To develop a greater understanding of flooding, hydrological and hydraulic flood models were developed and calibrated to historical floods. These models were then used to simulate a range of design floods that were the benchmark for assessing both past and future works.

Once flood behaviour is understood, a strategic approach to controlling development on flood prone land, assessing the advantages and disadvantages of flood mitigation options, flood proofing properties and buildings, educating and safeguarding communities and protecting the natural environment can be carried out with confidence. This Study provides such assessments, and actions arising from the Study recommendations were used to formulate this Floodplain Management Plan.

The ultimate outcome of the Johnstone River Flood Study was the formulation and selection of a floodplain management scheme for incorporation into this Plan. The scheme is a combination of the floodplain management measures recommended by the Steering Committee. The Plan defines a series of measures which, if implemented, help to reduce the impact of flooding in the lower Johnstone River floodplain area by controlling the flood risk and reducing flood damages.

Table A summarises the proposed floodplain management scheme, and lists the responsible agencies and indicative costs for each measure.

Funding Constraints

The implementation of the floodplain management scheme outlined in this Plan is partly subject to the allocation of funding by the State Government. However, Council should endeavour to implement some of the initiatives outlined in the Plan regardless of the level of funding from the State Government. The following floodplain management measures can be initiated (*either in part or in full*) following the adoption of the Plan by Council without waiting for State Government funding:

- **Raise Community Awareness (*in part*)** – It is anticipated that a significant portion of the funds required to implement this measure will be provided by the State Government. However, Council should begin to implement some aspects of the flood awareness campaign as soon as possible.
- **Investigate Alarms at Other Alert Stations (*in full*) -** This action would be undertaken by the Counter Disaster Committee with the cost being that associated with the time put into the task by members of the CDC and others.
- **Colour Banded Flood Totems (*in part*) -** It is anticipated that a significant portion of the funds required to implement this measure will be provided by the State Government. Before the measure is implemented it is recommended that the proposal in principle is discussed with the Department of Emergency Services and the Bureau of Meteorology. However, these discussions could be held prior to funding approval from the State.
- **GIS Emergency Management Maps (*in part*) -** It is anticipated that a significant portion of the funds required to implement this measure will be provided by the State Government. It is recommended that the provision of the necessary data by the Consultant be undertaken immediately.
- **Revised Public Warning System (*in full)* –** This measure does not require funding from the State Government. It is anticipated that the cost of implementing this measure is met by Council within its normal operating budget.
- **CDC Review of Study Outcomes (*in full)* -** This measure is a review of procedures and does not require funding from the State Government.
- **Development Controls (*in full*)** – This measure does not require any funding from the State Government. It is anticipated that the cost of implementing this measure is met by Council within its normal operating budget.
- **Raise Existing Saltwater Creek & Sweeneys Creek Floodgate Levees (*in part*) -** It is anticipated that a significant portion of the funds required to implement this measure will be provided by the State Government. However, further investigation into the impacts of the proposal are required and it is recommended that these begin immediately.

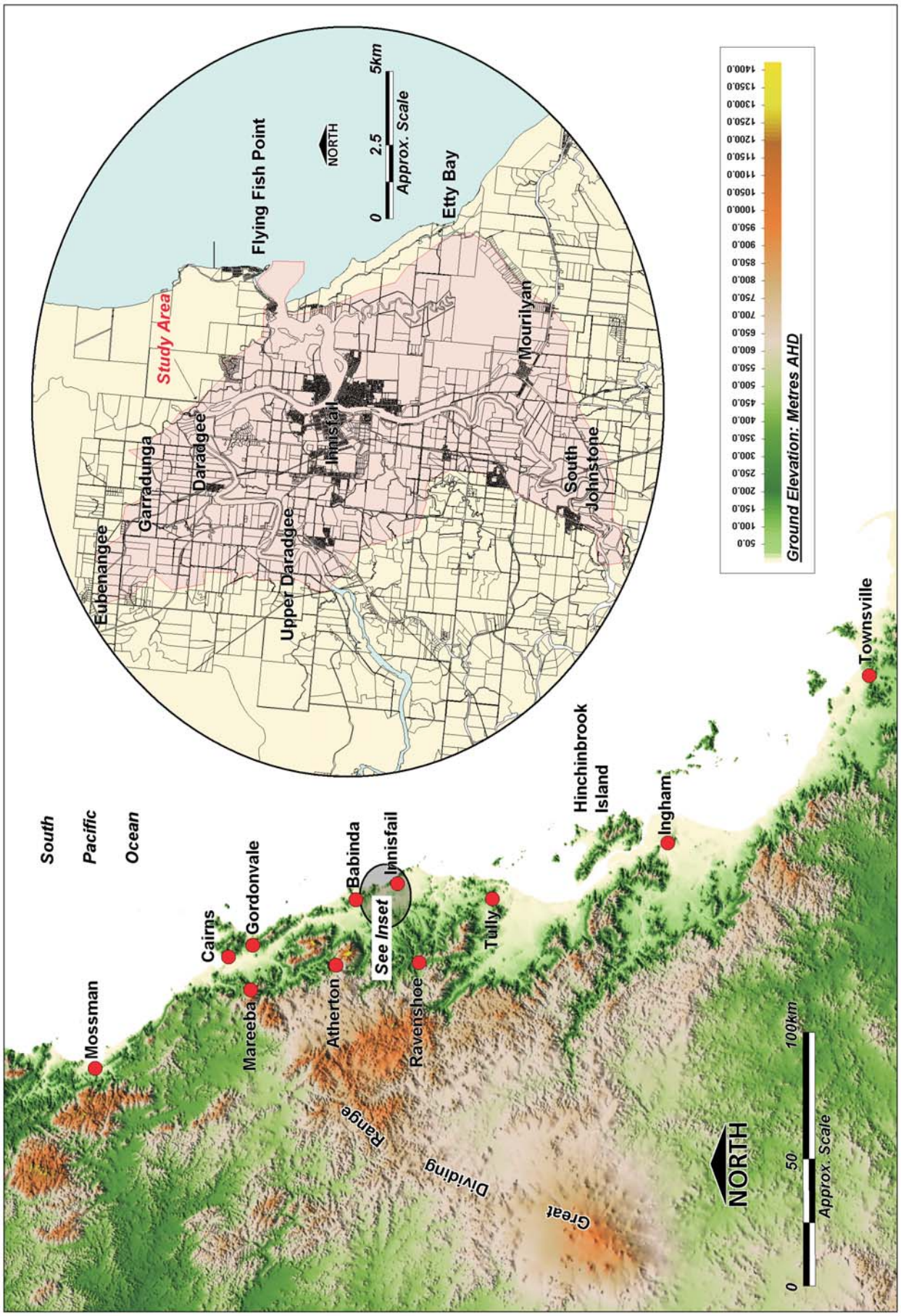
Overall Benefits

The **Response Modification Measures** make recommendations to improve the effectiveness of the *Flood Warning System* and *Emergency Management Planning* in the lower Johnstone River area. An important aspect of this is the *Raise Community Awareness* measure which helps to foster a high level of flood awareness. This combination is invaluable in minimising flood damages and trauma associated with flooding. An accurate, prompt warning system ensures that residents are given the best opportunity to remove their possessions and themselves from the dangers of floodwaters. The community awareness program ensures that the community understands the warning system and what actions to take. Also, in a community with a high level of flood awareness, it is less likely that people experience health and psychological trauma following a flood.

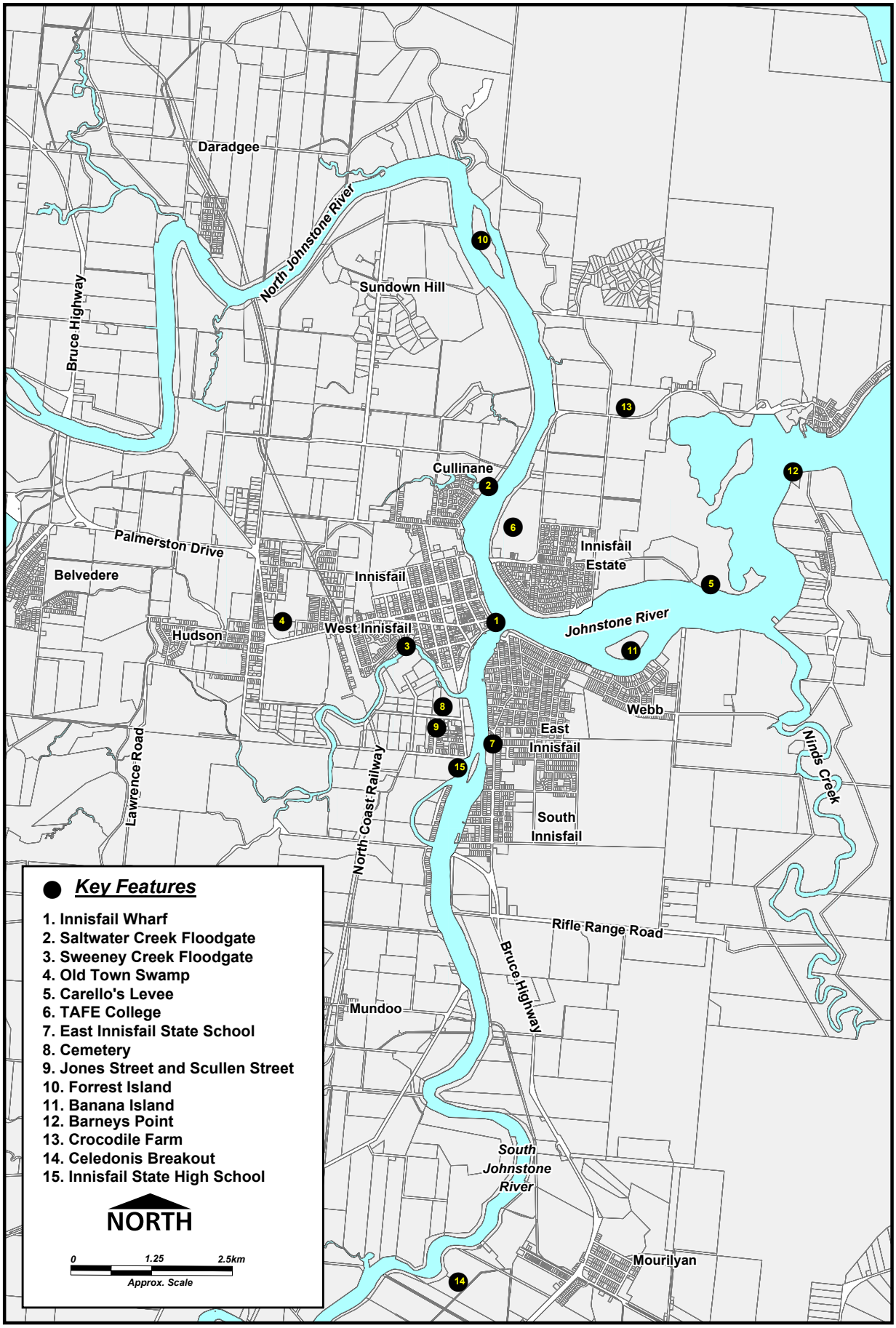
The **Property Modification Measures** comprise *Development Controls and Voluntary House Raising*. Development Controls ensure that new developments take into account the flood hazard in the area, thereby reducing the risk to life and limb and lowering the health, social, and psychological trauma associated with flooding. The risk of monetary damages to property is also greatly reduced. With these development controls, apart from rare floods, it is less likely that people residing in new dwellings require evacuation in the event of a flood and they may not have to remove possessions from their house. All of these factors help to reduce the impact of flooding.

The Voluntary House Raising measure reduces flood damages by providing financial assistance to help owners of highly flood prone houses to raise the floor level of their houses. Thus, the number of houses that are inundated (above floor) during flooding events is reduced. This measure is undertaken on a voluntary basis by the property owner.

The **Flood Modification Measure** offers significant protection from flooding for the floods that the raised Saltwater Creek and Sweeneys Creek levees keep out. The proposed raising scheme will decrease flood levels in the CBD in floods of magnitude up to about a 20 year ARI. For larger floods, raising the levees offers little or no additional protection to the current levees, although there is a benefit in that there is additional warning and evacuation time. Levee heights were selected as offering reasonable benefit-cost ratio with minimal flooding, visual and environmental impacts. There are also significant intangible benefits from raising the levees.



Locality Map **Figure 1**



Key Features **Figure 2**

Table A Proposed Floodplain Management Measures

Type	Measure	Priority	Cost	BC Ratio	Funding Responsibility	Section
Response Modification	Alarms on Nerada and Corsi Alert Stations	Immediate	Met by BoM	Not possible to determine	BoM	4.1
	Investigate Alarms at Other Alert Stations	Immediate	Normal Operating Budget of Council and other member organisations of the CDC	Not possible to determine	JSC	4.2
	Colour Banded Flood Totems	High	$40,000	Not possible to determine	DNRM & JSC	4.3
	GIS Emergency Management Maps	Immediate	Council's Normal Operating Budget	Not possible to determine	DNRM & JSC	4.4
	Revised Public Warning System	High	Council's Normal Operating Budget	Not possible to determine	JSC	4.5
	CDC Review of Study Outcomes	Immediate	Council's Normal Operating Budget	Not possible to determine	JSC	4.6
	Raise Community Awareness	High	$138,000	Not possible to determine	JSC	4.7
Property Modification	Voluntary House Raising	On-going	$1,200,000	0.33	DNRM & Residents	5.1
	Development Controls	High	Council's Normal Operating Budget	Not possible to determine	JSC	5.2
Flood Modification	Raise Existing Saltwater Creek & Sweeneys Creek Floodgate Levees	Medium	$175,000 to $318,000	4.7 to 2.6	DNRM & JSC	6.1
TOTAL			**$1,553,000 to $1,696,000 + Normal Operating Budgets**			

Economic Analysis

Indicative monetary costs were established where feasible for those measures for which the cost is not expected to fall within normal operating budgets of Council. These are summarised in Table B.

Table B Breakdown of Cost Estimates by Priority ($2002)

Priority	Council	DNRM	Homeowners	Total
Immediate Priority (ASAP)	-	-	-	-
High Priority (1 year)	$59,000+	$119,000+	$0	**$178,000**
Medium Priority (1 to 3 years)	$59,000 to $107,000	$116,000 to $211,000	$0	**$175,000 to $318,000**
Low Priority (>3 years or when the opportunity arises)	-	-	-	-
On-going Priority	$0	$800,000	$400,000	**$1,200,000**
Total Indicative Cost	**$118,000 to $166,000**	**$1,035,000 to $1,130,000**	**$400,000**	**$1,553,000 to $1,696,000**

+ These costs include the community awareness program over 10 years.

Review of Plan

The recommended actions proposed in this Plan are not set in concrete. They need to be reviewed and fine-tuned over time, taking into account the relative success of implemented actions and feedback from the community. The Plan needs to be continually revised, amended and updated.

Environmental Considerations

The proposed flood management measures will have no significant environmental impacts.

CONTENTS

LIST OF FIGURES

LIST OF TABLES

GLOSSARY

annual exceedance probability (AEP)	The chance of a flood of a given size (or larger) 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 (i.e. a 1 in 20 chance) of a peak discharge of 500 m^3/s (or larger) occurring in any one year. (see also average recurrence interval)
Australian Height Datum (AHD)	National survey datum corresponding approximately to mean sea level.
average annual damage (AAD)	Depending on its size (or severity), each flood will cause a different amount of flood damage. The average annual damage is the average damage in dollars per year that would occur in a designated area (e.g. the Innisfail area) from flooding over a very long period of time. In many years there may be no flood damage, in some years there will be minor damage (caused by small, relatively frequent floods) and, in a few years, there will be major flood damage (caused by large, rare flood events). Estimation of the average annual damage provides a basis for comparing the effectiveness of different floodplain management measures (i.e. the reduction in the annual average damage).
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 20yr ARI design flood will occur on average once every 20 years. ARI is another way of expressing the likelihood of occurrence of a flood event. (see also annual exceedance probability)
cadastral data	Property boundary data
catchment	The catchment at a particular point is the area of land that drains to that point.
design floor level	The minimum (lowest) floor level specified for a building.
design flood	A hypothetical flood representing a specific likelihood of occurrence (for example the 100 year or 1% probability flood). The design flood may comprise two or more single source dominated floods.
development	Existing or proposed works that may or may not impact upon flooding. Typical works are filling of land, and the construction of roads, floodways and buildings.
Discharge	The rate of flow of water measured in terms of volume over time (i.e. the amount of water moving past a point). Discharge and flow are interchangeable.
DEM/DTM	Digital Elevation Model or Digital Terrain Model - a three-dimensional model of the ground surface.
effective warning time	The available time that a community has from receiving a flood warning to when the flood reaches them.
flood	Relatively high river or creek flows, which overtop the natural or artificial banks, and inundate floodplains and/or coastal inundation resulting from super elevated sea levels and/or waves overtopping coastline defences.

flood awareness	An appreciation of the likely threats and consequences of flooding and an understanding of any flood warning and evacuation procedures. Communities with a high degree of flood awareness respond to flood warnings promptly and efficiently, greatly reducing the potential for damage and loss of life and limb. Communities with a low degree of flood awareness may not fully appreciate the importance of flood warnings and flood preparedness and consequently suffer greater personal and economic losses.
flood damage	The tangible and intangible costs of flooding.
flood behaviour	The pattern / characteristics / nature of a flood.
flood frequency analysis	An analysis of historical flood records to determine estimates of design flood flows.
flood fringe	Land that may be affected by flooding but is not designated as floodway or flood storage.
flood hazard	The potential risk to life and limb and potential damage to property resulting from flooding. The degree of flood hazard varies with circumstances across the full range of floods.
flood level	The height or elevation of floodwaters relative to a datum (typically the Australian Height Datum). Also referred to as "stage".
flood liable land	see flood prone land
floodplain	Land adjacent to a river or creek that is periodically inundated due to floods. The floodplain includes all land that is susceptible to inundation by the probable maximum flood (PMF) event.
floodplain management	The co-ordinated management of activities that occur on the floodplain.
floodplain management measures	A range of techniques that are aimed at reducing the impact of flooding. This can involve reduction of: flood damages, disruption and psychological trauma.
floodplain management plan	A document outlining a range of actions aimed at improving floodplain management. The plan is the principal means of managing the risks associated with the use of the floodplain. A floodplain risk management plan should be developed in accordance with the principles and guidelines contained in the CSIRO (2000). The plan will usually contain both written and diagrammatic information describing how particular areas of the floodplain are to be used and managed to achieve defined objectives.
floodplain management scheme	A floodplain management scheme comprises a combination of floodplain management measures. In general, one scheme is selected by the floodplain management committee and is incorporated into the plan.
flood planning levels (FPL)	Flood planning levels selected for planning purposes are derived from a combination of the adopted flood level plus freeboard, as determined in floodplain management studies and incorporated in floodplain risk management plans. Selection should be based on an understanding of the full range of flood behaviour and the associated flood risk. It should also take into account the social, economic and ecological consequences associated with floods of different severities. Different FPLs may be appropriate for different categories of landuse and for different flood plans. The concept of FPLs supersedes the "standard flood event". As FPLs do not necessarily extend to the limits of flood prone land, floodplain risk management plans may apply to flood prone land beyond that defined by the FPLs.

flood prone land	Land susceptible to inundation by the probable maximum flood (PMF) event. Under the merit policy, the flood prone definition should not be seen as necessarily precluding development. Floodplain Management Plans should encompass all flood prone land (i.e. the entire floodplain)
flood proofing	Measures taken to improve or modify the design, construction and alteration of buildings to minimise or eliminate flood damages and threats to life and limb.
flood source	The source of the floodwaters. In this study, the Johnstone River catchment is the primary source of floodwaters.
flood storages	Floodplain areas that are important for the temporary storage of floodwaters during a flood.
floodway	A flow path (sometimes artificial) that carries significant volumes of floodwaters during a flood.
freeboard	A factor of safety usually expressed as a height above the adopted flood level thus determing the flood planning level. Freeboard tends to compensate for factors such as wave action, localised hydraulic effects and uncertainties in the design flood levels.
historical flood	A flood that has actually occurred.
hydraulic	The term given to the study of water flow in rivers, estuaries and coastal systems.
hydrograph	A graph showing how a river or creek's discharge changes with time.
hydrology	The term given to the study of the rainfall-runoff process in catchments.
peak flood level, flow or velocity	The maximum flood level, flow or velocity occurring during a flood event.
photogrammetry	The technology used to obtain reliable measurements, maps, digital elevation models, and other GIS data primarily from aerial photography.
probable maximum flood (PMF)	An extreme flood deemed to be the maximum flood likely to occur.
probability	A statistical measure of the likely frequency or occurrence of flooding.
runoff	The amount of rainfall from a catchment that actually ends up as flowing water in the river or creek.
stage	See flood level.
stage hydrograph	A graph of water level over time.
TUFLOW	Fully two-dimensional unsteady flow hydraulic modelling software
URBS	Hydrological computer model software
velocity	The speed at which the floodwaters are moving. Typically, modelled velocities in a river or creek are quoted as the depth and width averaged velocity, i.e. the average velocity across the whole river or creek section.
water level	See flood level.

LIST OF ABBREVIATIONS

1D / 2D/ 3D	One dimensional / Two dimensional / Three dimensional
AEP	Annual Exceedance Probability
AHD	Australian Height Datum
ARI	Average Recurrence Interval
AR&R	Australian Rainfall and Runoff
BoM	Bureau of Meteorology
CBD	Central business district
CDC	Counter Disaster Committee
cm	centimetre
cumecs	cubic metres per second
DA	Development Application
DCP	Development Control Plan
DEM/DTM	Digital Elevation Model /Digital Terrain Model
DMR	Queensland Department of Main Roads
DNRM	Queensland Department of Natural Resources & Mines
DoT	Queensland Department of Transport
EIS	Environmental Impact Study
EPA	Queensland Environmental Protection Agency
ERA	Environmentally Referable Activity
FPL	Flood Planning Level
JSC	Johnstone Shire Council
JSRIT	Johnstone Shire River Improvement Trust
GIS	Geographic Information System
km	kilometre
m	metre
m^3/s	cubic metres per second
m AHD	Elevation in metres relative to the Australian Height Datum
PMF	Probable Maximum Flood
SES	QLD State Emergency Services

1 INTRODUCTION

1.1 Background

The Johnstone River system comprises the North Johnstone River and the South Johnstone River with their confluence being at the town of Innisfail. From the confluence, the river flows about 5 km to the ocean. The rivers have a combined catchment of about 1600 km^2 with the North Johnstone being the larger of the two with a catchment of about 1030 km^2. The locality of the river system is shown in Figure 1 and the key features in Figure 2.

The headwaters of the rivers are in the high rainfall area of the Cardwell Ranges. The rivers flow from the range down through gorges to the lower fertile floodplains that are predominantly utilised for agricultural purposes including sugarcane and banana farming. There are a number of townships on the floodplains including the major centre of Innisfail and the smaller townships of South Johnstone, Mourilyan, Wangan and Mundoo.

There is a history of severe flooding on the floodplain with considerable damage to property, agriculture and public infrastructure. Innisfail is most affected being at the confluence of the rivers and with development on flood prone land. Flooding in and around Innisfail town occurs initially through backup of Saltwater and Sweeneys Creeks and then through overtopping of the banks around Innisfail and further to the north in larger floods. The construction of floodgates on Sweeneys and Saltwater Creeks has helped to reduce the frequency of flooding in Innisfail, although the floodgates are overtopped in larger floods.

The suburbs of Webb, East Innisfail and South Innisfail are affected by overtopping of the river banks and by back up from the Johnstone River through the Ninds Creek catchment. Parts of Innisfail Estate are affected in larger floods through overtopping of the river bank. Mourilyan is affected in larger floods when the South Johnstone River overtops its banks. These floodwaters pass through Mourilyan and into the Ninds Creek catchment before rejoining the Johnstone River at the confluence with Ninds Creek.

Consideration of options to reduce flooding impacts, and planning for future development requires an understanding of the flood behaviour. To develop a greater understanding of flooding, hydrological and hydraulic flood models were developed and calibrated to historical floods. These models were then used to simulate a range of design floods that were the benchmark for assessing both past and future works.

Once flood behaviour is understood, a strategic approach to controlling development on flood prone land, assessing the advantages and disadvantages of flood mitigation options, flood proofing properties and buildings, educating and safeguarding communities and protecting the natural environment can be carried out with confidence. This Study provides such assessments, and actions arising from the Study recommendations were used to formulate this Floodplain Management Plan.

In 2000, the Johnstone Shire River Improvement Trust (JSRIT) issued a brief for the Johnstone River Flood Study to develop a Floodplain Management Plan. WBM Oceanics Australia was commissioned by the JSRIT to carry out this study. The Natural Disaster Risk Management Studies Program contributed 2/3 of the funding (1/3 from both Federal and State Governments) and 1/3 of the

funding for the study was provided by the Johnstone Shire Council through the Johnstone Shire River Improvement Trust. During the study, the Queensland Department of Main Roads contributed funds in recognition of the future value of the flood model.

The Plan focuses on the lower floodplain areas of the North and South Johnstone.

1.2 Objectives

The key objectives of the study were as follows:

1. develop a state-of-the-art computer model of the Johnstone Rivers System within the study area to define the nature and extent of the flood hazard;

2. model the effects of existing developments and existing flood mitigation measures to determine their impact on flooding, including community concerns raised during the resident survey and community open sessions;

3. propose, assess and recommend possible flood mitigation measures with consideration given to social, ecological and economic factors;

4. prepare a report detailing the development of the model, the assessment of the effect of existing development and flood mitigation measures, addressing community concerns and detailing proposed flood mitigation measures;

5. prepare a Floodplain Management Plan.

2 FLOODPLAIN MANAGEMENT IN THE JOHNSTONE RIVER FLOODPLAIN

The Johnstone River Flood Study comprises Stages 1 to 3 of the floodplain management process outlined in the overview of this document. The stages are repeated in Table 2-1. A summary of each of the objectives and findings of each of these stages is given in this Chapter.

Table 2-1 Floodplain Management Process

Stage	Description
1. Flood Behaviour Definition	The nature and extent of the flood problem are determined.
2. Floodplain Management Measures Investigation	Management measures for the floodplain are investigated in respect of both existing and proposed developments. These options are evaluated based on the impact on flood risk, while considering social, ecological and economic factors.
3. Floodplain Management Plan	Following acceptance of Stage 2 recommendations, the preferred management options are documented in a plan.
4. Implementation of the Plan	Involves formal adoption by Council of the floodplain risk management plan and a process of implementation for the selected flood, response and property modification options.

The Johnstone Shire River Improvement Trust formed a Steering Committee to oversee the Floodplain Management Study and to ensure that issues important to the Johnstone Rivers community have been addressed. The Steering Committee was comprised of:

- the River Trust
- community representatives;
- Chamber of Commerce representatives.

The Steering Committee had an important role in advising the Council and River Trust on recommendations for implementation in the Floodplain Management Plan. The mix of representatives provided a forum for the distillation and resolution of differing viewpoints before the plan is submitted to Council.

A series of discussion papers were presented and reviewed during the course of the study. These discussion papers represent the collective ideas of the consultant (WBM Oceanics Australia), the Steering Committee, and the community.

Throughout the study, regular meetings were held in Innisfail with the Committee at which the findings documented in the papers were discussed and issues were resolved. The discussion papers outlined the essential information about each floodplain management measure and, based on this information, the Committee decided whether individual measures were to be incorporated into a Floodplain Management Plan.

A summary of Stage 1 and 2 is given in Sections 2.1 and 2.2 respectively and this document constitutes Stage 3.

2.1 Stage 1 - Flood Behaviour Definition

The purpose of Stage 1 was to examine and define the flood behaviour of the lower Johnstone River system. This was done by:

- Reviewing relevant studies previously carried out.
- Identifying the nature and extent of historical floods.
- Developing predictive tools (computer models) that reproduce historical flood behaviour.
- Defining best estimates of the 2 yr, 5yr, 10yr, 20yr, 50yr, and 100yr ARI design floods.

Stage 1 is documented in detail in WBM (2003). A summary is given in this section.

Previous Studies

The most significant previous study was a floodplain management study by Cameron McNamara (Cameron McNamara, 1985). The study undertook hydraulic modelling using the one-dimensional software CELLS. The study recommended the construction of a major levee and pump system for Innisfail. However, the levee system was not implemented, probably because of concerns over the limited economic analysis undertaken in the study.

Fielding and Orpin (2000) is a study of the effects of Carello's levee on upstream flooding. The study was a desktop review and as such states "*the absolute result of the simplistic modelling analysis presented in this study is inconclusive*" but goes on to suggest that the potential for impacts should be recognised and investigated in any future flood studies.

Historical Flood Information Survey

An extensive survey of residents within the study area was conducted to gather historical data from those who have experienced Johnstone River floods and to identify local concerns within the region. The local knowledge of the flooding in both Innisfail and its surrounds was found to be invaluable. A number of flood heights in addition to those known to the JSC were identified and surveyed.

Computer Flood Modelling

Computer models are accurate, cost-effective and efficient tools to model a river's flood behaviour. For this study, the flood model comprises a hydrological model and a hydraulic model.

The hydrologic model determines the runoff that occurs following a particular rainfall event. The primary output from the hydrologic model is hydrographs at varying locations along the waterways to describe the quantity, rate and timing of stream flow that results from rainfall events. These hydrographs then become a key input into the hydraulic model.

The hydraulic model simulates the movement of flood waters through waterway reaches, storage elements, and hydraulic structures. The hydraulic model calculates flood levels and flow patterns and also models the complex effects of backwater, overtopping of embankments, waterway confluences, bridge constrictions and other hydraulic structure behaviour.

The Bureau of Meteorology (BoM) has established and calibrated an URBS hydrologic model of the Johnstone River catchment. This model was reviewed and adopted for the study. Some minor modifications to the model sub-catchments were made by WBM to match the locations of the hydraulic model boundaries.

The complicated nature of the floodplain flow patterns and importance of obtaining community confidence in the process required that state-of-the-art modelling techniques be adopted. For these reasons, TUFLOW, a fully 2D dynamic hydraulic modelling system was adopted. In total, the hydraulic model covers approximately 125 km^2 of the rivers and floodplain.

Information on the topography and characteristics of the catchments, rivers, creeks and floodplains were built into the models. The hydrologic and hydraulic models were calibrated/verified against the February 1999, March 1997 and March 1967 historical flood events to demonstrate the validity of the models. The calibration and verification illustrated the models' abilities to reproduce historic flood patterns collected during data collation and community consultation. Comparisons with comments on flooding patterns received during the historic flood information survey were also consistent with the hydraulic model's performance.

Design Floods

Design floods are hypothetical floods used for planning and floodplain management investigations. A design flood is defined by its probability of occurrence. It represents a flood which has a particular probability of occurring in any one year. For example, the 1% Annual Exceedence Probability (AEP) or 1 in 100 Average Recurrence Interval (ARI) flood is a best estimate of a flood which has 1 chance in 100 of occurring in any one year. It should be noted that planning for the 1 in 100 year ARI flood does not guarantee protection for the next 100 years.

Design flood levels in the Johnstone River system were assessed using an iterative approach comparing results of hydrologic/hydraulic model results for given rainfall events against results of frequency analyses on the North Johnstone at Goondi and Tung-Oil and on the South Johnstone at Central Mill. The final Johnstone River system design flows were determined by critical assessment of the results in consultation with the Steering Committee. Design flood levels, flows and velocities were determined for the 100, 50, 20, 10, 5 and 2 year ARI floods.

The design floods were used to make an assessment of the financial losses to residential and commercial properties. These financial losses were then used in Stage 2 as a basis to do an economic assessment of potential floodplain management measures. Historical damage to public infrastructure was documented where information was available.

The design flood results were presented in a variety of map formats showing flood levels and depths.

2.2 Stage 2 - Floodplain Management Measures Investigation

The primary objective of this stage was to propose, assess and recommend possible flood mitigation measures, with consideration given to social, ecological and economic factors, that would lead to the formulation of this Floodplain Management Plan.

The key aspects of this stage of the study were the assessment of existing flood damages, the definition of flood hazard and the identification and assessment of floodplain management measures aimed at reducing the impact of flooding on both the existing and future developments.

Stage 2 is documented in detail in WBM (2003). A summary is given in this section.

Existing Flood Damages Assessment

To improve floodplain management on the Lower Johnstone Rivers and to allow the effectiveness of management measures to be assessed, damages from flooding incurred on the floodplain were quantified. These damages establish the economic costs to society and are used to quantify the benefits of certain mitigation measures (eg. levees).

The Lower Johnstone Rivers region is a primary industry based economy serviced by a number of townships, the largest being Innisfail. The region comprises predominantly floodplain lands used for sugar cane, banana and pastoral activities. During flooding under existing conditions, agricultural activities sustain substantial flood damage, reflecting the location of these activities in the floodplain. Damages are not limited to the agricultural sector with significant damages also occurring to residential property, businesses and public infrastructure, particularly in larger floods.

Flood damages are classified as tangible or intangible, reflecting the ability to assign monetary values. Intangible damages arise from adverse social and environmental effects caused by flooding, including factors such as loss of life and limb, stress and anxiety. Tangible damages are monetary losses directly attributable to flooding. They may occur as direct or indirect flood damages. Direct flood damages result from the actions of floodwaters, inundation and flow, on property and structures. Indirect damages arise from the disruptions to physical and economic activities caused by flooding. Examples are the loss of sales, reduced productivity and the cost of alternative travel if road and rail links are broken.
The existing total flood damages are summarised in Table 2-2 and Table 2-3 with a breakdown of the rural damages into land use given in

Table 2-4 and a breakdown of the urban damages into building type in Table 2-5. The detailed procedure used to calculate these flood damages is explained in the Johnstone River Flood Study (WBM Oceanics Australia, 2003), but a brief summary is provided to explain the difference between the tables.

The full range of floods up to the probable maximum flood (PMF) is required to correctly calculate the AAD. The largest flood considered in this study is the 100 year ARI event and so a “correct” AAD was not calculated. However, an approximation was made for the residential/commercial damages in a PMF and included in the calculation of the average annual damages for residential and commercial properties. The rural damages in a PMF were not calculated. The total damages excluding the PMF damages are presented in Table 2-2. The total damages including the PMF residential and commercial damages are presented in Table 2-3. These calculations do not include damage to infrastructure or intangible damages.

Shown at the bottom of the tables is the average annual damage (AAD). The AAD is the average damage in dollars per year that would occur in a designated area from flooding over a very long period of time. In many years there may be no flood damage, in some years there will be minor

damage (caused by small, relatively frequent floods) and, in a few years, there will be major flood damage (caused by large, rare flood events). Estimation of the AAD provides a basis for comparing the effectiveness of different floodplain management measures (i.e. the reduction in the annual average damage).

The AAD excluding floods greater than the 100 year ARI is about $3 million and with the inclusion of an approximation to the residential and commercial PMF damages, the AAD is about $4.5 million. To properly calculate the AAD, the calculation of the PMF flood extent and height needs to be improved and the rural damages included. From the calculations done within the limitations of this study, it could be reasonably assumed that the AAD for the study area is > $4.5 million, excluding damages to infrastructure and intangible damages.

Apart from the lack of modelled flood data for events >100 year ARI, the other significant uncertainties in the calculation of the AAD are the banana damages and the floor level assumptions as detailed in WBM (2003). Importantly, these uncertainties will have no significant influence on the outcomes of the study because the AAD is primarily used for the economic assessment of flood management measures. In these assessments, the change in AAD as a result of the implementation of the measure is of interest, not the absolute AAD.

Table 2-2 Total Flood Damage (excl floods >100 Year ARI)

Flood Event (years ARI)	Annual Exceedence Probability	Existing Case ($2002)	
		Total Damages	Incremental Area Under Total Damages Curve
100	1%	$92,243,000	
50	2%	$52,127,000	$722,000
20	5%	$8,724,000	$913,000
10	10%	$4,380,000	$328,000
5	20%	$2,609,000	$349,000
2	50%	$888,000	$525,000
1	99%	$0	$222,000
Average Annual Damage (excl. floods > 100 year ARI)			**$3M**

+ Excluding infrastructure and intangible damages

Table 2-3 Total Flood Damage (PMF estimated)

Flood Event (years ARI)	Annual Exceedence Probability	Existing Case ($2002)	
		Total Damages	Incremental Area Under Total Damages Curve
PMF*	0%	$210,000,000	
100	1%	$92,243,000	$1,511,000
50	2%	$52,127,000	$721,850
20	5%	$8,724,000	$912,765
10	10%	$4,380,000	$327,600
5	20%	$2,609,000	$349,450
2	50%	$888,000	$524,550
1	99%	$0	$222,000
Average Annual Damage			**$4.5M**

+ Excluding infrastructure and intangible damages

* A PMF (probable maximum flood) was not modelled. The total damages estimate for the PMF was calculated assuming a flood level 2 m higher than the 100 year ARI flood level. Neither the damages estimate nor the flood level assumption should be quoted. The total damages figure for the PMF does not include rural damages.

Table 2-4 Rural Flood Damages per Land Use

Flood Event (years ARI)	Damages per Landuse ($2002)		
	Sugar Cane	Banana	Beef
100	$1,003,000	$7,790,000	$350,000
50	$819,000	$6,175,000	$334,000
20	$581,000	$4,028,000	$314,000
10	$418,000	$2,812,000	$290,000
5	$305,000	$1,843,000	$262,000
2	$167,000	$513,000	$202,000

Table 2-5 Flood Damages per Property Type

Flood Event (years ARI)	Existing Case ($2002)	
	Commercial	Residential
PMF*	$150,000,000	$60,000,000
100	$65,000,000	$18,000,000
50	$35,000,000	$10,000,000
20	$2,400,000	$1,400,000
10	$585,000	$275,000
5	$133,000	$67,000
2	$4,500	$1,500
1	$0	$0

* A PMF (probable maximum flood) was not modelled. The total damages estimate for the PMF was calculated assuming a flood level 2 m higher than the 100 year ARI flood level. Neither the damages estimate nor the flood level assumption should be quoted.

Flood Hazard Assessment

Flood hazard is the term used to describe the potential risk to life and limb and potential damage to property resulting from flooding. The degree of flood hazard varies both in time and place across the floodplain. Floodwaters are deep and fast flowing in some areas, whilst at other locations they are shallow and slow moving. It is important to determine and understand the variation in the degree of hazard and flood behaviour across the floodplain. The flood hazard categories that have been adopted for the Johnstone Rivers area are described in Table 2-6 and the flood hazard map of the study area is presented in Appendix A. These maps will be used for the purposes of controlling development. The criteria used to define each of the flood hazard categories are outlined in the Johnstone River Flood Study (WBM Oceanics Australia, 2003). The High Hazard – Wading Unsafe category is included as it may be of benefit to the State Emergency Service in their planning response. It is not recommended as a category for the purposes of development control.

Table 2-6 Flood Hazard Categories for Johnstone Floodplain

Hazard Category	Base Flood Event	Characteristics
Low	100 yr	• Areas that are inundated in a 100yr flood, but the floodwaters are relatively shallow (typically less than 1m deep) and are not flowing with high velocity • Adult can wade
High – Wading Unsafe	100 yr	• The depth and/or velocity are sufficiently high that wading is not possible - risk of drowning
High – Depth	100 yr	• Areas where the floodwaters are deep (> 1m), but are not flowing with high velocity. • Damage only to building contents, large trucks may be able to evacuate
High – Floodway	100 yr	• Typically areas where there is deep water flowing with a high velocity • Truck evacuation not possible, structural damage to light framed houses, high risk to life
Extreme	100 yr	• Typically areas where the velocity is > 2 m/s • All buildings likely to be destroyed, high probability of death

Assessment of Floodplain Management Measures

The Steering Committee identified a number of floodplain management measures as being worthy of assessment. Each measure was grouped into one of following three categories.

1. **Flood Modification Measures** - designed to alter the behaviour of the flood itself by reducing flood levels and/or velocities, or by excluding floodwaters from areas at risk.

2. **Property Modification Measures** - modifications to existing buildings to reduce the risk of flooding and/or imposition of controls on property and infrastructure development.

3. **Response Modification Measures** - aimed at increasing the ability of people to respond appropriately in times of flood and/or enhancing the flood warning and evacuation procedures in an area.

The floodplain management measures considered as part of the Study are described below.

Flood Modification Measures

The initial assessment of flood modification measures was a desktop review of all ideas collated from the Steering Committee, the community and WBM. From this review the Steering Committee selected measures for a preliminary flood height impact analysis and following a review of the preliminary analysis, the Steering Committee selected measures for a detailed analysis. Table 2-7 lists all of the flood modification measures considered by the Steering Committee, the level of analysis (preliminary or detailed) and the final recommendation of the Steering Committee.

Table 2-7 Flood Modification Measures & Steering Committee Decisions

Measure	Preliminary Analysis?	Detailed Analysis?	Recommended by SC?
Realignment of Carello's Levee	Yes	No	No
Channel at Carello's Levee (a) constructed channel (b) scoured channel;	 Yes No	 Yes Yes	 No No
Raise existing Saltwater and Sweeneys Creek floodgate levees	Yes	Yes	Yes
Webb Levee - along river bank from Corinda Street downstream	Yes	Yes	No
Levee around Webb as proposed in Cameron McNamara (1985)	No	No	No
River bank levee near Innisfail East State School	Yes	No	No
River bank levee near TAFE	No	No	No
Increase size of culverts at Crocodile Farm	No	No	No
Dredging options	Yes	Yes	No
Saltwater Creek devegetation	No	No	No
Increased cross-drainage along Coquette Point Road at Ninds Creek	No	No	No
Increase drainage capacity under Bruce Highway near Mourilyan	No	No	No
River levee bank to reduce/prevent breakout of river across to Mourilyan	No	No	No
Levee scheme as proposed by Cameron McNamara in 1985	Yes	No	No
Floodgate on Gracey Creek	No	No	No
Tabone diversion channel	Yes	No	No
Overflow channel into Ninds Creek and then to Mourilyan Harbour	No	No	No
Dam on North Johnstone	No	No	No

Property Modification Measures

- **Voluntary House Purchase**
  Purchasing houses that are in a high floodway risk area.
- **Voluntary House Raising**
  Raising the floor level of individual houses to a specified level. Thus, the number of houses that are inundated during flood events may be reduced.
- **Development Control Planning**
  The imposition of controls on property and infrastructure development. For example, setting the minimum habitable floor level for new houses based on the design flood levels.

Response Modification Measures

- **Flood Warning & Emergency Planning**
  Enhance and improve flood warning and emergency planning in the study area with a particular emphasis on floods larger than previously expereienced. An effective flood warning system, in combination with a high level of community awareness, is invaluable in minimising the flood damages and trauma associated with flooding. An accurate, prompt warning system ensures that residents are given the best opportunity to move their possessions out of the danger of floodwaters. Comprehensive emergency planning ensures that no time is wasted in the event of a flood and response measures are implemented efficiently.
- **Raising Community Awareness**
  Increase knowledge of flooding and the level of preparedness amongst the Johnstone River community. As the community becomes more aware of the potential for flooding, it is less likely that people experience health and psychological trauma following a flood. Also, the community is more likely to respond effectively to flood warnings and to remove possessions and themselves from the dangers of floodwaters.

Assessment Process

For each of the floodplain management measures investigated, a discussion paper was prepared for and presented to the Steering Committee. These discussion papers outlined the essential information about each measure and, based on this information, the Steering Committee decided whether individual measures were to be adopted or rejected.

Each modification measure was assessed in relation to the following criteria (where applicable):

- cost;
- benefit;
- hydraulic impacts;
- social issues;
- environmental issues; and
- funding constraints.

The assessment of the floodplain management measures investigated is summarised in Table 2-8; this table only includes the flood modification measures for which at least a preliminary analysis was undertaken. A detailed evaluation of the viability of each of these measures is contained in the Johnstone River Flood Study (WBM Oceanics Australia, 2003).

Table 2-8 Assessment of Floodplain Management Measures

Measure	Description	Investigation Details	Benefit-Cost Ratio	Hydraulic Impacts	Recommendations of the Committee
Realignment of Carello's Levee	Remove eastern section of levee with new levee to the north at point where levee removed. Portion of land to the east of new levee lowered to RL 2.0 m **Aim:** To re-open overbank flow area and reduce flood levels in upstream residential areas.	Preliminary analysis on flood model using February 1999 flood	Not calculated	Negligible	The committee recommended that the measure NOT be adopted because the flood benefits were negligible.
Carello's Channel	140 m wide channel across the corner of the river bend at the eastern end of Carello's property **Aim:** Improve the hydraulic efficiency of the bend thereby reducing upstream flood levels	Detailed analysis using 2, 5, 10, 20, 50 & 100 year ARI floods	0.3 (excludes maintenance, acid sulphate soil problems and revised floor levels)	Widespread reductions in the range 30 mm to 100 mm. Some increase on Carello's property.	The committee recommended that the measure NOT be adopted because of the low BCR, and high capital costs.
Carello's Channel – Naturally Scoured	Same as above, but it is assumed that the channel naturally scours giving a significant cost saving	Analysis assumed to be the same as above	0.1 to 2.8 – dependent on period for scouring to occur, rock protection not included	Assumed to be the same as above.	The committee recommended that the measure NOT be adopted because of the high uncertainty associated with the BCR and environmental issues.
Raise Levees at Existing Sweeneys and Saltwater Creek Floodgates	Raise and extend levees to 20 year level **Aim:** To decrease flood levels at commercial and residential properties in the CBD area and to the west	Detailed analysis using 2, 5, 10, 20, 50 & 100 year ARI floods.	2.6 or 4.7 – Lower BCR assumes an additional protective levee is constructed near Scullen Ave	Significant reductions in flood levels in CDB in floods up to 20 year ARI. Minor increases outside of areas protected by floodgates.	The committee recommended that the measure be included in the Plan because of the flood benefits, including increased warning time, the high BCR, relatively low capital cost. and no environmental issues.
River Bank Levee Near Innisfail East State School	100 year ARI levee to prevent overflow from South Johnstone river. **Aim:** To decrease peak flood levels in the lower areas of East and South Innisfail.	Preliminary analysis using 100 year ARI.	Not calculated	Decrease in flood level in small area East and South Innisfail. Widespread increases of about 40 mm across river and in Innisfail.	The committee recommended that the measure NOT be adopted for 2 reasons: i. the houses are generally high set in the areas that would benefit, and ii. the widespread increases in flood level..
River Dredging	Dredged river channel 40 m wide to RL –4.5 m AHD from about Saltwater Ck inlet to Flying Fish Point **Aim:** To increase conveyance capacity of channel thereby reducing floodplain flood levels. Dredging would also provide a navigation channel.	Detailed analysis using 2, 5, 10, 20, 50 & 100 year ARI floods.	0.5 to 1.7 depending on disposal method – does not include maintenance dredging which would substantially reduce BCR, BCR would reduce if revised floor levels used.	Widespread reductions in flood level from 30 mm to 120 mm.	The committee recommended that the measure NOT be adopted because of the risk in relation to the maintenance dredging requirements and the capital cost. However, the findings of this report could be used as supporting information in other dredging applications.

Measure	Description	Investigation Details	Benefit-Cost Ratio	Hydraulic Impacts	Recommendations of the Committee
Levee Scheme as proposed by Cameron McNamara (1985)	Levee system for Innisfail, Webb & East Innisfail **Aim:** To provide 100 year ARI protection from river flooding	Preliminary analysis using 100 year ARI.	Not calculated	250 mm to 450 mm reductions in areas protected by levee and 300 mm to 450 mm increases outside of levee	The committee recommended that the measure NOT be adopted because of the impacts outside of the levee and an anticipated high capital cost.
Tabone Diversion Channel	Diversion channel from North Johnstone River, upstream of Innisfail, to approximately Barney's Point. **Aim:** Remove flow from river to reduce flood levels in Innisfail, Innisfail Estate and Webb	Preliminary analysis using 100 year ARI.	Not calculated	Widespread reduction in flood level except in Webb. Increases in flood level around outlet, but not in inhabited areas.	The committee recommended that the measure NOT be adopted because of the anticipated high capital costs and potential environmental issues.
Voluntary House Purchase	Identify residential houses in high floodway hazard areas which may benefit from voluntary house purchase. **Aim:** To remove dwellings in high floodway hazard areas.	Identified residential dwellings located in High Hazard – Floodway or Extreme Hazard categories	Not calculated	-	No dwellings within the study area were within a these hazard categories and hence the committee recommended that this option NOT be included in the Plan.
Voluntary House Raising	Identify residential houses inundated in specific events. **Aim:** To offer funding to raise these houses to reduce flood damages and trauma.	**Inundation Level** a. 20 year b. 50 year c. 100 year	 0.33 0.2 0.13	-	Option a. is to be included in the Plan.
Development Control Planning	Develop planning controls suitable for various development types and flood situations. **Aim:** To reduce future flood damages by controlling future development on the floodplain.	-	-	-	JSC is currently finalising its new Town Planning Scheme and has advised that it would not be possible to modify it at this stage. However, the committee recommends that the principles of floodplain management be incorporated into the next revision.
Alarms on Nerada & Corsi Alert Stations	Install river height and rainfall alarms with message automatically sent to nominated CDC member. **Aim:** To enable faster activation of CDC	-	-	-	The committee recommended that this measure be included in Plan.
Investigate Alarms at other Alert Stations	Review ALERT network to identify other locations for installation of alarms **Aim:** To enable faster activation of CDC.	-	-	-	The committee recommended that this measure be included in Plan.

Measure	Description	Investigation Details	Benefit-Cost Ratio	Hydraulic Impacts	Recommendations of the Committee
Colour Banded Flood Totems	Installation of colour banded flood totems in conjunction with colour classification of floods **Aim:** Increase community awareness of flooding and allow quick assessment by residents of the implication of flood warning in their local area.	-	-	-	The committee recommended that this measure be included in Plan.
GIS Emergency Maps	Develop maps from computer modelling that show flood extent and depth. Maps would be developed for a range of gauge heights at the Innisfail Wharf. **Aim:** To provide a tool for emergency planning and response that will allow a fast assessment of likely flood extent especially for floods larger than experienced.	-	-	-	The committee recommended that this measure be included in Plan.
Flood Warden System	Develop a system of local flood wardens who have a responsibility to advise residents in their area of flood warning. **Aim:** To improve dissemination of flood warnings and community response.	-	-	-	The committee recommended that this measure be included in Plan.
Automated Telephone Warning System	Key people are automatically dialled and issued with a recorded flood warning message **Aim:** To improve dissemination of flood warnings and community response.	-	-	-	The committee recommended that this measure be included in Plan.
Flood Warnings to Local Business	Fax flood warnings to local business. **Aim:** To increase response time available to local business.	-	-	-	The committee recommended that this measure be included in Plan.
CDC Review of Study Outcomes	Review of data, assessments and recommendations in report. **Aim:** To ensure that emergency response plan is adequate, especially for larger flood events.	-	-	-	The committee recommended that this measure be included in Plan.
Flood Awareness Campaign	Develop a community awareness program. **Aim:** To minimise the psychological and monetary damage caused by flooding by increasing the level of preparedness of the community	-	-	-	The committee recommended that this measure be included in Plan.

Floodplain Management Plan

The ultimate outcome of the Study was the formulation and selection of the Floodplain Management Plan. A Floodplain Management Plan is a combination of the floodplain management measures approved by the Committee. The recommended flood management measures are summarised in Table 2-9.

Table 2-9 Recommended Floodplain Management Plan

Type	Measure	Section
Response Modification	Alarms on Nerada and Corsi Alert Stations	4.1
	Investigate Alarms at Other Alert Stations	4.2
	Colour Banded Flood Totems	4.3
	GIS Emergency Management Maps	4.4
	Revised Public Warning System	4.5
	CDC Review of Study Outcomes	4.6
	Raise Community Awareness	4.7
Property Modification	Voluntary House Raising	5.1
	Development Controls	5.2
Flood Modification	Raise Existing Saltwater Creek & Sweeneys Creek Floodgate Levees	6.1

3 OVERVIEW OF THE FLOODPLAIN MANAGEMENT PLAN

Table 3-1 summarises the proposed floodplain management measures, priorities, costs and funding responsibilities. A priority is assigned to each of the measures using the following classification system.

Immediate	Measures implemented immediately or as soon as possible (ASAP)
High	Measures implemented within one (1) year
Medium	Measures implemented within one (1) to three (3) years
Low	Long-term measures (implementation after three (3) years or when the opportunity arises)
On-going	On-going measures

Table 3-1 Proposed Floodplain Management Measures

Type	Measure	Priority	Cost	BC Ratio	Funding Responsibility	Section
Response Modification	Alarms on Nerada and Corsi Alert Stations	Immediate	Met by BoM	Not possible to determine	BoM	4.1
	Investigate Alarms at Other Alert Stations	Immediate	Normal Operating Budget of Council and other member organisations of the CDC	Not possible to determine	JSC	4.2
	Colour Banded Flood Totems	High	$40,000	Not possible to determine	DNRM & JSC	4.3
	GIS Emergency Management Maps	Immediate	Council's Normal Operating Budget	Not possible to determine	DNRM & JSC	4.4
	Revised Public Warning System	High	Council's Normal Operating Budget	Not possible to determine	JSC	4.5
	CDC Review of Study Outcomes	Immediate	Council's Normal Operating Budget	Not possible to determine	JSC	4.6
	Raise Community Awareness	High	$138,000	Not possible to determine	JSC	4.7
Property Modification	Voluntary House Raising	On-going	$1,200,000	0.33	DNRM & Residents	5.1
	Development Controls	High	Council's Normal Operating Budget	Not possible to determine	JSC	5.2
Flood Modification	Raise Existing Saltwater Creek & Sweeneys Creek Floodgate Levees	Medium	$175,000 to $318,000	4.7 to 2.6	DNRM & JSC	6.1
TOTAL			**$1,553,000 to $1,696,000 + Normal Operating Budgets**			

Funding Constraints

The implementation of the floodplain management scheme outlined in this Plan is partly subject to the allocation of funding by the State Government. However, Council should endeavour to implement some of the initiatives outlined in the Plan regardless of the level of funding from the State Government. The following floodplain management measures can be initiated (*either in part or in full*) following the adoption of the Plan by Council without waiting for State Government funding:

- **Raise Community Awareness (*in part*)** – It is anticipated that a significant portion of the funds required to implement this measure will be provided by the State Government. However, Council should begin to implement some aspects of the flood awareness campaign as soon as possible.
- **Investigate Alarms at Other Alert Stations (*in full*) -** This action would be undertaken by the Counter Disaster Committee with the cost being that associated with the time put into the task by members of the CDC and others.
- **Colour Banded Flood Totems (*in part*) -** It is anticipated that a significant portion of the funds required to implement this measure will be provided by the State Government. Before the measure is implemented it is recommended that the proposal in principle is discussed with the Department of Emergency Services and the Bureau of Meteorology. However, these discussions could be held prior to funding approval from the State.
- **GIS Emergency Management Maps (*in part*) -** It is anticipated that a significant portion of the funds required to implement this measure will be provided by the State Government. It is recommended that the provision of the necessary data by the Consultant be undertaken immediately.
- **Revised Public Warning System (*in full)* –** This measure does not require funding from the State Government. It is anticipated that the cost of implementing this measure is met by Council within its normal operating budget.
- **CDC Review of Study Outcomes (*in full)* -** This measure is a review of procedures and does not require funding from the State Government.
- **Development Controls (*in full*)** – This measure does not require any funding from the State Government. It is anticipated that the cost of implementing this measure is met by Council within its normal operating budget.
- **Raise Existing Saltwater Creek & Sweeneys Creek Floodgate Levees (*in part*) -** It is anticipated that a significant portion of the funds required to implement this measure will be provided by the State Government. However, further investigation into the impacts of the proposal are required and it is recommended that these begin immediately.

Overall Benefits

The **Response Modification Measures** make recommendations to improve the effectiveness of the *Flood Warning System* and *Emergency Management Planning* in the lower Johnstone River area. An important aspect of this is the *Raise Community Awareness* measure which helps to foster a high level of flood awareness. This combination is invaluable in minimising flood damages and trauma associated with flooding. An accurate, prompt warning system ensures that residents are given the

best opportunity to remove their possessions and themselves from the dangers of floodwaters. The community awareness program ensures that the community understands the warning system and what actions to take. Also, in a community with a high level of flood awareness, it is less likely that people experience health and psychological trauma following a flood.

The **Property Modification Measures** comprise *Development Controls and Voluntary House Raising*. Development Controls ensure that new developments take into account the flood hazard in the area, thereby reducing the risk to life and limb and lowering the health, social, and psychological trauma associated with flooding. The risk of monetary damages to property is also greatly reduced. With these development controls, apart from rare floods, it is less likely that people residing in new dwellings require evacuation in the event of a flood and they may not have to remove possessions from their house. All of these factors help to reduce the impact of flooding.

The Voluntary House Raising measure reduces flood damages by providing financial assistance to help owners of highly flood prone houses to raise the floor level of their houses. Thus, the number of houses that are inundated (above floor) during flooding events is reduced. This measure is undertaken on a voluntary basis by the property owner.

The **Flood Modification Measure** offers significant protection from flooding for the floods that the raised Saltwater Creek and Sweeneys Creek levees keep out. The proposed raising scheme will decrease flood levels in the CBD in floods of magnitude up to about a 20 year ARI. For larger floods, raising the levees offers little or no additional protection to the current levees, although there is a benefit in that there is additional warning and evacuation time. Levee heights were selected as offering reasonable benefit-cost ratio with minimal flooding, visual and environmental impacts. There are also significant intangible benefits from raising the levees.

Economic Analysis

Indicative monetary costs were established where feasible for those measures for which the cost is not expected to fall within normal operating budgets of Council. These are summarised in Table 3-2.

Table 3-2 Breakdown of Cost Estimates by Priority ($2002)

Priority	Council	DNRM	Homeowners	Total
Immediate Priority (ASAP)	-	-	-	-
High Priority (1 year)	$59,000[+]	$119,000[+]	$0	**$178,000**
Medium Priority (1 to 3 years)	$59,000 to $107,000	$116,000 to $211,000	$0	**$175,000 to $318,000**
Low Priority (>3 years or when the opportunity arises)	-	-	-	-
On-going Priority	$0	$800,000	$400,000	**$1,200,000**
Total Indicative Cost	**$118,000 to $166,000**	**$1,035,000 to $1,130,000**	**$400,000**	**$1,553,000 to $1,696,000**

[+] These costs include the community awareness program over 10 years.

All of the measures in the scheme have intangible benefits to which it is difficult to assign monetary value. These intangible benefits need to be considered when evaluating the benefits of the scheme.

Implementation Program

The implementation program for the measures are provided in the "Process for Implementation" tables in the description of each of the measures given in Chapters 4, 5 and 6.

Review of Plan

The recommended actions proposed in this Plan are not set in concrete. They need to be reviewed and fine-tuned over time, taking into account the relative success of implemented actions and feedback from the community.

Environmental Considerations

The proposed flood management measures will have no significant environmental impacts.

4 RESPONSE MODIFICATION MEASURES

An accurate, prompt warning system ensures that residents are given the best opportunity to remove their possessions and themselves from the dangers of floodwaters. The ultimate success of flood warning and emergency planning is closely linked to the effectiveness of issued warnings and the level of flood awareness throughout the community. The flood warning and emergency planning measures are described in this section.

4.1 Alarms for Nerada and Corsi Alert Stations

Aim

To provide earlier warning for the activation of the Counter Disaster Committee

Discussion

Under current procedures, the Counter Disaster Committee (CDC) is activated once the nominated representative receives a flood warning from the Bureau of Meterology. Although this system generally works well, the response time available on the Johnstone River can be as as short as about 6 hours. Any additonal warning time will allow the CDC and the community to better respond to the threat and thereby potentially reduce the risk to life and property.

Proposal

It is proposed to install river height and rainfall alarms at the Nerada and Corsi alert stations. The alarm would be triggered at a predetermined river height or rainfall scenario. The alarm would be sent to either a pager or mobile telephone of a nominated member of the CDC who then activates the CDC if required. This proposal will potentially increase the warning time, and hence preparation time, of the order of 2 hours.

Summary

Monetary Benefit	*
Monetary Cost [1]	-
Monetary Benefit-Cost Ratio	*
Number of Buildings with Improved Protection	All

Intangible Benefits

An effective flood warning system is invaluable in minimising the flood damages and trauma associated with flooding. An accurate, prompt warning system ensures that residents are given the best opportunity to remove possessions and themselves from the dangers of floodwaters. The intangible benefits are high.

* cannot be determined

[1] the BoM has advised that they can make the necessary modification to the software at these stations without any cost to the Shire.

Process for Implementation

Task	Responsible Agency	Time for Completion*
1 Discuss requirements with BoM	CDC	Underway
2 Establish river height and rainfall triggers	CDC/BoM	3 months
3 Make necessary adjustments to software at alert stations	BoM	5 months
4 Revise protocols in Emergency Management Plan for activation of CDC	CDC	6 months

* this is the target time for completion of the task from the start of implementation of the measure.

Proposed Funding Scheme

The BoM has advised that they would make the changes to the software at the Alert Stations at no cost to the Council. There would be a nominal on-going cost to the Shire associated with the pager or mobile telephone, although it is likely that nominated personnel would currently be supplied a mobile telephone by the Council or their employer.

4.2 Alarms at Other Alert Stations

Aim

To provide earlier warning for the activation of the Counter Disaster Committee

Discussion

Alarms at the Corsi and Nerada alert stations are proposed for rainfall and river height. This will provide additional warning time based on the conditions approximately one-third of the way up the catchment. Additonal warning time could be achieved by installing alarm systems on rainfall gauges further up the range. Any additonal warning time will allow the CDC and the community to better respond to the threat and thereby potentially reduce the risk to life and property.

Proposal

To investigate options for installing alarms at Alert rainfall gauges further up the range in both the North Johnstone River and South Johnstone River catchments. It is recommended that discussions be held with the Bureau of Meterology to determine the most appropriate gauges. Possibilities include Sutties Creek, Greenhaven, Milla Milla, Bartle View, Topaz and Crawfords Lookout. The alarm would be triggered at a predetermined rainfall scenario. The alarm would be sent to either a pager or mobile telephone of a nominated member of the CDC who then activates the CDC if required.

Summary

Monetary Benefit	*
Monetary Cost [1]	-
Monetary Benefit-Cost Ratio	*
Number of Buildings with Improved Protection	All

Intangible Benefits

An effective flood warning system is invaluable in minimising the flood damages and trauma associated with flooding. An accurate, prompt warning system ensures that residents are given the best opportunity to remove possessions and themselves from the dangers of floodwaters. The intangible benefits are high.

* cannot be determined

[1] the BoM has advised that they can make the necessary modification to the software at these stations without any cost to the Shire.

Process for Implementation

Task	Responsible Agency	Time for Completion*
1 Discuss requirements with BoM	CDC	Underway
2 Establish rainfall triggers	CDC/BoM	3 months
3 Make necessary adjustments to software at alert stations	BoM	5 months
4 Revise protocols in Emergency Management Plan for activation of CDC	CDC	6 months

* this is the target time for completion of the task from the start of implementation of the measure.

Proposed Funding Scheme

The BoM has advised that they would make the changes to the software at the Alert Stations at no cost to the Council. There would be a nominal on-going cost to the Shire associated with the pager or mobile telephone, although it is likely that nominated personnel would currently be supplied a mobile telephone by the Council or their employer.

4.3 Colour Banded Flood Totems

Aim

To improve dissemination of flood warning to local areas and to increase community awareness

Discussion

One of the difficulties for residents on the floodplain is understanding the implications of the predicted peak river flood height at the Innisfail Wharf in their local context. This is particularly a problem for new residents, but can equally be difficult for longer term residents when the predicted flood height is larger than they have experienced. A system that translates the predicted peak river height to local areas would allow residents to quickly appreciate the significance of the oncoming flood in their area and prepare appropriately.

Proposal

It is proposed to implement colour classification of floods and colour banded flood totems. During a flood, the colour classification of the flood is determined using a correlation between the predicted peak flood height at the Innisfail Wharf gauge and a colour system as shown in the example given in Appendix B. For example, if the predicted peak flood height issued by the BoM is 7.2 m gauge height, then the flood would receive a red classification. To allow the simple translation of this to local areas, totems are installed around the floodplain using the same colour sequencing; totems may simply be existing street name poles that are painted. This will allow residents to quickly ascertain the height that the flood is likely to reach; because the totems only show colour bands, residents will not get an exact level, but they will get an indication of the likely range of the peak flood height.

Because the flood height on the floodplain may be different from that in the river, output from the TUFLOW hydraulic model is initially used to establish the levels for the colour bands on the totems in the floodplain so that the hydraulic gradient is accounted for.

The height range of the coloured bands should be based on particular consequences of the flooding relating to emergency mapping. For example, if a large number of dwellings become inundated when a particular flood height is reached, this would be an appropriate height for a new colour band.

There are some areas on the floodplain where this approach may not be suitable without some further refinement of the system. The Innisfail CBD is one such example. Innisfail is effectively an off-river storage during floods, ie, it fills up once the river overtops its banks, initially at Sweeneys and Saltwater Creeks. Therefore, the peak flood height in Innisfail is dependent on both the river height and the duration that floodwaters are flowing into Innisfail. In its simplest form, the totem system does not account for the duration of flooding, but it may be possible to develop a system that incorporates duration using the BoM predicted hydrograph.

The BoM has raised some concerns relating the implementation of such a measures. Therefore, it is recommended that further discussions be undertaken with the BoM and the DES to resolve these matters.

It is recommended that consideration should be given to running a pilot program that would involve the establishment of a limited number of totems in a selected area to trial the system before it is fully implemented.

Summary

Monetary Benefit	*
Monetary Cost [1]	$40,000
Monetary Benefit-Cost Ratio	*
Number of Buildings with Improved Protection	All

Intangible Benefits

An effective flood warning system is invaluable in minimising the flood damages and trauma associated with flooding. An accurate, prompt warning system ensures that residents are given the best opportunity to remove possessions and themselves from the dangers of floodwaters. The intangible benefits are high.

* cannot be determined

[1] approximation only – cost will depend on number of totems installed and possible consultantcy fees to assist in design of system

Process for Implementation

	Task	Responsible Agency	Time for Completion*
1	Discuss system with BoM and DES	CDC	12 months
2	Design pilot system including revised flood warning procedures	CDC/BoM	15 months
3	Make adjustments to Emergency Management Plan	BoM	16 months
4	Install totems in pilot area and include in community awareness program	JSC	18 months

* this is the target time for completion of the task from the start of implementation of the measure.

Proposed Funding Scheme

The total monetary cost of the **Colour Banded Flood Totems** measure is estimated at $40,000, but this cost is dependent on the number of totems installed and possible consultancy fees to assist in the design of the scheme. It is anticipated that this cost is split between the DNRM Regional Flood Mitigation Program and the Council as follows:

DNRM Contribution	Council
$26,667	$13,333

4.4 GIS Emergency Flood Maps

Aim

To provide a tool to emergency services to determine the likely extent and height of flooding.

Discussion

One of the difficulties that emergency services staff face during a flood is determining where to allocate their resources. These decisions are best based on experience from previous flood events, but as staff change and previous big floods are further in the past, other tools that help the emergency services to determine likley extent and height of flooding would be beneficial.

Proposal

To develop GIS based emeregency flood maps depicting flood extent, depth and height. The maps will be developed for a range of flood heights at the Innisfail Wharf. GIS flood height surfaces will be generated using the TUFLOW hydraulic model and the Johnstone Shire Council will develop the flood maps.

Summary

Monetary Benefit	*
Monetary Cost [1]	$10,000
Monetary Benefit-Cost Ratio	*
Number of Buildings with Improved Protection	All

Intangible Benefits

Effective response during a flood can help minimise the flood damages and trauma associated with flooding. Being able to promptly warn those at risk and asign resources appropriately ensures that residents are given the best opportunity to remove possessions and themselves from the dangers of floodwaters. The intangible benefits are high.

* cannot be determined

[1] work will be predominantly done by JSC

Process for Implementation

	Task	Responsible Agency	Time for Completion*
1	WBM provide necessary flood surfaces	JSC	Completed
2	JSC Develop Flood maps	CDC/JSC	3 months
3	Make adjustments to Emergency Management Plan	BoM	6 months

* this is the target time for completion of the task from the start of implementation of the measure.

Proposed Funding Scheme

The development of GIS Emergency Flood Maps will be done in-house by Council with the costs within Council's normal operating budget. There will be some costs associated in consultancy fees in the provision of data to Council. These costs will be met by Council within its normal operating budget.

4.5 Revised Public Warning System

Aim

To improve the public warning system.

Discussion

The short response time of the Johnstone River catchment has led to situations in the past where residents and commercial businesses have been caught unaware of imminent flooding, particularly during the night.

Proposal

It is recommended that the CDC review its current procedures for disseminating information to the public and investigate options for improving the public warning system. Improvements could include a local flood warden system, faxing warnings to local business and a automated telephone warning system if such a system becomes available into the future. The revised public warning system would include the flood totems already identified in the plan.

The establishment of a local flood warden system would help to make people aware of flood warnings. The CDC would notify the local flood wardens who would then have the responsibility to disseminate this information to their local area. This may not be practical in the Johnstone catchment where the storm/cyclone event can still be over the town when the flood warnings start, thereby making it dangerous for a warden to be contacting residents. To further help the dissemination of flood warnings, local businesses could be faxed warnings or key members of the business community could be contacted and asked to notify their business neighbours.

Summary

Monetary Benefit	*
Monetary Cost [1]	-
Monetary Benefit-Cost Ratio	*
Number of Buildings with Improved Protection	All

Intangible Benefits

An effective flood warning system is invaluable in minimising the flood damages and trauma associated with flooding. An accurate, prompt warning system ensures that residents are given the best opportunity to remove possessions and themselves from the dangers of floodwaters. The intangible benefits are high.

* cannot be determined

[1] Council's normal operating budget

Process for Implementation

Task	Responsible Agency	Time for Completion*
1 CDC to review current public warning system	CDC	6 months
2 Revise Public Warning System	CDC	8 months
3 Make adjustments to Emergency Management Plan	CDC	10 months
4 Incorporate into Public Awareness Program	CDC	12 months

*this is the target time for completion of the task from the start of implementation of the measure.

Proposed Funding Scheme

There is no monetary cost for this measure. It is anticipated that the cost of implementing the measure is met by Council within its normal operating budget.

4.6 CDC Review of Study Outcomes

Aim

To ensure that emergency response plan is adequate, especially for larger flood events.

Discussion

The CDC and SES have good procedures in place for responding to community needs during floods based on many years of responding to flooding. However, the procedures are based on experience of floods up to about a 40 years ARI. Planning may not be adequate for floods larger than previously experienced.

Proposal

Outcomes from the Johnstone River Flood Study (WBM, 2003) should be reviewed to ensure that emergency management planning is adequate, especially for floods larger than previously experienced. For example, it is recommended that the CDC review evacuation triggers and safe evacuation areas, especially in larger floods. These could be related to the colour classification system. These areas or buildings would also be linked to the colour classification system.

Although it has not been determined as part of this study, consideration should be given to an assessment of the probable maximum flood (PMF). This is an extreme event, but the CDC should incorporate this size event into their counter disaster plan. The focus of disaster management during a flood of this magnitude should be on saving lives rather than property.

Summary

Monetary Benefit	*
Monetary Cost [1]	-
Monetary Benefit-Cost Ratio	*
Number of Buildings with Improved Protection	All

Intangible Benefits

An effective flood warning system is invaluable in minimising the flood damages and trauma associated with flooding. An accurate, prompt warning system ensures that business are given the best opportunity to remove possessions and themselves from the dangers of floodwaters. The intangible benefits are high.

* cannot be determined

[1] Council's normal operating budget

Process for Implementation

Task	Responsible Agency	Time for Completion*
1 Review of Flood Study	CDC	3 months
2 Amend Emergency Management Plan to incorporate proposal	CDC	6 months

* this is the target time for completion of the task from the start of implementation of the measure.

Proposed Funding Scheme

There is no monetary cost for the review. It is anticipated that the cost of implementing the measure is met by Council within its normal operating budget.

4.7 Raising Community Awareness

Aim

To increase knowledge of flooding and the level of preparedness amongst the Johnstone River community

Discussion

By raising community awareness of flooding issues and increasing the level of preparedness, the psychological and monetary damage caused by flooding is minimised. If people are aware that they reside in a flood prone area and that it is possible that a large flood might inundate their home and/or business, they are likely to react appropriately if a flood occurs. Conversely, if people are not aware of the seriousness of flooding in the area, they are unlikely to take flood warnings seriously, thus placing themselves and their property at risk. Furthermore, they may even place others at risk by hampering SES flood response efforts.

Proposal

An **Integrated Flood Awareness** campaign is proposed to increase the public's knowledge of flooding in the region. Such a campaign is most likely to be a success if it conveys simple messages that can be reinforced and reiterated by all facets of the public relations exercise.

All aspects of the campaign should reinforce the concept of the coloured flood band classification system explained in Section 4.3. The coloured flood totem provides the link between the community flood awareness campaign and the SES flood warning system. The coloured flood band system is used in all aspects of floodplain management in the region, thereby ensuring that there is consistency in the message being conveyed. This allows residents to become familiar with the terminology being used to describe the magnitude of floods.

The flood awareness campaign utilises two different categories of messages:

- **General Messages** - messages that relate to the whole community and are conveyed via public media (e.g. newspapers); and
- **Specific Messages** - messages that address the susceptibility of individual households to flooding and are conveyed via private media (e.g. individual household packages).

General Messages

The general messages that are relevant to the entire Johnstone community could include:

- many areas of the Johnstone region are flood prone;
- floods can cause serious damage to property and can endanger the lives of people and animals;
- there are different categories of floods and the impacts of these different types of floods vary;
- a Floodplain Management Plan has been developed to help reduce the damage caused by floods;
- the Plan will only be effective if community members are willing to cooperate and act; and

- more detailed information about flooding in the Johnstone region is available from the SES.

A number of different methods and media could be utilised to help convey these messages. If the colour classification of floods is adopted, the colour scheme could be used in all aspects of floodplain management in the region, thereby ensuring that there was consistency in the message being conveyed. This would allow residents to become familiar with the terminology being used to describe the magnitude of floods.

Tools utilised to convey the general messages are described in the table below.

Table 4-1 Tools utilised to Convey General Messages

Tool	Description
Slogan	• a simple slogan that appears on signs, booklets, stickers etc.
Flood Signs	• show the coloured flood bands and the heights of previous floods; • erected along the riverbank (e.g. next to bridges) and include photographs of previous floods at that location; • an obvious location would be at the Innisfail Wharf
Totem Poles	• show the coloured flood bands and possibly the heights of previous floods, although the lack of historical information or signage may help to reduce vandalism; • erected on the roadside at various locations throughout the Johnstone River; • one option is to paint the coloured flood bands on street sign poles.
Flood Awareness Leaflets	• containing general flooding information, including an explanation of the coloured flood bands; • could be a new leaflet or an expansion and renaming of existing cyclone booklet; • sent to homes on a regular basis (e.g. sent out with the rates notice once a year).
Flood Awareness Week	• a week of the year (preferably at the start of Summer) devoted to promoting flood awareness; • features on flooding, including dramatic photographs of previous floods, run in the local newspapers; • local radio stations encouraged to hold competitions with a flood theme etc; • workshops with flood wardens; • guided tours showing flood marks, mitigation systems and flood warning systems.
Flood Education in Schools	• provide schools with information kits and activities that are designed to increase flood awareness; • co-ordinated with the flood awareness week.
Web site	• include flood awareness and flood warning information on JSC web site

Specific Messages

The aim of the specific messages would be to inform people of whether their house and/or business is located in a flood prone area and answer questions such as: "Is my home really at risk of being inundated by a flood?" Diagrams could be generated, which use floor level, ground level and flood level data to generate flooding information that is specific to individual buildings; this would require floor level survey. If people can see that the 1967 flood would have resulted in their house being inundated, they are likely to react seriously to flood warnings and follow the advice of the SES. Specific messages would only need to be conveyed to people who own buildings that are at risk of being inundated (i.e. within the Probable Maximum Flood (PMF) extent – not determined as part of this study).

An effective method of conveying the simple messages is the distribution of a household flood information package. Such a package contains the items listed in the table below.

Table 4-2 Tools utilised to Convey Specific Messages

Tool	Description
Flood Information Brochure	• contains information about the history of flooding in the region, an explanation of why the household packages are being distributed, what the coloured flood bands represent and general information about what to do before, during and after a flood; • includes contact details of relevant personnel at the SES and Council for people who want to obtain more information about flooding;
Household Flood Diagram	• a basic diagram, similar to that depicted in Appendix C, showing the floor level of the building in relation to the coloured flood bands and the height of previous floods; • the information is specific to the location of the building; • floor levels are currently not available to allow the generation of these diagrams; • the largest flood in WBM (2003) was the 100 year ARI – it is recommended that a larger flood than this be shown on these diagrams.

Summary

	$2002
Monetary Benefit	*
Monetary Cost [1]	$138,000
Monetary Benefit-Cost Ratio	*
Number of Buildings with Improved Protection	All
Intangible Benefits	

As the community becomes more aware of the potential for flooding, it is less likely that people experience health and psychological trauma following a flood. Also, the community is more likely to respond effectively to flood warnings and to remove possessions and themselves from the dangers of floodwaters. The intangible benefits are high.

* cannot be determined

[1] based on an estimate of $10,000 per year over the next ten years – some costs may be met by Council within normal operating budgets

Process for Implementation

Task	Responsible Agency	Time for Completion*
1. Select the tools that are to be utilised to convey the general messages and the specific messages.	CDC	6 months
2. Determine a timeline for the implementation of the tools selected in Task 1. The timeline should cover the next 5 year period.	CDC	6 months
3. Prioritise the tools selected in Task 1. This facilitates the implementation of some initiatives regardless of the level of State Government funding.	CDC	6 months
4. Communicate proposed scheme to community	CDC	6 months
5. Specify criteria to determine the scope of people to receive the household flood information packages (e.g. houses located within 100yr flood extent)	CDC	1 year
6. Develop the household flood information packages	CDC/SES/DES	1 year
7. Assess the progress of implementation of this measure and the success of the actions. Develop a new timeline for implementation to cover the next 5 year period.	CDC	5 years

* this is the target time for completion of the task from the start of implementation of the measure.

Proposed Funding Scheme

The total monetary cost of the **Raising Community Awareness** measure is estimated at $138,000 over 10 years assuming $10,000 per year. It is anticipated that this cost is split between the DNRM Regional Flood Mitigation Program and the homeowners as follows:

DNRM Contribution	Homeowner Contribution
$92,000	$46,000

5 PROPERTY MODIFICATION MEASURES

5.1 Voluntary House Raising

Aim

To reduce flood damages by raising the floor level of individual houses to a specified level.

Discussion

House raising can only be undertaken on a voluntary basis. The monetary benefits of house raising arise from the reduction in the number of houses that are inundated (above floor) by floodwaters. By reducing the number of houses that are inundated, monetary savings are made through the reduction in property damages.

In addition, there are various health, social and psychological benefits as people are spared the trauma associated with having their homes inundated by floodwaters. It is important to note that the monetary benefit and costing provided are based on the assumption that all property owners accept the offer of a subsidy to raise the floor level of their house. The acceptance of offers by property owners is entirely their choice.

Proposal

The three scenarios in Table 5-1 were considered in the Johnstone River Flood Study (WBM Oceanics Australia, 2003). The Steering Committee recommended Option A with 1/3 of the cost contributed by the owner as the raising of a house is likely to result in an increase in property value.

Table 5-1 Description of Voluntary House Raising Options

Option	A	B	C
Description	Raising of houses currently inundated by a 20 year flood event	Raising of houses currently inundated by a 50 year flood event	Raising of houses currently inundated by a 100 year flood event

Summary

	$2002
Monetary Benefit	$400,000
Monetary Cost	$1,200,000
Monetary Benefit-Cost Ratio	0.33
Number of Buildings with Improved Protection	48
Intangible Benefits	High

In addition to the reduction in monetary damages, a major benefit of voluntary house raising is that it reduces the number of people that require evacuating. Also, it is less likely that residents need to remove their possessions from the house due to the higher flood immunity. The health problems and psychological trauma experienced by residents is reduced as a result of these factors. The intangible benefit is **high**.

The analysis was based on an approximation of floor levels as explained in WBM (2003). Therefore the number of houses identified for the scheme is approximate only.

Process for Implementation

	Task	Responsible Agency	Time for Completion*
1	Contact the owners of the houses flagged in the analysis for house raising, and explain the following: (a) conditions of the subsidy offer (e.g. identify excluded items such as landscaping costs). (b) susceptibility of the individual house to flooding (c) anticipated benefits of raising the floor level of the house (d) funding arrangement (e) requirement for floor level survey to confirm eligibility	Council	2 years
2	Insert a house raising information sheet in the rates notice. This notice explains the house raising measure and invites homeowners to check with Council as to whether their house was assessed as part of the Study. Owners of houses that were not assessed are encouraged to notify Council if they believe their house is at or below the 20 year ARI level want their house to be considered.	Council	2 years
3	Perform an individual assessment of houses identified as a result of Task 2: (a) survey the floor level of the house. (b) determine the 20yr design flood levels. (c) inform the owner of the result and make a formal subsidy offer (if applicable).	Council	3 years
4	Initiate follow-up contact on an annual basis with owners who have not accepted offer.	Council	annually

* this is the target time for completion of the task from the start of implementation.

Proposed Funding Scheme

Based on the assumption that all of the identified forty-eight (48) house owners accept the house raising subsidy, the total monetary cost of the **Voluntary House Raising** measure is estimated at $1,200,000. It is anticipated that this cost is split between the DNRM Regional Flood Mitigation Program and the homeowners as follows:

DNRM Contribution	Homeowner Contribution	Council
$800,000	$400,000	Nil

It is likely that the number of houses that could practically be raised in a year would be about 10. Therefore, it is recommended that a funding application to DNRM be based on a 5 year program.

5.2 Development Control Planning

Aim

To minimise the risk to life and limb and potential damage to property resulting from flooding by controlling development on the floodplain.

Discussion

Best practice floodplain management places emphasis on the use of non-structural measures to reduce the flood risk. The use of flood planning controls for developments is identified as an effective method of minimising the future impacts of flooding

Examples of flood planning matrices were given in the Johnstone River Flood Study (WBM, 2003) and incorporate:

- **Flood Hazard Categories** – the floodplain is divided into areas of varying flood hazard using the categories described in Section 2.2. Flood hazard maps of the Johnstone Rivers area presented in Appendix A;
- **Development / Building Types** – the matrices account for the different development and building types defined by Council; and
- **Flood Control Measures** – a variety of control measures take into consideration the different development / building types and the implications of the various flood hazard categories.

The flood planning matrices specify control measures for the following factors:

- minimum fill levels and minimum floor levels (i.e. flood planning levels);
- building components and structural soundness;
- impact of the proposed development on the movement of floodwaters;
- evacuation and access; and
- notification of susceptibility to flooding.

Flood hazard maps (Appendix A) were developed for use in conjunction with the flood planning matrices. There is the potential for a significant advantage in being able to access the land use and flood hazard category from a GIS database as both items are able to be provided with one on-screen query. The data has been developed with this in mind.

Proposal

It is considered that the adoption of floodplain management principles into the Planning Scheme is fundamental and should occur. The example planning matrices presented WBM (2003) incorporate these principles, but it is understood there may be some difficulty in incorporating such a document into new planning schemes that are being developed under IPA (1998). An alternative may be to incorporate the recommendations in the matrix into the new scheme but in a compatible format.

Summary

Monetary Benefit	*
Monetary Cost	#
Monetary Benefit-Cost Ratio	*
Number of Buildings with Improved Protection	All future development
Intangible Benefits	High

Controls on new development lower the health, social, and psychological trauma associated with flooding. In addition, it is less likely that people residing in new dwellings require evacuation and they may not need to remove their possessions. All of these factors help reduce the impact of flooding. The intangible benefit in the long-term is **high**.

* cannot be determined – the aim of development control planning is to control future development and reduce future flood damages and it is not possible to quantify the monetary benefits that arise from this

cost to be met by Council within its normal operating budget

Process for Implementation

	Task	Responsible Agency	Time for Completion*
1	Review the example flood planning matrices in WBM (2003) and determine whether they can be modified to be incorporated into planning scheme. If so, tailor to Johnstone floodplain.	Council	6 months
2	If matrices cannot be incorporated into scheme, incorporate floodplain management principles into scheme using alternate strategy.	Council	12 months

* this is the target time for completion of the task from the start of implementation of the measure.

Proposed Funding Scheme

There is no monetary cost for the **Development Control Planning** measure. It is anticipated that the cost of implementing the measure is met by Council within its normal operating budget.

6 FLOOD MODIFICATION MEASURES

6.1 Raise Existing Saltwater Creek and Sweeneys Creek Floodgate Levees

Aim

To decrease flood levels at commercial and residential properties in the CBD area and to the west.

Discussion

During flooding, Innisfail acts as a storage basin with floodwater initially backing up through Saltwater and Sweeneys Creeks before there is widespread overtopping of the banks. These two creeks are currently floodgated, although the floodgates are overtopped in relatively small flood events. Increasing the levee height at the floodgates will further reduce the flow into Innisfail resulting in a reduction in flood level.

Proposal

It is proposed to raise the levees at the Saltwater Creek and Sweeneys Creek floodgates to a 20 year ARI level. An additional levee at Frith Road is required to minimise the flood height impacts to the north of the road. The locations of the levees are shown in Figure 6-1.

It was shown in WBM (2003) that raising the levees is likely to increase flood levels in the Jones Street area in Innisfail (south of the cemetery) of the order of 20 mm to 30 mm in a 20 year ARI event. In the 50 year ARI event there was no significant impact on flood levels in this area. Investigations were undertaken into additional levees in the Jones Street area to mitigate this impact, but these were only moderately successful and would be at considerable expense. Therefore, it is proposed that further investigation be undertaken to determine the significance of about a 30 mm increase in flood level in Jones Street in a 20 year ARI flood, remembering that the impacts are not evident in a 50 year ARI event.

The raising of the levees is not expected to have any environmental impacts given that the floodgates are already in place. The increase in floodgate levee height would bring a positive social benefit by increasing the warning time to residents and business protected by the levees. However, it is likely that the fall of the floodwaters in the town area will be slightly retarded by the increased height on the levees.

Summary

Monetary Benefit	$822,000
Monetary Cost	# $175,000 to $318,000
Monetary Benefit-Cost Ratio	# 4.7 to 2.6
Number of Buildings with Improved Protection	*
Intangible Benefits	High

Levees lower the health, social, and psychological trauma associated with flooding. In addition, it is less likely that people residing in dwellings inside the levee require evacuation and they may not need to remove or raise their possessions. Similarly, the levees will provide benefits ot business. All of these factors reduce the impact of flooding. The intangible benefit is **high**.

* not calculated

dependent on additonal levee works in Jones Street area.

Process for Implementation

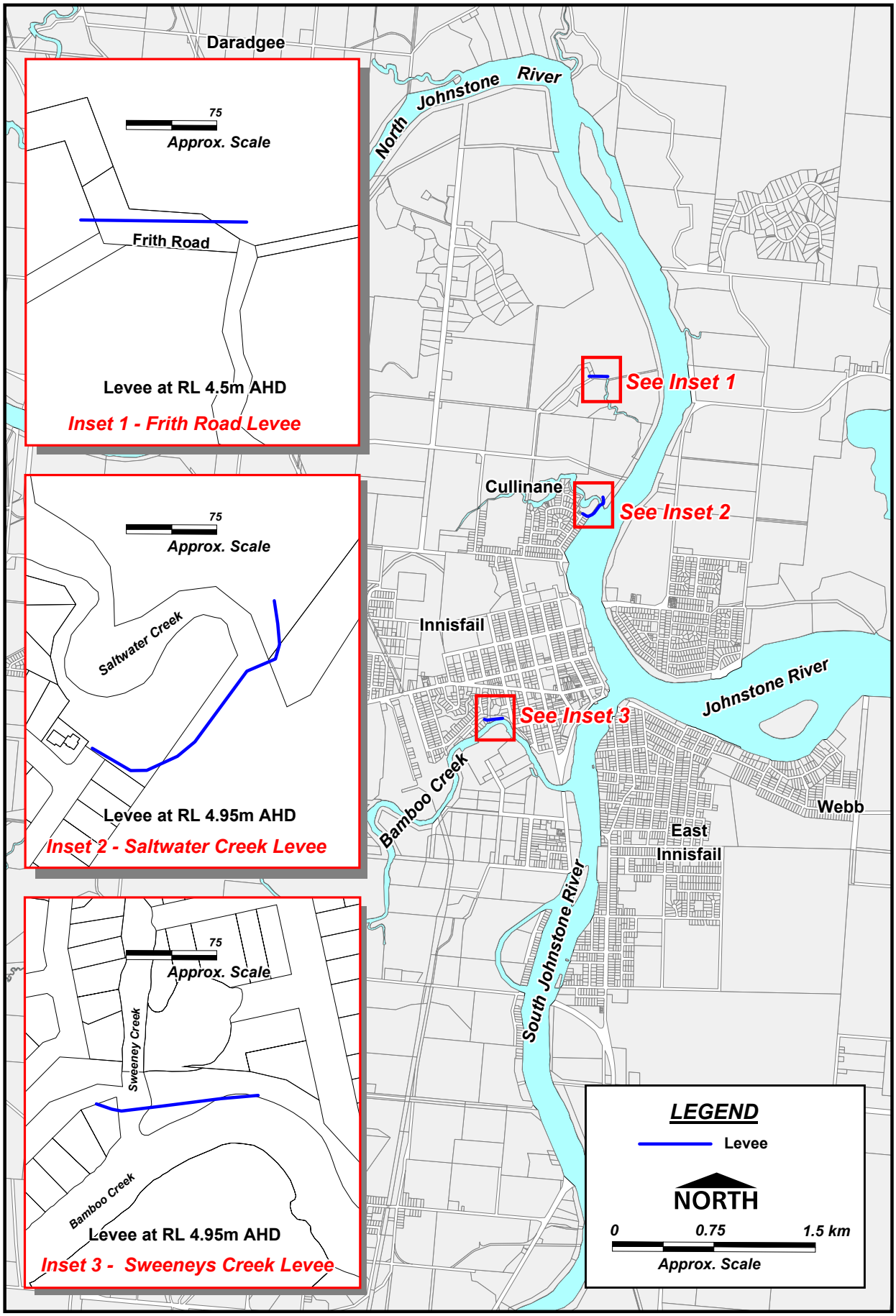
Task	Responsible Agency	Time for Completion*
1 Determine significance of increases in flood level in Jones Street area	Council	12 months
2 Seek funding from Regional Flood Mitigation Strategy for Design and Construction	Council	18 months
3 Carry out Detailed Design	Council	24 months
4 Raise levees and associated works	Council	36 months

* this is the target time for completion of the task from the start of implementation of the measure.

As an interim measure, it would be possible to use temporary sandbags to raise the levees to the levels prescribed in WBM (2003).

Proposed Funding Scheme

Two-thirds (2/3) of design and construction costs should be available through the Regional Flood Mitigation Program administered by the DNRM.



Approximate Location of Levees **Figure 6-1**

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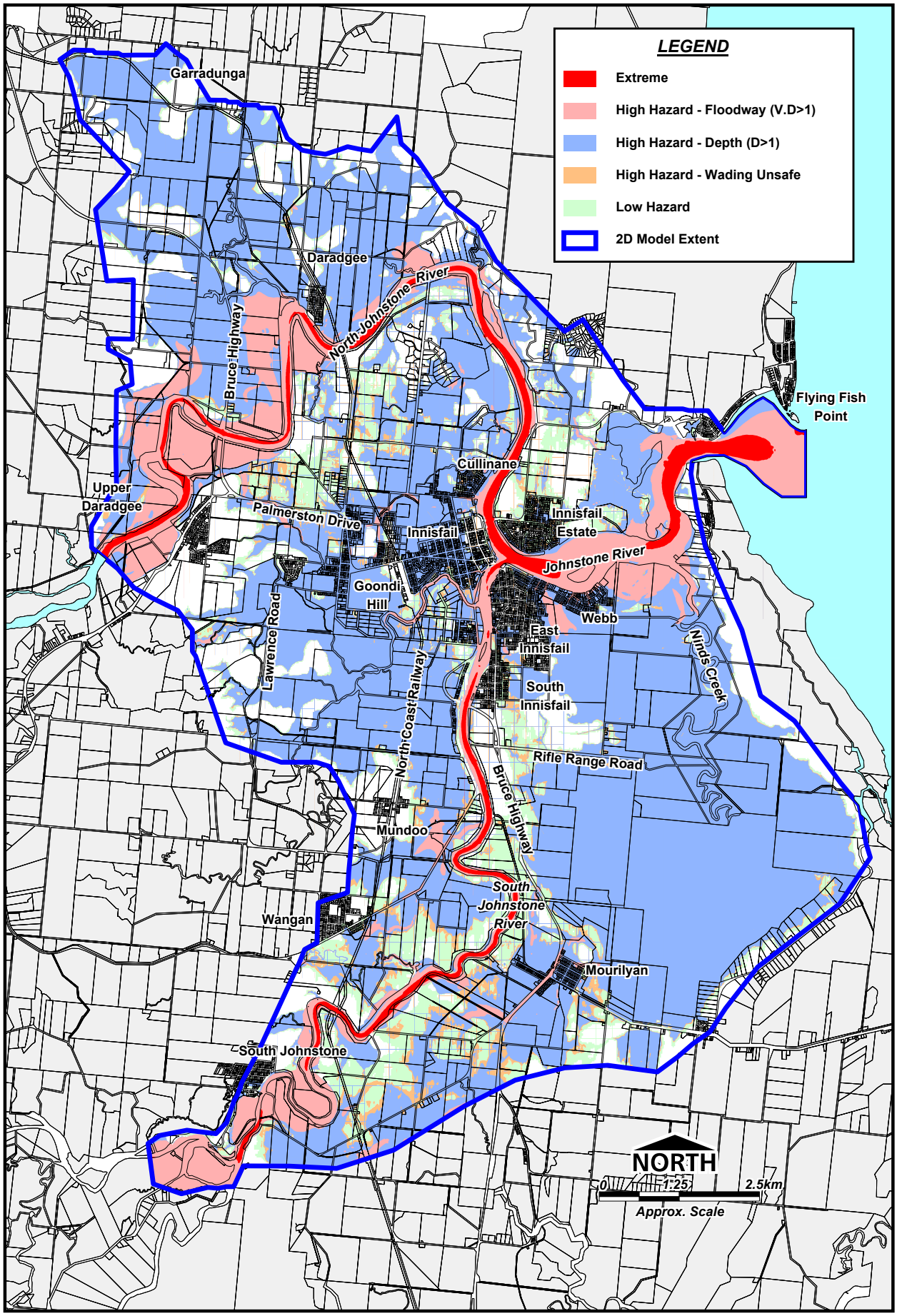
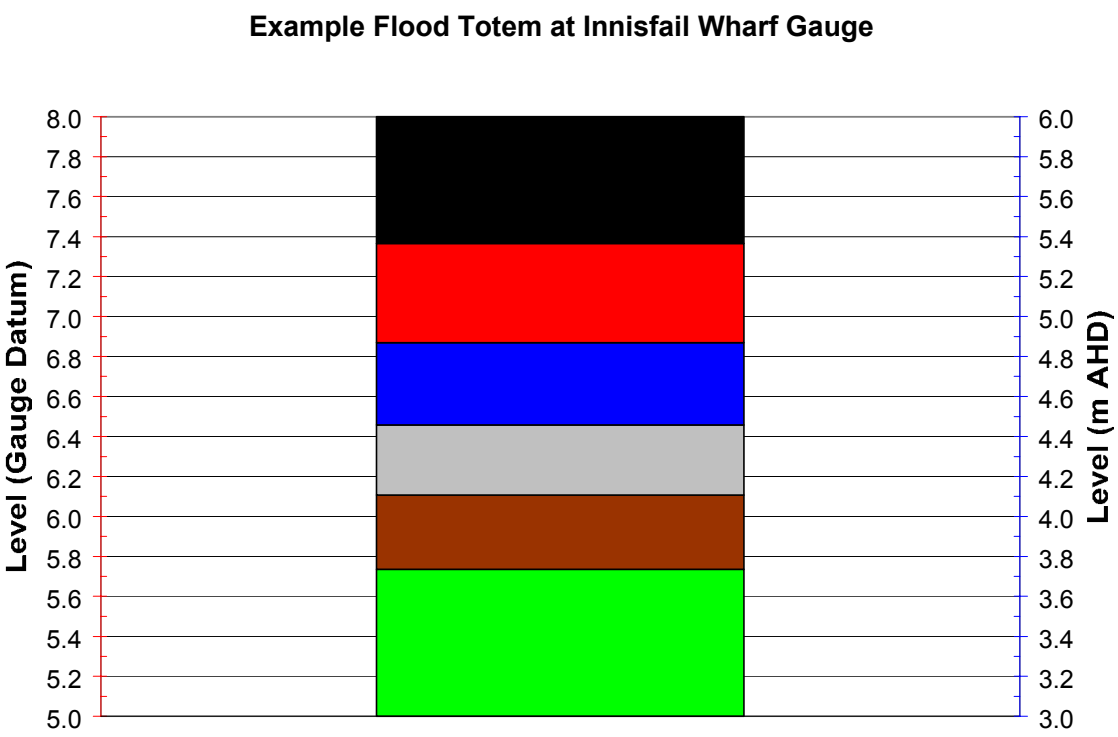
APPENDIX A: FLOOD HAZARD MAP

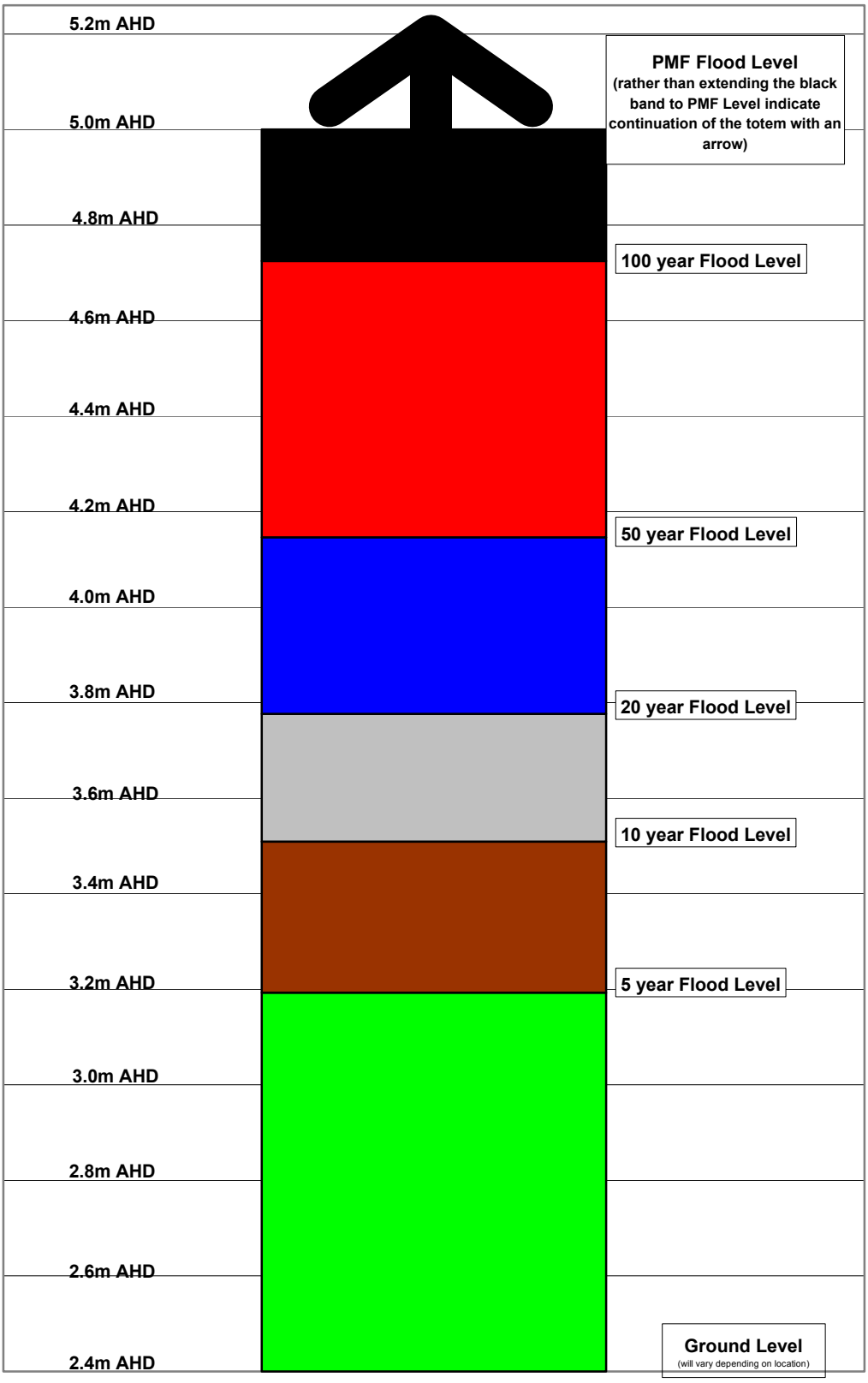


100 Year ARI Flood Hazard Mapping

APPENDIX B: EXAMPLE FLOOD TOTEMS



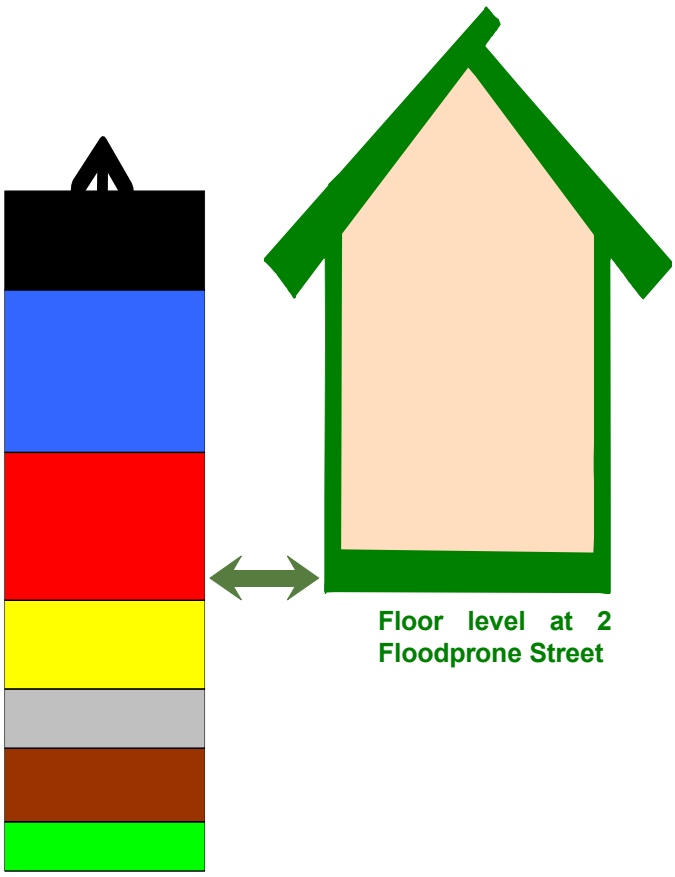
Example Flood Classification at Johnstone River Gauge at Innisfail Wharf



Example Flood Totem cnr Jodrell and Marjorie Streets

Note that the actual totem would only show colours, not flood levels or flood ARI and the change in bands should be based on consequences rather than ARI.

APPENDIX C: HOUSEHOLD FLOOD DIAGRAM



Example of a Household Flood Diagram