# Statement of Mr John Rauber

## Chief Executive Officer

## Moreton Bay Regional Council

## Volume 1 of 1

**QFCI**

JM

Date: 26/09/11

Exhibit Number: 617

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## STATEMENT TO QLD FLOODS COMMISSION OF INQUIRY

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|---|---|
| **NAME:** | Mr John Rauber |

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| **OCCUPATION:** Chief Executive Officer – Moreton Bay Regional Council |

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|---|
| **DATE OF STATEMENT:** 9 September 2011 |

I, JOHN RAUBER, Chief Executive Officer of Moreton Bay Regional Council (MBRC), 220 Gympie Road, Strathpine, Queensland, being under oath, say as to the points raised in the letter dated 19 August 2011 – **Reference Doc 1680908**:

1. **Whether all documents requested by the Requirement dated 1 March 2011 have been provided to the Commission.**

   1.1 To the best of my knowledge, all documents requested by the Commission have been provided.

2. **The details of any draft flood studies obtained or made available to the Council since March 2011.**

   2.1 Immediately following amalgamation, Moreton Bay Regional Council (MBRC) commenced the preparation of a region wide flood study referred to as the Regional Floodplain Database (RFD). A full copy of the currently available documentation was provided to the Inquiry on 22 March 2011 as part of Council's 'Submission of Information' package. No further documentation has been developed since this time. Further details on the RFD, including a project status update, are provided below.

3. **Any changes to the Council's land planning processes, policies or other statutory instruments in response to flooding that occurred during the period 1 December 2010 to 31 January 2011, including drafts, considerations and adopted documents of Council.**

   3.1 There have been no changes to land planning processes in response to the flooding that occurred between 1 December 2010 and 31 January 2011 as the current planning schemes already cover flood issues through current provisions, codes and policies.

   3.2 Council is in the process of developing a document referred to as the 'Moreton Bay Regional Council Floodplain Risk Management Framework'. This document is a work in progress that is currently being presented to internal stakeholders and has not yet been presented to or endorsed by the Executive Management Team or Council. The intention of this work is to develop a clear strategy for the identification, prioritisation and implementation of floodplain risk management measures in the region including the flood mitigation capital works program. Once further progress

is made on development of the framework, it will be presented to Council for formal consideration and adoption.

3.3 A copy of the current draft framework documents (Volumes 1 and 2) are included as **Attachments 1680908-1a and 1680908-1b**.

4. **How information about flood risk for specific properties is made available and any processes for obtaining this information applicable to each of the following:**

**a. members of the public;**
**b. insurance companies; and**
**c. prospective developers and their representatives.**

4.1 ***Members of the public and insurance companies***
Council made available, in February 2011, regional scale flood mapping on its website for free download and viewing by members of the public. This mapping shows Council's available '1 in 100 year' (1% annual exceedance chance) flood mapping at a sufficient level of detail that residents may discern the general level of flood affectation for their property or frequently attended location (e.g. work or school). The mapping classifies the floodplain into different depth zones to assist with interpretation of likely risk. The mapping can be accessed by visiting Council's website www.moretonbay.qld.gov.au/floodplains. Flood studies used to derive this mapping are also available for free download from the website or for viewing at Council's customer service centres at Strathpine, Redcliffe and Caboolture. Copies of flood studies are also available for purchase for a standard fee.

4.2 In addition, Council provides a property-based flood search service whereby members of the public may request a flood search containing more detail about the flood affectation of their property. This search includes a more detailed map of the flood extent at the property of interest, along with an estimated 1 in 100 year flood surface elevation for the property where such information is available. An example flood search is provided on Council's website at the address described above. A standard search fee per property applies.

4.3 Council's process for providing flood information to insurance companies or prospective developers and their representatives involves a request being made by the interested party to Council. Requests are considered on a case by case basis; however in most circumstances the information is provided free of charge. The type of information requested by these parties normally comprises of the digital files necessary to allow one or more of Council's existing flood models to be re-deployed to test the impact of a development scenario. In some circumstances the request is for flood data in spatial data format suitable for use in a Geographical Information System.

4.4 Any recipient of digital files is required by Council to sign a data agreement that restricts the use of the information to the nominated purpose.

4.5 From a planning/development assessment perspective, Council has flood assessments for all watercourses in the Moreton Bay Regional Council area and the natural Q100 flood hazard areas are depicted of Council's internal

computerised spatial mapping system (GIS). Council has also recently assessed overland flows assuming the existing underground stormwater systems are blocked or overloaded. This gives development assessment officers very good information on where development applications impact on natural flood hazard management areas as well as runoff paths from minor catchments to the existing watercourses.

4.6 ***Prospective Developers and their representatives***
There are three (3) formal ways that developers and their representatives can obtain information about flood risk:

- PD Online – Property Search

http://pdonline.moretonbay.qld.gov.au/Modules/propertymaster/default.aspx

- Flood Search

http://www.moretonbay.qld.gov.au/living.aspx?id=728

- Pre-lodgement Service

http://www.moretonbay.qld.gov.au/development.aspx?id=824

4.7 PD Online
Through Council's corporate website (www.moretonbay.qld.gov.au), *PD Online* allows 24 hour/7day access to carry out a search on specific properties and view mapping that shows Major Streams, Waterways and Wetland Protection Areas free of charge. Enquirers cannot obtain flood extent mapping from this enquiry but can quickly determine whether there is a likelihood of being impacted by flooding.

4.8 Flood Search
Enquirers can also request a *Flood Search* through Council's Corporate website. A Flood Search attracts a fee and can also be requested by phoning Council during business hours. After lodging the request and payment of the relevant fee the enquirer will receive a *Flood Check Property Report* which shows the mapped extent of Q100 year flood inundation over the land. The report also gives the maximum Q100 flood level, its data source and the stormwater catchment name.

4.9 Pre-lodgement Service
Council has always provided a free pre-lodgement advice service. This service can be requested through Council's corporate website, by email, phone or fax to Council. This service is well used by prospective developers in the MBRC region.

4.10 Following the request a meeting is arranged with the applicant who is encouraged to provide an agenda or list of issues. Council provides senior experienced technical staff for these meetings. At the meeting detailed information from Council's GIS mapping system can be viewed and detailed information provided for a wide range of issues including whether the development is within the natural flood hazard management area or subject to major flooding. Details are also often provided of latest estimated flood levels and the extent of inundation during the Defined Flood Event / Q100 flood. Advice is also provided, where necessary, on typical mitigation measures and other planning scheme, State Planning Policy and other statutory requirements. Where developers are required to provide detailed reports on flooding, stormwater management or other mitigation measures they will be referred to Council's Drainage, Waterways and Coastal Planning area for further information.

5. **Whether and to what extent Council's infrastructure (for example, sewers, roads, stormwater) was affected by flooding that occurred during the period 1 December 2010 to 31 January 2011, citing specific examples where possible.**

5.1 The 2011 flood event caused damage to Council's road, parks and building assets. Total damage to all assets is estimated at $31.29M, comprising $27.1M damage to road assets, $3.53M damage to park assets, and $661K damage to Council building assets.

5.2 A cross section of flood affected infrastructure within MBRC was as follows:

5.3 **Roads**:

5.3.1 Gap Road, Bellthorpe - damaged section of road - longitudinal crack down approximate centreline of pavement in steep rural country was reconstructed - coincided as main route of transporting avocado crop out of Bellthorpe to market;

5.3.2 Bellthorpe Range Road, Bellthorpe - a 1.5km section of roadway was severely damaged - major erosion, loss of guardrail, drainage failure and localised batter / bank slippages - this section has been closed since January 2011 - current works at tender stage for reconstruction - estimated time to reopen March 2012;

5.3.3 Jimna Court, Deception Bay - major pavement and supporting retaining wall failure leading to structural damage to immediate upstream dwellings (x2) - initially damaged in October 2010 rains; further damaged in December 2010 / January 2011 rains - restricted / limited access for residents in Jimna Court whilst the pavement and supporting earthen embankment was redesigned and reconstructed, with the inclusion of substantive drainage system - October 2010 through to July 2011;

5.3.4 Mt Nebo Road, Mt Nebo - major landslips affecting pavement and associated access;

5.3.5 Bridge - Laceys Creek Road - abutment erosion, significant shoulder erosion.

5.4 **Parks & Reserves:**

5.4.1 Sweeney Reserve, Petrie - major damage / loss of existing infrastructure - park furniture, playground equipment, shade structures, road and car parking pavements, toilet block etc - park has been closed since 11 January 2011;

5.4.2 Centenary Lakes, Caboolture - major damage / loss of existing infrastructure - fences, softfall to numerous locations, irrigation systems (electrical equipment), pumps overhauled, park furniture, footpaths, park furniture, playground equipment, shade structures, road and car parking pavements, toilet block etc - park has been closed since 11 January 2011.

5.5 **Buildings & Facilities:**

5.5.1 Dayboro Pool - replacement of pool heating units;

5.5.2 Dayboro Art Gallery - footpath repaired and external wall sheeting repaired and repainted;

5.5.3 Mt Glorious Road - LED early warning (fire) sign replaced.

5.6 In relation to sewer infrastructure, I understand that the Queensland Flood Commission of Inquiry has sought information from Unitywater regarding water and sewerage infrastructure matters. Unitywater are best placed to provide information pertaining to the degree if any, of the flood affectation of these assets, as well as the capacity of such assets.

**6 For point 5, details of the reconstruction of this infrastructure including costs and programs.**

6.1 Complete list of damaged assets is noted as per **Attachment 1680907-1**.

**7 Funding arrangements for repairs to damaged Council infrastructure.**

7.1 Council is progressively repairing and remediating its damaged infrastructure assets through a combination of Council, State and Federal Government funding sources, such as rate revenue and National Disaster Relief & Recovery Arrangements (NDRRA) revenues.

7.2 Council has received $2.8M from the Queensland Reconstruction Authority (QRA) / NDRRA as the initial tranche of funds. Council is working with the QRA in progressing funding submissions/applications.

**8 Any policies or other documents which require property owners to have an evacuation plan and/or route in the case of flooding.**

8.1 MBRC does not have any formal policies or documents which require property owners to have an evacuation plan and/or route in the case of flooding.

8.2 MBRC's emergency (now disaster) web link provides information with regard to:

8.2.1 preparing emergency checklist and plan (Red Cross and EMQ webpage links);
8.2.2 evacuation advice - when to evacuate, where to go, what to take and how to prepare, make the decision, mandatory evacuations and what not to take;
8.2.3 evacuation centre advice – location of fifteen evacuation centres and their status (open or closed);
8.2.4 what is a flood, what you can do to prepare for floods, including access to information such as flood maps etc, what to do whether you evacuate or stay.

**9 A description of the Regional Floodplain Database Project, including, but not limited to, its purpose, the method used to obtain information and the status of the project.**

9.1 Following amalgamation, MBRC commenced the preparation of a flood study known as the Regional Floodplain Database (RFD). The project covers 2700 square kilometres of catchment including numerous complex

rural and urban floodplains. The project is possibly the single largest flood study ever undertaken in Australia and will require $2.4m and three years to complete.

9.2 The RFD is being prepared by Council's Drainage Waterways and Coastal Planning Unit (DWCP) under the guidance of a Study Advisory Group. The project is also being delivered with the assistance of several experienced floodplain consultant teams. The project is funded by Moreton Bay Regional Council, Emergency Management Queensland and Emergency Management Australia under the Natural Disaster Resilience Program (NDRP).

9.3 The purpose of the RFD is to provide Council and the community with a detailed description of flood behaviour for all river and creek floodplains in the region. This information will underpin Council's strategic decision making with respect to floodplain management and assist the community gain a better appreciation of their flood risk.

9.4 It is estimated that the project will take a further 12 months to complete to a stage where all data is stored onto Council's centralised GIS database. Following this, the RFD will go into maintenance mode.

9.5 A full copy of the currently available documentation for the project was provided to the Inquiry on 22 March 2011 as part of Council's 'Submission of Information' package. This information is preliminary, subject to change and not publicly released, however may be of use to the Inquiry should it wish to better understand more about some particular aspects of the project.

**10 Whether, and to what extent Council has considered implementing a 'buy-back scheme' to residents who own properties that are particularly susceptible to flooding.**

10.1 MBRC are currently preparing a draft flood affected property buy back policy. Council is scheduled to be presented with a draft policy for consideration in late September 2011 / early October 2011.

All the facts sworn to in this affidavit are true and correct to my knowledge and belief except as stated otherwise.

Sworn by JOHN RAUBER at )
Strathpine this 9th day of September 2011 )
before me, Angus James Conaghan: )

[redacted]

[redacted]

Attachment 1680908-1a

Moreton Bay Regional Council

# Floodplain Risk Management Framework

## Volume 1 DRAFT

August 2011

1
Identify the Flood Risk

2
Analyse the Flood Risk

3
Prepare a Plan

4
Implement the Plan

**Acknowledgements:**

A draft of the Moreton Bay Regional Council Floodplain Risk Management Framework (FRMF) was prepared for Council by its consultants GHD and Molino Stewart in March 2011.

Following completion of the first draft, Council accepted primary responsibility for the ongoing development and modification of the FRMF. Council has modified some of the FRMF content and structure to reflect subsequent changes in its understandings and organisational aspirations. However Council wishes to acknowledge substantial input from its consultant partners during the intial development phase.


CLIENTS|PEOPLE|PERFORMANCE

MOLINO STEWART

ENVIRONMENT & NATURAL HAZARDS

**Document Control:**

| *Revision* | *Date* | *Document Purpose* | *Author(s)* | *Reviewer(s)* | *Approved by* |
|---|---|---|---|---|---|
| *D1* | *March 2011* | *Draft for Discussion* | *GHD/Molino Stewart* | *Steve Roso/ Lavanya Susarla* | *N/A* |
| *D2* | *August 2011* | *Draft for Discussion* | *Steve Roso* | | *N/A* |
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Floodplain Risk Management Plan

# 1 INTRODUCTION

## 1.1 Background

Flooding is perhaps the most manageable of all natural hazards. There is typically more uncertainty about the onset of other events such as tropical cyclones, drought, earthquakes and bushfires.

It is relatively straightforward to determine how and why a flood occurs, and where it will happen. Flooding can be planned for, its effects can be mitigated and regulations can be put in place to address the residual problem remaining after mitigation. The parameters we do not know are mainly when, and how large, the flood will be.

There is a growing expectation within the community that State and Local Governments will be capable of managing natural hazards in an efficient and effective manner, which minimizes loss of life and property and ideally the avoidance of a potential disaster.

Significant areas of the Moreton Bay Regional Council MBRC area are subject to flooding including river and creek flooding, storm tide and overland flow.

It is within the above context that Council has determined to develop a strategic framework within which its floodplain risk management measures will be conceptualised, assessed and implemented.

This Floodplain Risk Management Framework (FRMF) is not currently a formal requirement of any State legislation, however this does not prevent Council from being pro-active in the implemention of relevant investigation and planning activities to inform the formal flood planning and disaster management processes.

## 1.2 Vision

The vision for the FRMF is that:

*"Floodplains in MBRC will be managed for the long-term benefit of the community such that hazards to people and damages to property and infrastructure are minimised and the intrinsic environmental values of the floodplain are protected"*

This vision is developed from the vision contained in the Government's State Planning Policy 1/03: Mitigating the Adverse Impacts of Flood, Bushfire and Landslide, published in 2003 as follows:

*"The Queensland Government considers that development should minimise the potential adverse impacts of flood, bushfire and landslide on people, property, economic activity and the environment."*

The FRMF vision should be followed using a value-based approach to the management of flood risk that balances social, economic, environmental and flood risk parameters to determine whether particular development or use of the floodplain is appropriate and sustainable. With this approach, the FRMF avoids the unnecessary alienation of flood prone land. It also ensures that flood prone land is not the subject of uncontrolled development, inconsistent with its exposure to flooding.

The FRMF has been prepared in accordance with best practice to meet the following broad principles:

- All levels of government and the local community know and accept their responsibilities

for managing flood risk and all relevant agencies provide aid to the community in recovering from the devastating impacts of flooding;

- Flood risk and flood behaviour is understood and considered in a strategic manner in the development decision-making process;
- Land use planning and development controls minimise both the exposure of people to flood hazard and the potential damages to property and infrastructure;
- A broad range of floodplain management measures are assessed across a broad range of floods up to the Probable Maximum Flood, and floodplain management measures appropriate to the location and acceptable to the local community economically, socially and environmentally are used to manage flood risk; and
- All relevant agencies work in partnership to provide flood forecasting and warning systems and emergency response arrangements that cope with the impacts of flooding on the community in light of the available flood intelligence.

## 1.3 How to Use the FRMF

The FRMF provides a guide to the development and implementation of Floodplain Risk Management Plans, developed to establish sound, long-term floodplain management outcomes that satisfy the social and economic needs of the community as well as being attuned with the natural ecosystems within the floodplain.

The FRMF (Volume 1) document describes and documents:

- Basic floodplain risk management concepts (**Section 2**)
- The legislative imperative for floodplain risk management (**Section 3**)
- The Floodplain Risk Management Framework itself (**Section 4**)
- The roles and responsibilities of relevant stakeholders in implementing the FRMF (**Section 5**)

Volume 1 of the FRMF is to be read and interpreted in a global sense with reference to the overall framework objectives described in **Section 4.1.1**. The FRMF is targeted at a strategic management level. Volume 2 of the FRMF contains a series of more detailed practice notes which provide further detail on how the framework should be implemented.

To ensure that the underlying philosophies are applied without exception, individual portions or sections of the FRMF should not be interpreted outside the overall philosophy of the FRMF. In the case of any inconsistency, Volume 1 of the FRMF takes precedence over Volume 2.

## 1.4 Previous Studies and Planning Decisions

The framework introduced in this document aims to provide a consistency of approach across a significant local government area in South-east Queensland, leading to the achievement of the Vision outlined in **Section 1.2** above. The establishment of the FRMF does not negate the results of any previous flood studies and planning decisions undertaken by either MBRC or its predecessors. These studies and decisions are important tools in floodplain management within MBRC and will remain so until there is a need to revisit or upgrade the results and outcomes.

# 2 FLOODPLAIN RISK MANAGEMENT CONCEPTS

It should be noted in all the discussion that follows, "floodplain" is defined as land that is subject to inundation by floods, regardless of source, up to and including the Probable Maximum Flood (PMF) event. This is synonymous with the term "flood prone land".

## 2.1 Factors for Effective Floodplain Risk Management

Drawing on "Floodplain Risk Management in Australia: Best Practice Principles and Guidelines" (SCARM Report 73, 2000), the principal requirements for effective floodplain management are:

- An authority with the primary responsibility for floodplain management policy and practice;
- Appropriate and effective legislative powers for the responsible authority, with powers applied on a catchment-wide basis;
- Appropriate mechanisms for coordination of land use planning and floodplain management on a catchment wide basis;
- A community awareness of the flooding problem and the planning/management process, and a willingness to become involved;
- Completion of flood studies and floodplain management studies overseen by a steering committee representing all interested or affected parties;
- Provision of adequate resources to undertake studies and implement measures;
- Access to technical advice, standards and guidelines for the authority responsible for floodplain management;
- Legal provisions ensuring that the responsible authority exercises its powers responsibly, such as legal liability for the consequences of decisions; and
- Provision for intercession by a Central Authority when necessary.

While some of these Factors raise State- or Nation-wide issues in their application, many relate directly to the application of sound floodplain management by a Council or local government authority.

## 2.2 Best Practice Principles - Floodplain Risk Management

There are a number of best practice principles that should be pursued in effective floodplain management as follows:

### *2.2.1 A Pro-Active Response*

The fundamental best practice principle of floodplain management is the adoption of a pro-active response to the flood problem, a response that first recognises the various flooding problems and then moves to address these issues and problems before they develop to or are experienced at extreme levels.

It is this Principle that is the driving force behind the development of the MBRC Floodplain Risk Management Framework.

### 2.2.2 Community Expectations

Floodplain management must strive to ensure that the community is:

- Able to live and work on floodplains without risk to life and safety or unacceptable risk of damage to goods, possessions and infrastructure because of flooding;
- Secure in the knowledge that effective arrangements are in place to alleviate the economic and social costs of flooding and foster recovery of the flooded area and its residents/occupants; and
- Actively involved in the floodplain management process, both in the development of a Floodplain Risk Management Plan and in meeting their obligations under that plan.

### 2.2.3 Policy and Implementation

Effective policy and legislation are vital in providing a reliable social and legal foundation for floodplain management and thus it is essential that there is an integrated policy framework within all agencies that supports the management of floodplains and addresses the reduction of flood risk to life and property.

### 2.2.4 Recognize the three distinct types of Flood Problem

Current floodplain management practice recognises three distinct types of flood problems, described below:

- The existing problem refers to existing buildings and developments on flood prone land. Such buildings and developments, by virtue of their presence and location, are exposed to an "existing" risk of flooding.
- The future problem refers to buildings and developments that may be built on flood prone land in the future. Such buildings and developments may be exposed to a "future" flood risk, i.e. a risk that does not materialise until developments occur or that may result from climate change.
- The residual problem refers to the risk associated with floods generally and with those floods that exceed management measures already in place. That is, unless a floodplain management measure is designed to withstand the PMF, it will be exceeded by a sufficiently large flood at some time in the future. It is not a matter of if, but of when.

### 2.2.5 Risk Appreciation

Best practice principles to foster the community's appreciation of flood risk, exposure to flood hazard and appropriate responses include:

- Documentation of flood risk by relevant agencies in an easily understood manner on flood maps, certificates of title and information brochures to enable individuals and the community to assess flood risk.
- Ongoing community education by all relevant agencies in conjunction with emergency management agencies through a co-ordinated community education plan.

### 2.2.6 The Floodplain Risk Management Plan

The implementation of a comprehensive investigative and planning process that develops a Floodplain Risk Management Plan is the most effective and equitable way to realise the multiple objectives of floodplain management.

### 2.2.7 The Flood Emergency Plan

Preparation of a flood emergency plan encompassing flood preparedness, prevention, response and recovery arrangements is the most effective way to address the residual flood risks associated with flood events.

It should be noted that flood warning should be an integral part of the flood response arrangements.

### 2.2.8 Appropriate Land Uses

The careful matching of land use to flood hazard both maximises the benefits of using the floodplain and minimises the risks and consequences of flooding.

### 2.2.9 Flood Maps

Flood maps that show the extent, depth, velocity and hazard of flooding for nominated flood events are an important tool for the preparation of Floodplain Risk Management Plans and flood emergency plans.

However, there needs to be:

- Recognition that flood maps are necessarily inexact.
- Considerable care taken with the depiction and explanation of flooding features so that the map is easily understood by the local community and is not subject to misleading interpretation.

The land use planning controls that flow from flood maps should be incorporated into statutory planning instruments in a timely and expeditious manner.

### 2.2.10 Floodplain Risk Management Measures

There are three generally recognised ways of managing floodplains to reduce flood losses:

- By modifying the behaviour of the flood itself (Flood Modification);
- By modifying or removing existing properties and/or by imposing controls on property and infrastructure development (Property Modification); and
- By modifying the response of the population at risk to better cope with a flood event (Response Modification).

Floodplain management measures should not be considered in isolation. Rather, they must be considered collectively on a risk management basis that allows their interactions, their suitability and effectiveness, and their social, ecological and economic impacts to be assessed on a catchment-wide, cumulative basis.

### 2.2.11 Flood Behaviour

An understanding of flooding behaviour, i.e. flood discharges, flood levels, flood velocities, duration of flooding, rate of rise of floodwaters, etc. is fundamental to the preparation of effective floodplain management and flood emergency plans. It must be recognised that the behaviour of each flood will have a unique combination of these parameters and none are likely to behave across all parameters in the way predicted by design flood events used in flood models. For example, several real floods and a design flood may all have the same peak but are likely to have different rates of rise and durations.

### 2.2.12 Performance Indicators and Data Collection

Flood behaviour, damage and other data should be collected expeditiously after an actual flood event has occurred, allowing an evaluation of the flood modelling and the effectiveness of floodplain management measures. Simultaneously, flood emergency operations should be reviewed in consultation with communities and, where necessary, modified.

# 3 LEGISLATIVE IMPERATIVE

There are two significant pieces of legislation that support the establishment of a FRMF within the MBRC area of responsibility. These Acts of Parliament are:

- The Sustainable Planning Act (2009); and
- The Disaster Management Act 2003 (as amended to 2010).

The Coastal Protection and Management Act (1995 as amended to 2010) also contains supporting requirements however this Act provides for the same requirements for a specific type of flood risk (i.e. storm tide), rather than the more general approach of those Acts discussed below.

## 3.1 Sustainable Planning Act 2009

The Sustainable Planning Act (2009) (SPA) replaced the Integrated Planning Act (IPA) – the currently published guidelines on the application of the Act are based on the IPA and are in the process of review. However, as the Acts have the same objectives and purposes, the guidelines remain relevant to the current situation.

The Purpose of the Act is "to seek to achieve ecological sustainability by:

(a) managing the process by which development takes place, including ensuring the process is accountable, effective and efficient and delivers sustainable outcomes; and

(b) managing the effects of development on the environment, including managing the use of premises; and

(c) continuing the coordination and integration of planning at the local, regional and State levels."

Note that under this Act, Ecological sustainability is defined as "a balance that integrates—

(a) protection of ecological processes and natural systems at local, regional, State and wider levels; and

(b) economic development; and

(c) maintenance of the cultural, economic, physical and social wellbeing of people and communities."

To achieve the requirements of the Act, local government is required to prepare Planning Documents that identify areas of natural hazard, which includes flooding from all sources, so that its development decision making process:

- is accountable, coordinated, effective and efficient; and
- takes account of short and long-term environmental effects of development at local, regional, State and wider levels, including, for example, the effects of development on climate change; and
- applies the precautionary principle; and
- seeks to provide for equity between present and future generations; and
- ensures the sustainable use of renewable natural resources and the prudent use of non-

renewable natural resources by, for example, considering alternatives to the use of non-renewable natural resources; and

- avoids, if practicable, or otherwise lessening, adverse environmental effects of development, including, for example climate change and urban congestion; and adverse effects on human health.

A Guideline to the application of this Act is the State Planning Policy 1/03 Guideline": Mitigating the Adverse Impacts of Flood, Bushfire and Landslide

Section 5.2 states that the intention of the State Planning Policy (SPP) is that, wherever practicable, natural hazard management areas should be identified through a comprehensive and detailed natural hazard assessment study. Outcome 4 of the SPP requires natural hazard management areas to be identified when planning schemes are made or amended, and these should be integrated with the planning strategies and detailed planning measures required under Outcomes 5 and 6 of the SPP.

Section 5.7 states that a default mechanism for flood hazard management was not adopted for the SPP as reliable flood data was not available. Therefore, the development assessment components of the SPP apply in relation to flood only where a local government has adopted a Defined Flood Event (DFE) for managing development, and that DFE has been translated into a natural hazard management area (flood) identified in the planning scheme. A local government wishing to address flood issues urgently could identify a natural hazard management area (flood) and appropriate development assessment criteria in a temporary local planning instrument prior to making or amending the planning scheme.

Section 5.8 states that in relation to flood hazard management, the SPP sets out the State's position that generally, the appropriate flood event for determining a natural hazard management area (flood) is the 1% Annual Exceedance Probability (AEP) flood. However, the SPP recognises that the adoption of a different DFE may be appropriate depending on the circumstances of individual localities and the proposed land use for the area, e.g. a 0.2% AEP may be the desirable DFE for an emergency services building or hospital. The adoption of a lower DFE would require the local government to demonstrate by thorough analysis that the proposed level of flood protection is appropriate to the circumstances of the locality.

Appendix 2 of the Guidelines - Undertaking Natural Hazard Assessment – Flood – indicates that (Section A2.8) Outcome 4 of the SPP requires natural hazard management areas for flood to be identified in planning schemes. Section A2.11 indicates that natural hazard management areas (flood) ideally should be determined from a comprehensive floodplain management study.

## 3.2 Disaster Management Act (2003, as amended to 2010)

The Disaster Management Act 2003 (DMA) forms the legislative basis for disaster management arrangements for Queensland including:

- establishing disaster management groups for the State, Disaster Districts and Local Government areas;
- detailing planning requirements at each level;
- maintaining the role and operations of the State Emergency Service (SES) and establishment of Emergency Service Units (ESUs); and
- providing for the conferring of powers on selected individuals and groups.

The main objectives of the DMA are:

- To help communities mitigate the potential adverse effects of an event; and prepare for managing the effects of an event; and to effectively respond to and recover from a disaster or an emergency situation.
- To provide for effective disaster management for the state,
- To establish a framework for the management of the SES to ensure the effective performance of their functions.

The Objects of the current DMA have been amended to include reference to the following principles of disaster management (inter alia):

- effective disaster management requires planning across all four phases of disaster management: prevention, preparation, response and recovery;
- that all hazards, whether natural or caused by humans, should be managed using a disaster management framework;
- that it is primarily local governments that are responsible for managing disasters in their local government area and that district and state groups should provide local governments with appropriate resources and support to be able to manage disaster operations.

The functions of a local government under the DMA are to:

- ensure it has a disaster response capability (as outlined under s80 (2) of the DMA);
- approve its local disaster management plan prepared under part 3 of the DMA;
- ensure information about an event or a disaster in its area is promptly given to the District Disaster Coordinator (DDC) for the Disaster District in which its area is situated;
- perform other functions given to the local government under this Act.

Local government is best situated to provide first-hand knowledge and understanding of social, economic, infrastructure and environmental issues within their respective communities and are ideally placed to support its community from a disaster management perspective. This is achieved through the Local Disaster Management Group (LDMG) where Local Governments coordinate their response to a disaster.

Section 57 (1) of the Disaster Management Act 2003 requires local governments to develop a local disaster management plan (LDMP) as a part of their response capability for disaster management in their area. Section 57 (2)(f) further requires that the LDMP must address matters stated in the disaster management guidelines and Section 58 states that the LDMP must be consistent with the disaster management guidelines.

Section 63 (1) gives authority to the Chief Executive of the Department to prepare guidelines to inform State, District and Local Groups about the preparation of plans and matters to be included in plans.

## 3.3 The Floodplain Risk Management Plan

Although a Floodplain Risk Management Plan is not a formal requirement of either the Sustainable Planning Act (2009) or the Disaster Management Act (2003), this does not prevent local government from implementing investigation and planning activities which will inform formal flood planning and disaster management processes and documenting a process for conducting these activities in the form of a framework.

There is a growing expectation within the community that state and local governments will be capable of managing natural disasters in an efficient and effective manner, which minimizes loss of life and property. It is within the context of the Legislative requirements above and the community expectations that Council is developing its FRMF as a pre-cursor to development of a Floodplain Risk Management Plan.

The relationship of the Legislation and the floodplain risk management process is shown in **Figure 3.1**.

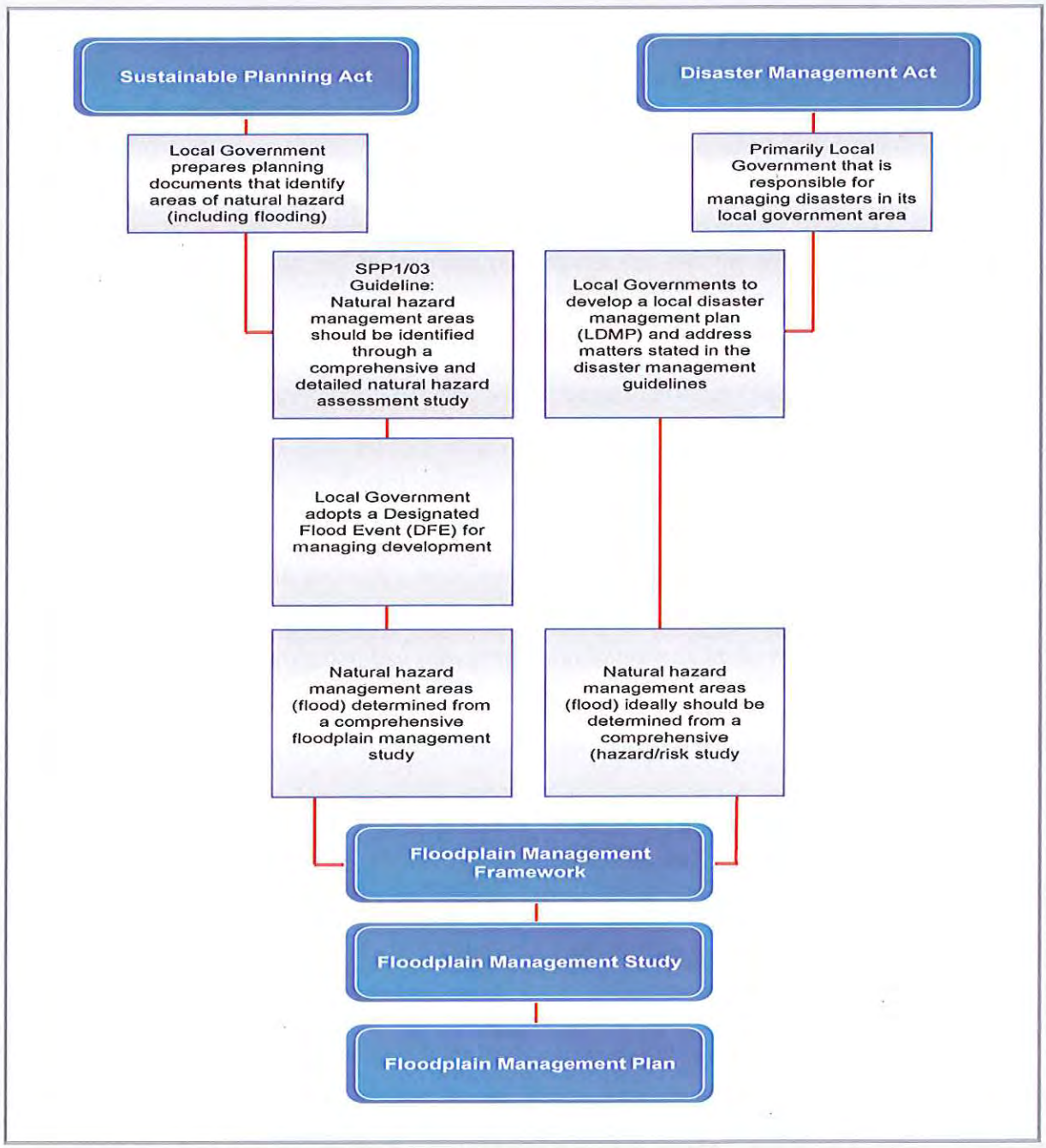


**Figure 3.1 Legislation and Floodplain Risk Management Process**

# 4 FLOODPLAIN RISK MANAGEMENT FRAMEWORK

## 4.1 Overview

### *4.1.1 Framework Objectives*

The objectives of the FRMF are:

- To ensure that all levels of government and the local community are aware of their responsibilities for managing flood risk.
- To ensure floodplain management functions are integrated within a broader sustainable land management framework.
- To ensure that flood risk and flood behaviour is understood and considered in a strategic manner in the decision-making process and that land use is consistent with flood risk and potential damages.
- To ensure land use planning and development controls minimise both the exposure of people to flood hazard and damage costs to property and infrastructure.
- To ensure a broad range of floodplain management measures (both structural and non-structural) are considered and flood mitigation measures appropriate to the location and acceptable to the local community are used to manage flood risk where economically, socially and environmentally viable.

The formulation and implementation of a Floodplain Risk Management Plan describing a course of action to address the above objectives is a cornerstone of the FRMF. The development and implementation of a Floodplain Risk Management Plan is acheived through the application of a four step process described in **Figure 4.1** below.

The FRMF is generally addressed to the management of floods arising from heavy rainfall (river & creek flooding), storm tide, and urban flash flooding (overland flowpaths). The special circumstances relating to unusually high tides (e.g. so-called "king" tides), tsunami, local ponding from heavy rainfall and dam failure are outside the reach of the FRMF however the general principles may apply when Council is ready to pursue strategic planning for these forms of flooding.

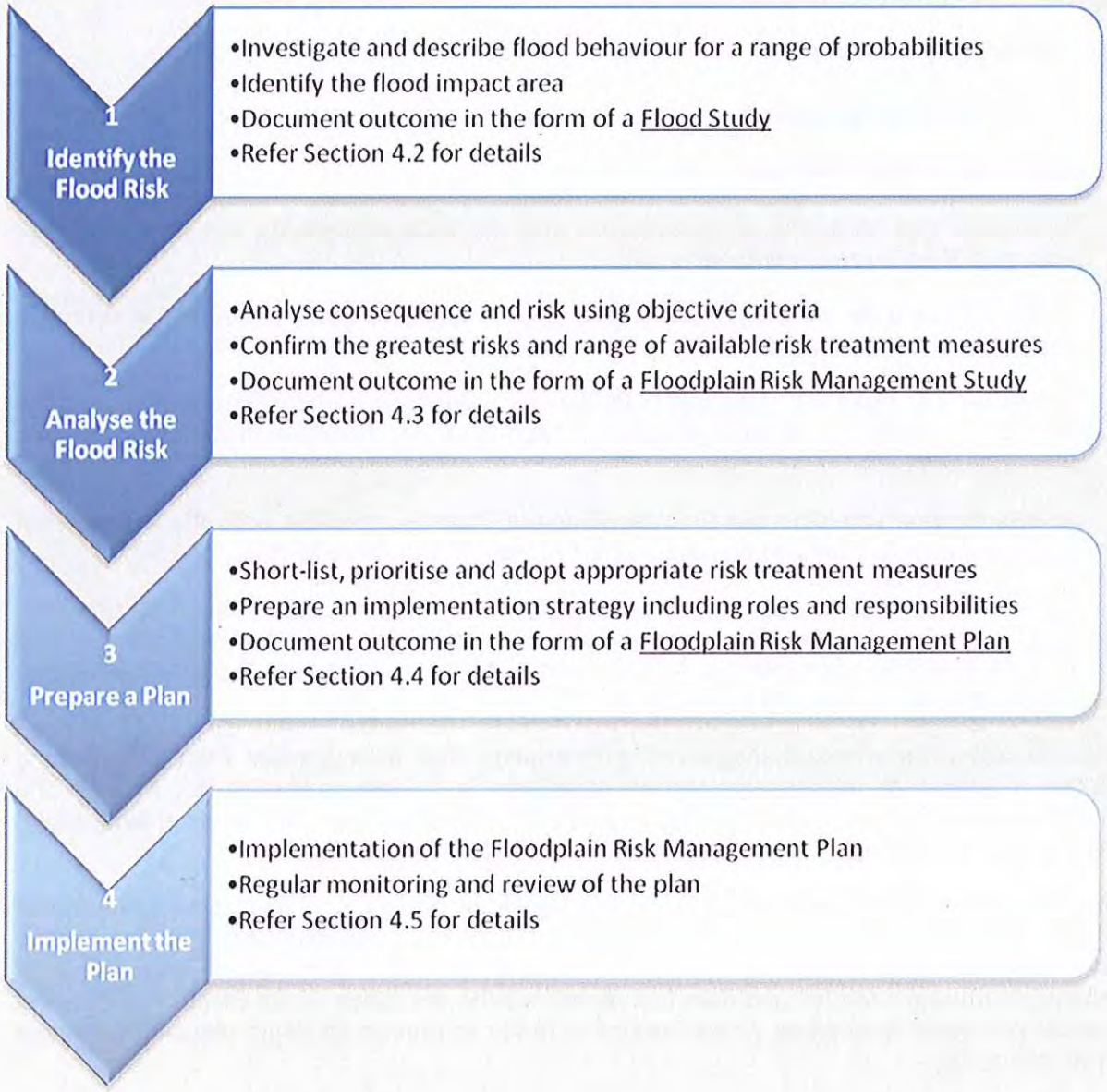


**Figure 4.1 MBRC Floodplain Risk Management Framework**

### *4.1.2 Floodplain Risk Management Committee*

During the application of the FRMF the formation of a Floodplain Risk Management Committee (the Committee) is recommended. The committee can be a technical steering group, a separate entity or part of an existing committee such as the Local Disaster Management Group (LDMG), however the LDMG must be focused on flooding issues when operating as a Floodplain Risk Management Committee.

It would generally be chaired by Council however special arrangements would be needed if studies and plans require co-ordination with adjoining local government areas.

Responsibility for planning matters lies with the Council as a whole and as the Committee is

advisory in nature, it should report directly to Council. Its principal objective is to assist council in the development and implementation of one or more Floodplain Risk Management Plans for its service area. The Committee is both the focus of, and a forum for, the discussion of technical, social, economic and ecological issues and for the distillation of possibly differing viewpoints on these issues.

Once the Committee has completed the primary task of developing the Floodplain Risk Management Plan including its implementation strategy, and council has adopted these, it is suggested that a limited group remain to oversee implementation.

At the time of preparation of this FRMF, Council does not have in place a Floodplain Risk Management Committee, nevertheless some of the steps in the framework process are being advanced. While Council's efforts to progress various aspects of the floodplain management process should be encouraged, an immediate priority should be to establish the committee and bring all relevant activity under its supervision.

### *4.1.3 Attainment Levels*

The FRMF recognizes two levels of attainment for each step in the procedure

- Basic – the level of detail acheived supports a basic understanding of the risks and the management measures that are available for their treatment. One of the recommended measures of a basic Floodplain Risk Management Plan should be progression towards an advanced level of attainment for the entire region or, as a minimum, those floodplain precincts where risks are considered likely to be greatest. A basic plan may be completed in the absence of a formal Floodplain Risk Management Committee.

- Advanced – the level of detail acheived supports a detailed understanding of the risks and management measures that are available for their treatment including detailed evaluation and prioritisation of measures and clear recommendations for their implementation. Advanced planning should not be undertaken in the absence of supervision by a Floodplain Risk Management Committee.

## 4.2 Step 1 - Identify the Flood Risk

Identifying flood risk first requires the collection of a variety of data to assess flood behaviour and the effectiveness, costs and benefits of management measures. It is important to define the data currently available and that needed for the study, to identify information gaps. The Floodplain Risk Management Committee (refer relevant **Practice Note**) should initiate studies, where gaps exist, to collect the social, economic, flooding, ecological, land use, cultural, and emergency management data required in management studies. Where relevant data exists this should be collated and referred to in investigations.

Data collection is not an end in itself; it is input to enable preparation of properly informed studies, management plans and floodplain management decisions associated with each type of flood affectation. There are three major types of flooding within the Moreton Bay Region requiring investigation:

- River and Creek Flooding
- Storm Tide (tropical cyclone or east coast low)
- Overland Flow

Other forms of flooding (not specifically addressed by the FRMF) include unusually high tides (e.g. so-called "king" tides), tsunami, local ponding from heavy rainfall and dam failure.

A flood study is a comprehensive technical investigation of flood behaviour. It defines the nature of flood risk by providing information on the extent, level and velocity of floodwaters and on the distribution of flood flows across various sections of the floodplain for the full range of flood events up to and including the PMF.

Flood studies are necessary because detailed knowledge of flood characteristics is required to deal with existing problems, future development and the residual flood risk. Major components of a flood study involve determining discharge (hydrologic aspects) and water levels, velocities, etc (hydraulic aspects) for floods of varying severity. Council has determined that WBNM is the preferred method for hydrologic studies and that the numerical modelling system TUFLOW is to be used for investigating the hydraulic aspects of the floodplain.

The flood study also determines hydraulic and hazard categories within the floodplain for the potential range of floods and land use scenarios in order to consider cumulative effects. The FRMF recognises three hydraulic categories (floodways, flood storage and flood fringe) and five hazard categories as described in the practice notes contained in **Volume 2**.

Investigating the full range of flood events up to and including the PMF enables changes in the nature and consequences of flooding to be assessed as flood severity increases. These may include increases in velocity and depth, changes in hazard category, the creation of 'islands' (which may be completely inundated in larger events), and the number of properties inundated etc.

Determining appropriate areas for different types of development generally depends upon flood exposure of the land, as defined by hydraulic and hazard categorisation. This information is also weighed objectively in selecting Defined Flood Events.

Finally, climate change may affect the weather events that cause flooding, sea levels may continue to rise and the pattern of flood producing storms may change significantly in terms of both frequency of event and intensity. Their potential impacts need to be considered when identifying the flood risk.

## 4.3 Step 2 - Analyse the Flood Risk

Once Step 1 is completed a Floodplain Risk Management Study is to be prepared to objectively analyse the risks associated with flooding and to identify, assess and compare various flood management options.

The Floodplain Risk Management Study draws together the results of the flood study and data collection exercises. It provides information and tools to allow strategic assessment of the impacts of management options for existing, future and residual flood risk on flood behaviour and hazard and the social, economic, ecological and cultural costs and benefits of options. It also provides the basis for robust decision making in the management plan.

The suite of flood management measures that a management study will propose generally involves a mix of options as it is unusual for a single management option to manage the full range of flood risk. Determining the optimum mix of measures can require complex studies, exercise of professional judgement and extensive community consultation. Typical options considered are indicated in **Table 4.1** and should include:

- **property modification measures** including development controls in new areas, and voluntary purchase and house raising in developed areas;
- **response modification measures** such as evacuation and associated operational logistics; and

- **flood modification measures** including levees and bypass channels

The impact of management works or proposed developments on flooding behaviour elsewhere should be assessed on a cumulative rather than individual or ad hoc basis within the context of the management plan. This includes both the effect of development on flood behaviour and the number of people who may require evacuation, particularly in rare flood events. Where mitigation works are considered, they should be designed to produce net positive ecological outcomes, where practical and feasible.

**Volume 2** provides advice to aid in Floodplain Risk Management Study preparation including advice on hydraulic and hazard categorisation and determination of Defined Flood Events (DFEs). Unless the DFE is based on the PMF, a larger flood than that used to determine the DFE can always occur. It is not a matter of if but when. The difference in flood levels, damages, and the area of inundation and the number of dwellings to be evacuated in the PMF event relative to the event upon which the DFE is based, serves to alert a council to the upper limit of the costs and consequences of flooding. **Volume 2** also provides details on the typical management options available to address the full range of risk and guidance on flood damage determination to allow incorporation into benefit cost calculations.

**Table 4.1 Typical Floodplain Risk Management Measures**

| ***Flood Modification Measures*** | ***Property Modification Measures*** | ***Response Modification Measures*** |
|---|---|---|
| *flood control dams* | *zoning* | *flood plans* |
| *bypass floodways* | *building and development controls* | *flood prediction and warning* |
| *levees* | *voluntary purchase* | *evacuation arrangements* |
| *channel improvements* | *house raising* | *recovery plans* |
| *retarding basins* | *flood proofing buildings* | *community education* |
| *flood gates* | *flood access* | *community preparedness* |

Finally, in consideration of the potential changes to the weather events that cause flooding, the design life of projects must be subject to close scrutiny so as to avoid costly upgrading or redesign of adopted measures.

## 4.4 Step 3 - Prepare a Floodplain Risk Management Plan

The purpose of a Floodplain Risk Management Plan is to provide input into the strategic and statutory planning roles of councils and to prioritise the range of management measures adopted from the Floodplain Risk Management Study. It does not, by intent, purport to be the only document relevant to development of flood prone land. The management plan provides the type of information necessary for adequate forward planning for flood prone land.

The advantages to both council and the community in general of having a properly considered Floodplain Risk Management Plan in place include:

- Having a proper basis for managing and using flood prone land to provide a balance between danger to personal safety and economic losses due to flooding, and social, ecological and cultural interests. This provides the current and future community best value from managing and using its floodplains;
- Optimising use of community infrastructure, such as roads, water supply and sewerage;

- Minimising personal danger to residents, visitors and emergency response personnel and community flood damage;
- Land can be identified for development and the impacts of its development on flooding and the affects of flooding on the development can be effectively considered. This provides a sound basis for incorporating floodplain management outcomes in revising council's planning instruments and development controls. It allows the community to grow in a responsible and socially cohesive fashion in consideration of flood issues. It also provides for increased certainty, from a flood perspective, for development applications in line with the relevant Planning requirements; and
- Having a basis for more timely assessment of development applications for flood prone land, especially where council's Planning Instruments and development control plans and/or policies have been altered, in light of the management plan, to incorporate appropriate zonings, and flood related controls. Individual development applications are thus limited to the best way to achieve the required outcomes on individual sites.

Review of management plans should be triggered by the following instances:

- Elapsed time - review regularly, around every 10 to 15 years, down to 5 if a flood has occurred in the meantime;
- After significant flood events which provide additional data on flood behaviour;
- Where significant changes occur to the factors influencing the decisions in the plan, including changes to local flood plans;
- Where impediments to implementation exist that warrant a review; and
- Where changes in future land use trends outside those considered in the management plan are proposed.

This review should account for changes across the full range of issues originally addressed and consider any associated emergent issues. Further detail on the preparation of Floodplain Risk Management Plans is included within the practice notes in **Volume 2**.

## 4.5 Step 4 - Implement the Floodplain Risk Management Plan

Once a Floodplain Risk Management Plan has been adopted, it needs to be implemented. Certain components can be implemented relatively quickly, such as incorporating flood related development controls into policy and Planning Instruments and flood education programs. Others require additional investigations and design, and funding.

It is unlikely that any management plan could be implemented immediately in its entirety. For example, availability of funding will determine when mitigation works can commence. Consequently, an implementation strategy is required to stage components dependent on funding availability and the management plan needs to consider adoption of interim measures. The implementation strategy should be developed during the preparation of the management plan and incorporated in the plan.

# 5 ROLES & RESPONSIBILITIES

The primary responsibility for the application of sound floodplain management rests with local government. However, all levels of Government can contribute to or have partial responsibility for floodplain management.

## 5.1 Commonwealth Government

The Commonwealth Government has a general responsibility for the economic and social well being of the nation. To this end, the Commonwealth Government currently:

- Encourages the development of effective long-term strategies for the sustainable management of the nation's floodplains;
- Provides flood forecasting services by the Bureau of Meteorology;
- Supports the development of emergency management capabilities through the activities of Emergency Management Australia; and
- Provides financial assistance under the Natural Disaster Relief Arrangement (NDRA), which is administered by the Department of Finance in conjunction with State and Territory Treasury Departments when flood damage and disruption is greater than a preset amount.

## 5.2 State Government

The roles of each State Government Agency are summarised below. The principal floodplain management role of State and Territory Governments has been stated as follows (DPIE, 1992):

"....to develop appropriate standards and strategic approaches for floodplain management and to ensure that they are applied in a coordinated and integrated fashion across the State. This role encompasses the provision of expert technical support via a principal water resources authority(s), of planning advice through a state planning agency and of effective counter disaster and welfare services".

**The following sub-sections will need to be developed in consultation with relevant agencies.**

### *5.2.1 Department of Environment and Resource Management*

### *5.2.2 Department of Local Government and Planning*

### *5.2.3 Department of Community Safety*

### *5.2.4 Emergency Management Queensland*

### *5.2.5 Queensland Police*

### *5.2.6 Department of Transport and Main Roads*

- Provides a safe and efficient road network that deals with flood impacts by minimising the flood risk to the travelling public, and restoring relevant flood affected infrastructure; and

- Makes predictions of road closures/re-openings and possible failure modes, if any.

### 5.2.7 Department of Communities

- Lead agency for human recovery services (coordination, emergency accommodation, food and clothing, financial support).

### 5.2.8 Energex

- Provides electricity supply infrastructure in flood prone areas;
- Maintains integrity of electricity supply;
- Ensures safe operation of electricity infrastructure in flood conditions; and
- Reinstates electricity infrastructure to provide immediate serviceability.

### 5.2.9 Obligations of State Government Agencies

It is a fundamental best practice principle of floodplain management that government agencies, be they Local, State or Commonwealth, are bound by the best practice principles of the FRMF.

Government agencies, whether State or Commonwealth, undertaking works or developments on flood prone land must comply with the provisions of Floodplain Risk Management Plans. When planning such works or developments, it is essential that the agency takes into account the nature and extent of the flood problem, the impact of the development on flood behaviour, and the impact of flooding on likely hazard levels at the development site.

If the proposed development is or could form part of infrastructure required for flood emergency management, e.g. a police station, hospital, telephone exchange or school, consideration should be given to relocating the development at a flood-free site (if possible), or ensuring that the proposed development can meet its intended emergency use when a flood eventuates.

Government agencies should seek the advice of local government with respect to flood behaviour, EMQ with respect to flood emergency procedures, Department of Infrastructure and Planning, as well as Council, in relation to planning considerations and the natural resource and environmental protection agencies in relation to environmental matters.

## 5.3 Local Government

Local government has a number of roles and responsibilities in the effective management of the floodplain. The principal roles and responsibilities are detailed below.

### 5.3.1 Preparation of Floodplain Risk Management Plans

Flood prone land needs to be managed in accordance with its flood risk. This is achieved through the preparation and implementation of a Floodplain Risk Management Plan, which also considers the social, environmental and economic costs and benefits of the use and management of flood prone land. As part of this process, the council requires sound information concerning flood behaviour, flood impacts and the other planning factors that affect the use of flood prone land.

The preparation of a Floodplain Risk Management Plan is most effectively undertaken within the process described in the FRMF, involving the compilation of a flood study and a

floodplain management study prior to defining a Floodplain Risk Management Plan. The floodplain management process should involve comprehensive community consultation and public exhibition of the Floodplain Risk Management Plan to facilitate community understanding and acceptance of the proposals.

### 5.3.2 Planning Schemes

Local agencies should incorporate the planning provisions of Floodplain Risk Management Plans into statutory planning instruments.

### 5.3.3 Flood Emergency Plans

The preparation of a local flood emergency plan is the responsibility of local government as well as the provision of manpower, equipment and facilities to assist in flood response activities.

For the local flood emergency plan to be effective, local government needs to work in concert with EMQ to promote flood awareness in the community by supplying flood data and advice to property owners, residents, visitors, potential purchasers and investors. In recognition of the turnover in residents, and human fallibility, such information should be provided on a regular basis.

### 5.3.4 Implementation and Review of Management Strategies

Once a Floodplain Risk Management Plan has been adopted, local government is responsible for the administration of many of the provisions of the plan, including:

- The investigation, design, construction and maintenance of structural flood mitigation works;
- The establishment of a formal asset management program for floodplain management measures;
- The administration of land use controls;
- The administration of building controls (e.g. minimum floor levels);
- The provision and maintenance of plant, equipment and manpower, as specified in the local flood emergency plan for the area; and
- Fostering, in conjunction with EMQ, improved flood awareness through public education programs.

Floodplain management measures, be they structural or otherwise, constitute a valuable community asset; public funds have been spent on analysis, design, construction and implementation of these management measures. As such, the measures need to be effectively managed and maintained to ensure that they will perform as required, on those infrequent occasions when they are needed.

It is also essential that the Floodplain Risk Management Plan be reviewed in detail on a regular basis, every 10 to 15 years without flooding but immediately after a flood event that tests the management measures.

## 5.4 Developers

### 5.4.1 Conforming Developments

Once a Floodplain Risk Management Plan has been prepared, most if not all of the

provisions and conditions relating to suitable or 'conforming' developments on the floodplain will be specified in the plan. This will assist developers in their preparation of applications for such developments.

Before preparing and submitting applications, developers are advised to liaise with local government regarding the provisions and conditions of conforming developments.

### *5.4.2 Non-Conforming Developments*

A Floodplain Risk Management Plan does not necessarily exclude non-conforming developments. However, it serves to alert both local government and the developer to the fact that, in general terms, non-conforming developments are not appropriate to the flood risk and flood hazard at the proposed site.

Should a developer wish to propose a non-conforming development, particularly where a developer derives financial benefit from developing the land, a number of detailed technical studies will need to be undertaken at the developer's expense to justify the proposal. These studies include:

- A flood study that addresses the following for a range of flood events up to the PMF:
    - Impact of floods on the proposed development;
    - Impact of the development on existing flood behaviour and flood hazard at other locations;
    - Hazard levels at the proposed development site; and
    - Any additional demands on emergency services associated with the development.
- An economic study to demonstrate that the proposed development is equitable and is economically and socially justified on a local community and regional basis;
- An environmental study to identify and address any adverse environmental impacts; and
- A floodplain management study to demonstrate that the development does not exacerbate and ideally enhances current floodplain management arrangements and will not place people at undue risk.

Developers are strongly advised to liaise with local government regarding the scope and detail of issues to be addressed in the supporting studies. If there are significant adverse impacts, the proposal must specify compensatory measures that reduce the impacts to acceptable levels. Compensatory measures may be subject to approval by consent authorities.

### *5.4.3 Financial Contributions*

Where required by Council, developers will be expected to contribute to the costs of floodplain management measures arising from the effects of their development.

## 5.5 The Flood Prone Community

The community has a basic responsibility in regard to the management of residual flood risk - to both inform themselves and keep up to date with appropriate action to take in the event of a flood.

Residual flood risk can best be addressed through flood emergency plans. If these plans are

to be successful, it is essential that the community knows what to do and how to do it effectively when flood warnings are issued. Council and EMQ have an important role to play in raising flood awareness through public education campaigns.

In areas where structural flood mitigation works have been built, individuals should be aware that in general the works do not eliminate flood hazard, and that problems and danger can arise when floods greater than the design flood event occur. When levees are overtopped, water levels within the protected area can rise quickly and evacuation routes may be cut, creating hazardous conditions.

All of these issues should be addressed in the Floodplain Risk Management Plan for the area. As part of these plans, flood prone individuals should be made aware of the flood risk to which they are exposed, the functioning of the flood warning and evacuation systems, and appropriate actions to be taken when warnings are issued. This information should be freely available from the local agency. The general community - both flood prone and flood-free individuals - should be encouraged to inform themselves of flooding matters.

# 6 GLOSSARY

**Table 6.1 Glossary of Terms**

| *Term* | *Description of Term* |
|---|---|
| *Annual exceedance probability (AEP)* | *The chance of a flood of a given or larger size occurring in any one year, usually expressed as a percentage (see also ARI).* |
| *Australian Height Datum (AHD)* | *The national surface level datum approximately corresponding to mean sea level.* |
| *Average annual damage (AAD)* | *AAD is the average damage per year that would occur in a nominated development situation from flooding over a very long period of time.* |
| *Average recurrence interval (ARI)* | *The long-term average number of years between the occurrence of a flood as big as or larger than the selected event. ARI is another way of expressing the likelihood of occurrence of a flood event.* |
| *Caravan and moveable home parks* | *Standards relating to their siting, design, construction and management can be found in the Regulations under the Residential Tenancies and Rooming Accommodation Act.* |
| *Catchment* | *The land area draining through the main stream, as well as tributary streams, to a particular site. It always relates to an area above a specific location.* |
| *Consent authority* | *The council, government agency or person having the function to determine a development application for land use.* |
| *Defined flood extent* | *Area of land covered by the largest known flood, used for flood planning and management measures. Its return period (ARI) is defined by MBRC.* |
| *Defined Flood Event (DFE)* | *Flood event(s) selected for floodplain management purposes. DFEs are the combinations of flood levels (derived from significant historical flood events or floods of specific AEPs) and relevant freeboards.* |
| *Development* | *In the FRMF:*<br>*Infill development: refers to the development of vacant blocks of land that are generally surrounded by developed properties and is permissible under the current zoning of the land.* |
| | *New development: refers to development of a completely different nature to that associated with the former land use.* |

| Term | Description of Term |
|---|---|
| | Redevelopment: refers to rebuilding in an area and generally does not require either re-zoning or major extensions to urban services. |
| Discharge | The rate of flow of water measured in terms of volume per unit time, for example, cubic metres per second ($m^3/s$). |
| Ecologically Sustainable Development (ESD) | Using, conserving and enhancing natural resources so that ecological processes, on which life depends, are maintained, and the total quality of life, now and in the future, can be maintained or increased. |
| Effective warning time | The time available after receiving advice of an impending flood and before floodwater prevents appropriate flood response actions being undertaken. |
| Emergency management | A range of measures to manage risks to communities and the environment. In the flood context it may include measures to prevent, prepare for, respond to and recover from flooding. |
| Flash flooding | Flooding which is sudden and unexpected, often caused by sudden local or nearby heavy rainfall. It is often defined as flooding which peaks within six hours of the causative rain. |
| Flood | A stream flow which overtops the natural or artificial banks in any part of a stream, river, estuary, lake or dam, and/or local overland flooding associated with major drainage before entering a watercourse, and/or coastal inundation resulting from super-elevated sea levels and/or waves overtopping coastline defences excluding tsunami. |
| Flood awareness | Awareness is an appreciation of the likely effects of flooding and knowledge of the relevant flood warning, response and evacuation procedures. |
| Flood education | Flood education seeks to provide information to raise awareness of the flood problem so as to enable individuals to understand how to manage themselves and their property in response to flood warnings and in a flood event. It invokes a state of flood readiness. |
| Flood fringe areas | The remaining area of flood prone land after floodway and flood storage areas have been defined. |
| Flood liable land | Flood liable land is synonymous with flood prone land (i.e. land susceptible to flooding by the PMF event). Note that the term flood liable land covers the whole floodplain, not just that part below the Flood Planning Area (FPA). |

| Term | Description of Term |
|---|---|
| *Flood mitigation standard* | *The average recurrence interval of the flood, selected as part of the floodplain management process that forms the basis for physical works to modify the impacts of flooding.* |
| *Floodplain* | *The area of land which is subject to inundation by floods up to and including the PMF event, i.e., flood prone land.* |
| *Floodplain management options* | *The measures that might be feasible for the management of a particular area of the floodplain.* |
| *Floodplain Risk Management Plan* | *A management plan developed in accordance with the principles and guidelines in the FRMF. It usually includes both written and diagrammatic information describing how particular areas of flood prone land are to be used and managed to achieve defined objectives.* |
| *Flood planning area* | *The area of land below the DFE and thus subject to flood related development controls.* |
| *Flood proofing* | *A combination of measures incorporated in the design, construction and alteration of individual buildings or structures subject to flooding, to reduce or eliminate flood damages.* |
| *Flood prone land* | *Land susceptible to flooding by the PMF event. Flood prone land is synonymous with flood liable land.* |
| *Flood readiness* | *Readiness is an ability to react within the effective warning time.* |
| *Flood risk* | *Potential danger to personal safety and potential damage to property resulting from flooding. Flood risk is divided into 3 types, existing, future and residual risks. They are described below.*<br>*Existing flood risk: the risk a community is exposed to as a result of its location on the floodplain.*<br>*Future flood risk: the risk a community may be exposed to as a result of new development on the floodplain.*<br>*Residual flood risk: the risk a community is exposed to after floodplain management measures have been implemented. For an area without any floodplain management measures, the residual flood risk is simply the existence of its flood exposure.* |
| *Flood storage areas* | *Flood storage areas are locations where significant volumes of flood water are held back by natural controls. These areas may be considered to be a sub-category of floodway as the development controls applied in the area are basically the same.* |

| Term | Description of Term |
|---|---|
| *Floodway areas* | *Those areas of the floodplain where a significant discharge of water occurs during floods. They are often aligned with naturally defined channels. Floodways are areas that, even if only partially blocked, would cause a significant redistribution of flood flow, or a significant increase in flood levels.* |
| *Freeboard* | *Provides reasonable certainty that the risk exposure selected in deciding on a particular flood chosen as the basis for the DFE is actually provided. It is a factor of safety typically used in relation to the setting of floor levels, levee crest levels, etc. Freeboard is included in the Defined Flood Event.* |
| *Habitable room* | *In a residential situation: a living or working area, such as a lounge room, dining room, rumpus room, kitchen, bedroom or workroom. In an industrial or commercial situation: an area used for offices or to store valuable possessions susceptible to flood damage in the event of a flood.* |
| *Hazard* | *A source of potential harm or a situation with a potential to cause loss. In relation to the FRMF, the hazard is flooding which has the potential to cause damage to the community.* |
| *Hydraulics* | *Term given to the study of water flow in waterways; in particular, the evaluation of flow parameters such as water level and velocity.* |
| *Hydrograph* | *A graph which shows how the discharge or stage/flood level at any particular location varies with time during a flood.* |
| *Hydrology* | *Term given to the study of the rainfall and runoff process; in particular, the evaluation of peak flows, flow volumes and the derivation of hydrographs for a range of floods.* |
| *Local Flood Plan* | *A sub-plan of a disaster plan that deals specifically with flooding. They can exist at state, regional and local levels. Local flood plans are prepared under the leadership of EMQ.* |
| *Local overland flooding* | *Inundation by local runoff rather than overbank discharge from a stream, river, estuary, lake or dam. Not directly addressed by the FRMF.* |
| *Local drainage* | *Smaller scale problems in urban areas. They are outside the definition of major drainage in the FRMF.* |
| *Mainstream flooding* | *Inundation of normally dry land occurring when water overflows the natural or artificial banks of a stream, river, estuary, lake or dam.* |

| Term | Description of Term |
|---|---|
| *Major drainage* | *Councils have discretion in determining whether urban drainage problems are associated with major or local drainage. For the purposes of the FRMF, major drainage involves:*<br>*The floodplains of original watercourses (which may now be piped, channelised or diverted), or sloping areas where overland flows develop along alternative paths once system capacity is exceeded; and/or*<br>*Water depths generally in excess of 0.3m (in the major system design storm as defined in the current version of Australian Rainfall and Runoff).*<br>*These conditions may result in:*<br>*Danger to personal safety and property damage to both premises and vehicles; and/or*<br>*Major overland flowpaths through developed areas outside of defined drainage reserves; and/or*<br>*The potential to affect a number of buildings along the major flow path.* |
| *Minor, moderate and major flooding* | *Both EMQ and the Bureau of Meteorology use the following definitions in flood warnings to give a general indication of the types of problems expected with a flood:*<br>*Minor flooding: causes inconvenience such as closing of minor roads and the submergence of low level bridges*<br>*— Moderate flooding: low-lying areas are inundated requiring removal of stock and/or evacuation of some houses. Main traffic routes may be covered*<br>*— Major flooding: appreciable urban areas are flooded and/or extensive rural areas are flooded. Properties, villages and towns can be isolated.* |
| *Modification measures* | *Measures that either modify the flood, the property or the response to flooding.* |
| *Peak discharge* | *The maximum discharge occurring during a flood event.* |
| *Probable maximum flood* | *The PMF is the largest flood that could conceivably occur at a particular location, usually estimated from probable maximum precipitation coupled with the worst flood producing catchment conditions. It is not physically or economically possible to provide complete protection against this event. The PMF defines the extent of flood prone land, that is, the floodplain.* |

| Term | Description of Term |
|---|---|
| *Probable maximum precipitation* | *The probable maximum precipitation (PMP) is the greatest depth of precipitation for a given duration meteorologically possible over a given size storm area at a particular location at a particular time of the year, with no allowance made for long-term climatic trends (World Meteorological Organisation, 1986). It is the primary input to PMF estimation.* |
| *Probability* | *A statistical measure of the expected chance of flooding (see AEP).* |
| *Risk* | *Chance of something happening that will have an impact. It is measured in terms of consequences and likelihood. In floodplain investigations, it is the likelihood of consequences arising from the interaction of floods, communities and the environment.* |
| *Runoff* | *The amount of rainfall which actually ends up as streamflow, also known as rainfall excess.* |
| *Stage* | *Equivalent to water level (both measured with reference to a specified datum).* |
| *Stage hydrograph* | *A graph that shows how the water level at a particular location changes with time during a flood.* |
| *Survey plan* | *A plan prepared by a registered surveyor.* |
| *Value-based approach* | *The value-based approach weighs social, economic, ecological and cultural impacts of land use options for different flood prone areas together with flood damage, hazard and behaviour implications, and environmental protection and well being of the State's rivers and floodplains. The value-based approach operates at two levels. At the strategic level it allows for the consideration of social, economic, ecological, cultural and flooding issues to determine strategies for the management of future flood risk which are formulated into council plans, policy, and Planning Instruments. At a site specific level, it involves consideration of the best way of conditioning development allowable under the Floodplain Risk Management Plan, local floodplain management policy and Planning Instruments.* |
| *Water surface profile* | *A graph showing the flood stage at any given location along a watercourse at a particular time.* |

Attachment 1680908-16

Moreton Bay Regional Council

# Floodplain Risk Management Framework

## Volume 2 PRACTICE NOTES DRAFT

August 2011

# PRACTICE NOTE LISTING

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- FLOODPLAIN RISK MANAGEMENT PLAN

# PRACTICE NOTE

# FLOODPLAIN RISK MANAGEMENT COMMITTEE

## INTRODUCTION

The establishment of a Floodplain Risk Management Committee by council is usually the first formal step in the floodplain management process. The committee can be a technical steering group, a separate entity or part of an existing committee such as the Local Disaster Management Group (LDMG), however the LDMG must be focused on flooding issues when operating as a Floodplain Risk Management Committee.

Council will need to decide on the appropriate approach to ensure the committee is effective for its area.

The Floodplain Risk Management Committee acts as both a focus and forum for the discussion of technical, social, economic, environmental and cultural issues and for the distillation of possibly differing viewpoints on these issues into a management plan. It achieves this by ensuring that all stakeholders (often with competing desires) are equally represented.

## NEED FOR A COMMITTEE

The development of a Floodplain Risk Management Plan must take into consideration a number of diverse issues which include:

- the risk, danger to personal safety and property damage, imposed on existing land uses (the existing risk);
- the impact of flooding on potential future land uses and occupants and of that development on flooding (the future risk);
- the management of the continuing flood risk remaining in both existing and future development areas after works and controls are implemented (residual risk);
- the environmental impact of existing and potential future developments and floodplain management measures;
- the broad scale catchment issues such as water quality, riverine and floodplain enhancement and land management;
- cumulative impacts as a result of changes in hydrology, floodplain geometry, or other factors;
- the potential economic cost and benefits to both the private and public sectors of floodplain occupation and flood management measures;
- potential intangible flood costs, including physical and psychological effects of flooding;

- social factors, including the needs and aspirations of the local community, both existing and in the future;
- planning options and restrictions, including special zonings and planning controls, opportunities; and
- the protection of Aboriginal sites and places and European heritage.

The expertise necessary to address these issues needs to be drawn from a variety of sources, including:

- the local council itself (both elected representatives and council staff);
- the local community;
- key stakeholder groups;
- environmental interest groups;
- State and Commonwealth Government agencies; and
- specialist consultants, as engaged.

The development and implementation of a Floodplain Risk Management Plan is solely a local council responsibility in urban situations.

Given the complexity and range of issues to be addressed in the process as outlined above, the committee needs to be able to coordinate and disseminate the interests, advice and expertise available from State and Commonwealth Government agencies and the local community. The committee may, therefore, be established as a specialist technical committee to deal with these technical issues.

In certain circumstances it may be necessary to establish a single committee involving adjoining council(s) to effect coordinated planning. This may be appropriate where the floodplain under investigation embraces more than one local government area and where structural, land use or flood response measures in one council area are likely to influence the effectiveness of management measures or flood behaviour in other council areas. Consideration should also be given to the relationship with adjoining councils, and if necessary, the establishment of an overall committee to address the flooding problems on a catchment wide basis.

## ROLE OF THE COMMITTEE

The management committee does not have any formal powers. Rather, it has an advisory role with its principal objective to assist the council in the development and implementation of a management plan for the area(s) under its jurisdiction. However, the committee also assists in:

- formulating objectives (in accordance with ESD principles), strategies and outcomes sought from the process;
- providing a link between the local community and council;
- identifying the flood problem to be assessed and the study area;
- considering and making recommendations to council on appropriate development controls for use until the management plan is completed, approved and implemented;

- supervising the collection of necessary data and supervising and monitoring the progress and findings of studies being undertaken in the various stages of the management plan;
- providing input into known flood behaviour as part of the flood study;
- identifying management options and providing input into their consideration as part of the management study;
- identifying implementation strategies for the management plan;
- monitoring and assessing the effectiveness of the management plan during and after its implementation;
- coordinating and monitoring the community education programs essential to the long term viability of the management plan; and
- coordination with emergency management, planning and other advisory bodies.

Once the committee has completed the prime task of developing a management plan and associated implementation strategy, and the council has adopted these, it is suggested that a limited group remain to oversee implementation.

## MEMBERSHIP OF THE COMMITTEE

The membership of the committee needs to be a balanced representation of stakeholders such as agencies, groups and/or individuals effecting, affected by or coordinating floodplain management. Membership should be flexible to ensure the right mix of interests is represented. Typically, membership would include:

- elected members of council;
- council staff from engineering, planning and environmental disciplines;
- an appropriate number of representatives of the local community (for example, local flood affected landholders (residential and business), relevant stakeholder bodies (e.g. the chamber of commerce), and environmental groups);
- officers from DERM and DCS; and
- representative(s) from EMQ (SES).

Officers from other relevant government agencies or departments may be co-opted to the committee as and when required.

Because the responsibility for planning matters lies with council, the committee should report either to council or to its appropriate standing committee, which has the final decision making power.

## ROLE OF COMMITTEE MEMBERS

The primary role and responsibility of the committee is to ensure that all important aspects of floodplain management are given due consideration. It should be noted that the committee is tasked with seeking solutions to the existing, future and continuing flood risk issues, not solely on addressing the past.

It is also important to note that State Government agency representatives do not have committee voting rights but provide advice in relation to their departmental functions and their area of expertise.

## TECHNICAL SUB-COMMITTEE

The role of this sub-committee of the Floodplain Risk Management Committee should be to provide technical assistance to enable the committee to fulfil its advisory role to council efficiently, confident that studies and option assessments are technically adequate and the options proposed are practical and feasible.

The roles of the technical sub-committee may include:

- preliminary development of process and individual study objectives for further consideration by the full committee;
- collection of background data for studies available to council, DERM and EMQ;
- preparation of technical project briefs in consultation with the committee;
- review of proposals from consultants in consultation with the committee;
- review of modelling, management options, reports and presentations for technical adequacy prior to presentation and review by the full committee; and
- advice on any other technical matters upon request by the committee.

The technical sub-committee should have membership from council staff (both engineering and strategic planning) and relevant government agencies.

## COMMUNITY ENGAGEMENT

The local community, both flood prone and otherwise, has a key role to play in the development, implementation and success of a management plan. If it is to be accepted and successful, it is essential that clear and concise communications flow between the committee and the community so that affected individuals and community groups can 'have their say' and learn of their roles and responsibilities.

The following approach is suggested to establish and maintain communication between the council, committee and the local community however It is important that an appropriate methodology should be developed for the specific study area, community and locality. Council should arrange to:

- involve and inform the community (through media releases, newsletters and public meetings) on a range of issues. These include the role and responsibilities of the committee, its intention to instigate a study/studies for preparation of a management plan, the work council is undertaking for the flood study, and progress on the studies and plan. Affected residents should also be informed of the length of time until finalisation of the management plan and implementation of management measures, and of the nature of development controls pending management plan completion;
- call for representatives of the general community and action groups to self nominate for the committee, clearly stating the expected role of members at this time;

- use established local community groups, where they exist, and encourage their representation on the committee;
- make one or two contact people known to the community, usually staff members of council, who can be contacted regarding questions relating to floodplain management, during the development and implementation of the management plan;
- seek historic flood information from the community as early as possible in the flood study to provide an opportunity for them to learn about the proposal to prepare a plan but to have their local knowledge acknowledged and respected
- define clear goals for each study and estimate the time to complete each investigation and when direct community consultation and feedback is proposed;
- release information to the community and members of the committee at regular intervals, rather than waiting until the completion of one of the formal stages of the management plan, or associated formal meetings of the committee;
- consider appropriate development controls for use until the management plan is completed considering recommendations of the management committee;
- ensure that simple, clear messages are used to explain the situation in uncomplicated language and relate any implications to property owners and potential development applicants when disseminating information;
- formally adopt the management plan at the completion of the preparation and consideration process; and
- consider changes to the local flood risk management policy and council's strategic planning instruments and associated development controls during the implementation phase, where strategies result in altered flood behaviour.

## COMMITMENT OF COMMITTEE MEMBERS

The floodplain management process is neither short nor simple, nor is it the singular responsibility of council officers, consultants or government officers to have input to the process.

The management committee must comprise members who are committed to and actively involved in the preparation and implementation of the management plan. It may take 3 to 5 years to develop the plan and the implementation of all recommendations may take much longer.

In view of the length of time involved the turnover of committee members, including both council staff and elected representatives, can be a problem. Whilst little can be done with respect to the potential turnover of council and government officers, the structure of the committee should be decided with consideration of its long term viability and relationship with other committees in operation in the local area. Attempts should be made to co-opt local community members who are enthusiastic, energetic and likely to 'see the distance' to complete the management plan.

## TRADEOFFS

By necessity, the adopted management plan will be a compromise involving trade-offs. Certain individuals may be disadvantaged, others advantaged, but the community as a whole will be better off.

An important role of the management committee will be to assist in the presentation and resolution of conflicting desires and requirements on the part of various community groups and individuals. Public meetings, often spirited, are an important part of this process.

# PRACTICE NOTE

# FLOODPLAIN DATA COLLECTION

## INTRODUCTION

Data Collection is a key step of the floodplain management process, though it is generally undertaken as part of both the flood study and management study, as without appropriate data, these studies cannot be effectively completed. Data Collection is not an end in itself. Data is required to enable preparation of properly informed flood studies, management studies and plans.

Data Collection combined with the investigations under the floodplain management process provides the basis for robust and informed decision making. It highlights the available background information and associated data gaps that may need to be filled as part of investigations.

## INITIAL CONSIDERATIONS

Prior to commencing any studies and data collection, the steering committee needs to consider the:

- Overall objectives of the floodplain management process;
- Known community information sources, concerns or aspirations in relation to floodplain management and any associated constraints on potential management measures; and
- The objectives of the step being undertaken.

This knowledge enables the determination of the data necessary for studies and associated decision making.

## OBJECTIVES

The objective of Data Collection is to clearly define the data currently available and that necessary for studies. Where relevant information exists this should be collated and referenced in investigations. Where information gaps exist, studies should be initiated to collect this, where necessary.

## NECESSARY DATA

Data to be collected, collated, or estimated, where relevant, should include:

- Historic flood and land use data including:
  - Past reports;
  - Flood behaviour in general as well as major flow paths, peak flood levels, flow velocities, rate of rise of flood waters, travel time;
  - Historic flood damage;
  - The effects on the community of flooding to different heights including road closures, isolation and the need to evacuate.
- Rainfall records and projections of future rainfall characteristics;
- Topography and the geology of area, including soil types (for example, acid sulfate soils) and rates of erosion and deposition;
- Current floodplain management measures, their effectiveness and deficiencies, including environmental disturbance and impacts on water quality;
- Current and potential future land use and development trends within the catchment including available land and future demand for different types of development;
- Information on current flood related zonings and development controls;
- Current levels of community and individual flood readiness;
- Likely community disruption caused by flooding;
- Groundwater and local recharge areas;
- Aquatic and terrestrial flora and fauna surveys and habitat information, especially on threatened species, endangered populations and ecological communities;
- Areas of Aboriginal and historical cultural significance; and
- Relevant climate change data.

The steering committee should establish its objectives in this area, be aware of the need for information and instigate appropriate studies as early as practical to enable consideration of the associated constraints in developing management options.

## COMPLIMENTARY STUDIES AND PLANS

In addition to the technical flood studies, a range of complementary studies (land use, cultural and environmental) can be important in determining the compatibility and assessment of floodplain management measures.

Land use and social and environmental impacts cannot be considered in isolation from the flooding situation as they are highly interactive. The long term balancing of these issues is a primary principle of sound floodplain management.

Where this information does not exist and it is seen as central to effective and robust decision making consideration should be given to deriving it in the management study or as a separate if co-ordinated study.

## Land Use Planning Studies

An important consideration in the management study is the desired or likely mix of future land use, future growth areas and associated supply and demand issues, in consideration of regional as well as local factors.

Management studies provide an ideal opportunity to assess the long term future direction of the study area, its exposure to flood hazard, the cumulative impacts of development strategies and associated limits and conditions to manage development.

This is particularly important where land is unzoned, land use planning has not been previously determined, or changes to land use are being considered. Management studies can aid decision making by providing information on:

- The flood hazard on the land;
- Cumulative impacts of development on flooding;
- Impacts of flooding on potential development; and
- Information on appropriate development limits, types, and associated supporting development conditions.

Studies also involve examining flood risk in existing development areas. This may highlight opportunities or issues that need consideration if areas are to be redeveloped.

## Environmental Studies and Plans

The natural attributes of floodplains are very important to both the economy and the natural environment. Clearing for agriculture, urban development and flood mitigation, drainage and irrigation works has extensively modified the environment of most floodplains.

Depending on the characteristics of the environment where the management study is being undertaken, analysis of the riverine and floodplain environment, including the identification of key habitat areas and the importance of a natural flooding regime to surrounding areas, needs to be considered.

The environmental characteristics of the floodplain need to be considered in most management studies, especially in areas where there are flood-dependent ecosystems such as freshwater wetlands or river red gum forests, or in areas with acid sulfate soils.

These considerations should ensure compatibility of floodplain management measures to the relevant environmental issues.

## Cultural Studies

Protection of Aboriginal sites and places should be considered as part of any activities or works likely to affect floodplains. The *Aboriginal Cultural Heritage Act 2003* and the *Torres Strait Islander Act 2003* provides a series of protection and enforcement measures in relation to Aboriginal sites.

Where an area is likely to contain Aboriginal sites, survey work must be undertaken in consultation with the local Aboriginal community to assess the presence and significance of sites; if present, the requirements of the *Aboriginal Cultural Heritage Act 2003* and the *Torres Strait Islander Act 2003* must be satisfied.

In addition, consideration should be given to the occurrence and likely impact on European heritage items of local, regional, state and national significance, as required under the *Queensland Heritage Act 1992*. Consultation should be undertaken with the Council, Queensland Heritage Council or the Australian Heritage Commission in this regard.

# PRACTICE NOTE

# FLOOD STUDY

## INTRODUCTION

The principal technical foundation of a Floodplain Risk Management Plan is the Flood Study. To satisfy all the technical demands of a Floodplain Risk Management Plan, it must be a comprehensive technical investigation of flooding behaviour, defining the extent, depth and velocity of floodwaters for floods of various magnitudes up to the Probable Maximum Flood (PMF). This analysis enables both the hydraulic category and hazard category to be determined and identifies aspects of flooding behaviour that require special consideration, e.g. the rate of rise of floodwaters, the creation of "islands" from which evacuation is difficult or impossible. Accordingly, it is essential that the flood study should address not only the peak results but also the variation over time of the flood event.

## SUGGESTED PROCESS

The steps laid out below outline a suggested approach for a Flood Study. Some steps may change with the specific area under consideration. More detailed comments are provided in the following sections.

**Stage One - Data Compilation and Review**

- Task 1.1 - Inception Meeting
- Task 1.2 - Quality Assurance Plan
- Task 1.3 – Community Consultation
- Task 1.4 – Meetings and Presentations – regularly throughout Project
- Task 1.5 - Site Investigation and Data Collection
- Task 1.6 - Survey Data (if required)

**Stage Two - Flood Study**

- Task 2.1 – Establish Hydrologic Inputs
- Task 2.2 – Design Discharge Hydrographs
- Task.2.3 – Establish Hydraulic Models
  - Calibrate and Verify Hydraulic Model
- Task 2.4 – Modelling Of Design Events for Existing Conditions
  - Blockages
  - Model Sensitivity

  - Flood Contour Mapping
  - Hydraulic Categories & Provisional Flood Hazard Mapping
- Task 2.5 – Overland Flow Events

**Stage 3 - Reporting**

- Task 3.1 – Draft Flood Study Report - Contents:
  - Foreword
  - Executive Summary
  - Introduction
  - Background
  - Hydrology
  - Hydraulics
  - Modelling
  - Findings –
    - Flood profiles,
    - The flood level, velocity and flows in tabular form.
    - Flood "mapping" and hazard categorisation.
  - Specific Discussions and Recommendations
  - References - As appropriate.
  - Appendices -
- Task 3.2 – Final Report and Project Conclusion

## THE STUDY AREA

The study area or extent must be determined with all potential issues relevant to the community and longer-term development considerations (within a reasonable time frame) in mind. Therefore, the study area must not simply focus on any current problem area. The study area needs to also consider:

- The source of flood problems, whether riverine, coastal or overland flooding, or some combination;
- Potential impacts from other catchments or coastal influences;
- The potential impacts of extreme events, such as possible cross catchment flows; and
- That the flood study may provide the basis for a number of management studies and plans.

## FLOOD STUDY COMPONENTS

There are two principal components that may apply to a flood study:

- Hydrologic analysis to estimate the flood discharge; and
- Hydraulic analysis to determine the extent, depth and velocity of flooding.

The hydrologic and hydraulic analysis components are common to all flood studies regardless of the source of flooding – the specific requirements of each will vary depending on the source.

A number of assumptions and a relatively large degree of uncertainty can be associated with these analyses. The implications of this uncertainty need to be assessed by an experienced practitioner in the flood study.

Council has determined that WBNM is the preferred method for hydrologic studies associated with rainfall/runoff and TUFLOW is to be used for investigating the hydraulic aspects of the floodplain. Tidal information and storm surge data should be obtained through the Bureau of Meteorology and/or reputable investigations (e.g. Harper et al. 2001; Cardno 2009).

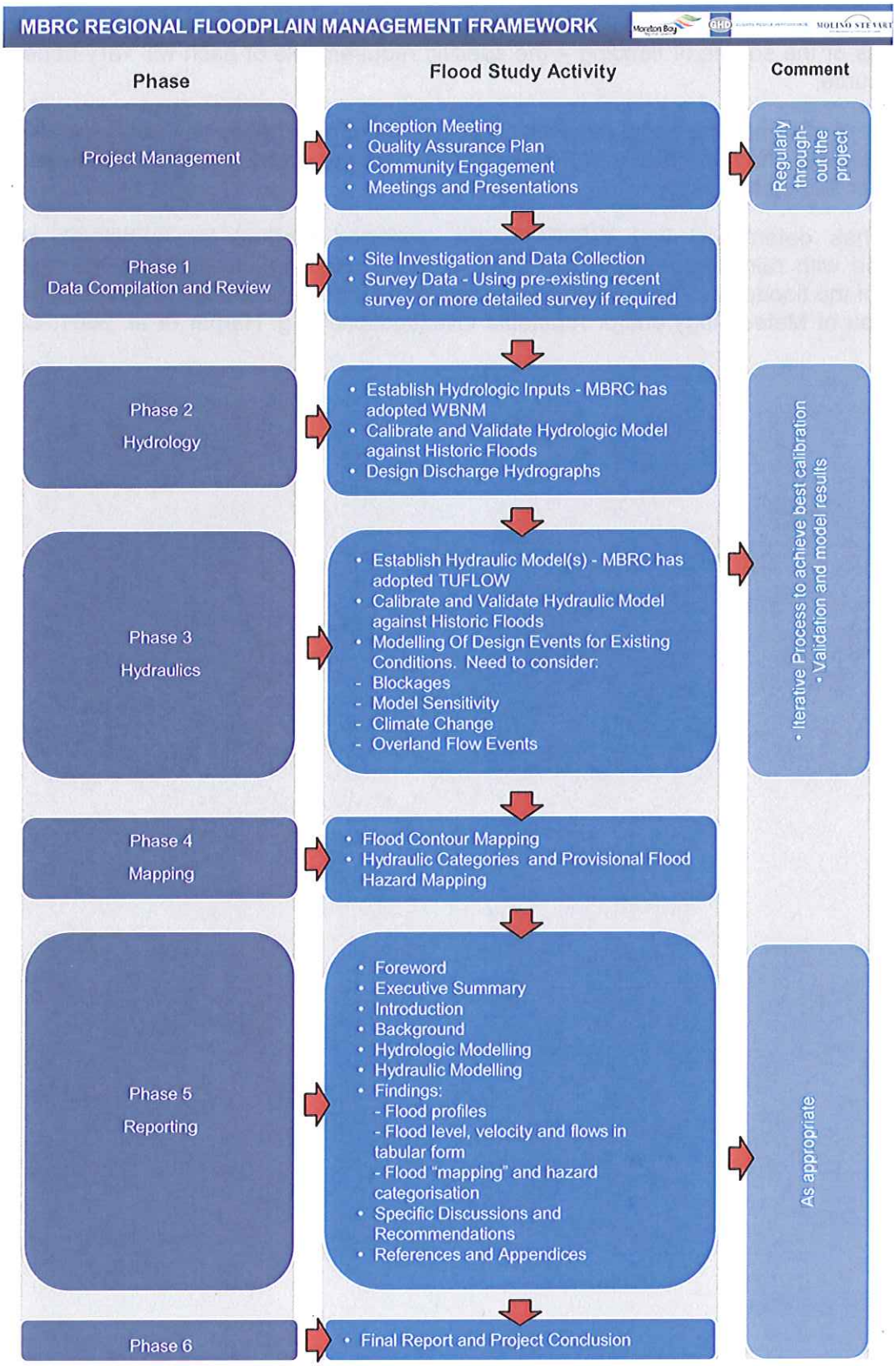


**Figure 1 Flood Study flow diagram**

## FLOODPLAIN MAPPING

The principal results from a flood study are:

- Production of technical data for the flood events of interest, up to and including the PMF; and
- Mapping of the extent of flooding of the watercourses within the study area.

The impact of changes in storm surge and mean sea level under a changing climate may need to be considered when developing the hydraulic model.

A typical Flood Map is illustrated in Figure 2 below.

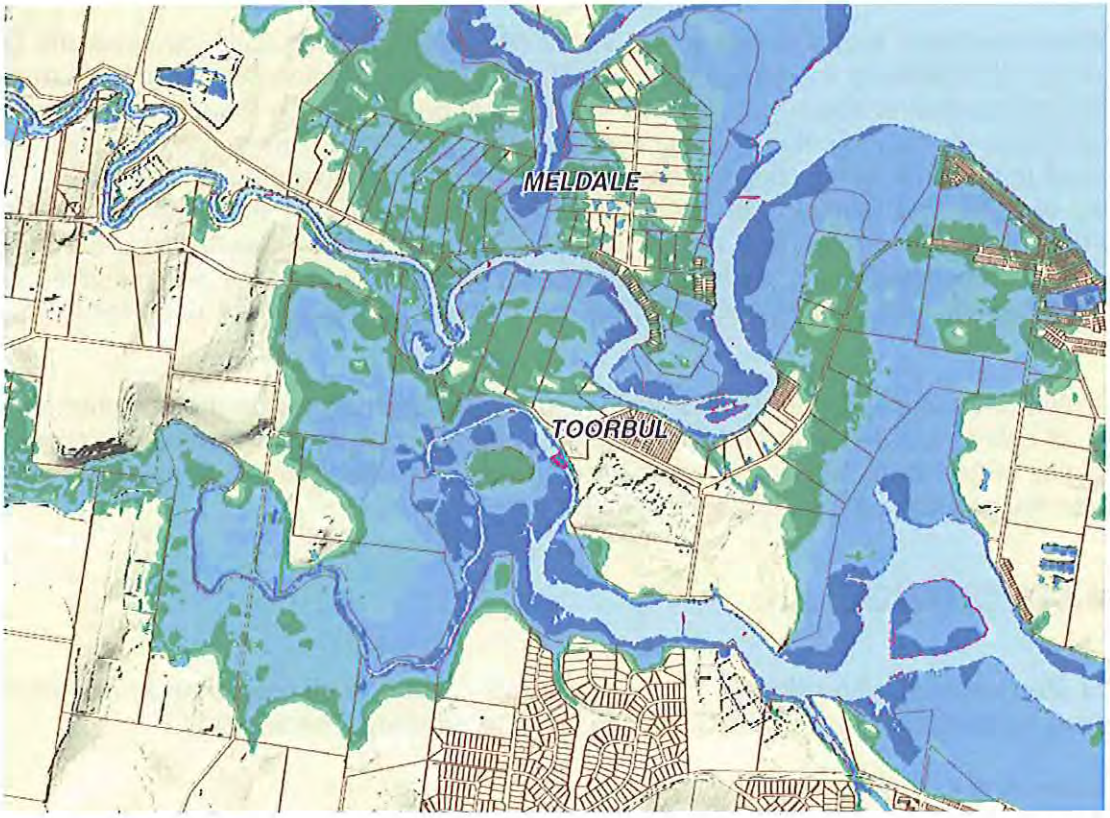


**Figure 2 Typical Flood Mapping (extract from MBRC Storm Tide Hazard Study, 2009)**

Flood maps showing the extent, depth, velocity and hazard of flooding for nominated flood events are an important tool for the preparation of Floodplain Risk Management Plans and flood emergency plans.

However, it must be recognised that flood maps are necessarily inexact. Flood maps can be derived by a variety of techniques and be based on contour mapping from a range of sources. The underlying inaccuracies in the topographic data used to derive flood maps need to be recognised and evaluated, as these inaccuracies affect the estimated boundaries of the area of inundated land.

If flood maps are to become public documents, considerable care needs to be taken with the depiction and explanation of flooding features so that the map is easily understood by the local community and is not subject to misleading interpretation. To this end, flooding

features such as the floodway, flood fringe and flood prone land should not be depicted with unjustifiable accuracy, i.e. with "hard edges". Rather, the boundary of flooding features should reflect the underlying uncertainty in analysis.

The land use planning controls that flow from flood maps should be incorporated into statutory planning instruments in a timely and expeditious manner. Geographical Information Systems (GIS) should be used to prepare all flood maps, whether for internal use by a floodplain management agency or for public use. GIS facilitates amendments to maps and the inclusion of subsidiary data that could be required in flood management, e.g. the location and floor levels of flood-liable buildings. This data can be readily incorporated into the MBRC flood database provided the output requirements are specifically stated in any study brief.

## ACCOUNTING FOR UNCERTAINTY

As outlined in earlier sections, every step in the hydrologic and hydraulic components of a flood study contributes to the uncertainty associated with the estimates of the design levels, velocities and extent of flooding. It is essential that this uncertainty be identified and that the implications, in terms of the flood study objectives and desired outcomes, are quantified. The degree of uncertainty in the design flood estimates will vary depending on the quality and quantity of flood and rainfall data available. In general the greater the available data the greater the confidence in the final design estimates. Ensuring that experienced practitioners carry out the hydrologic and hydraulic components of the flood study will minimise any systematic errors and enable a satisfactory assessment of the overall uncertainty to be carried out.

Sensitivity analyses in relation to input variables can be used to provide an indication of the degree of risk associated with errors in adopted criteria, coefficients or assumptions made. The results of sensitivity analyses should be considered in management decisions and may influence the decision on the freeboard adopted.

## CLIMATE CHANGE

A flood study should also address the possible implications of climate change on flooding behaviour as discussed in the MBRC Climate Change Strategy. These include:

- Increases in sea level;
- Altered weather patterns may intensify storms and so increase the severity of the resulting floods; and
- Increased intensity and frequency of extreme events.

The consequences of these increases on flood levels and behaviour should be analysed as part of a flood study either:

- Qualitatively based upon the broad range of floods being examined (up to and including the PMF); or
- Sensitivity analyses can be examined in relation to rainfall intensity, or downstream water level conditions for key flood events.

This provides a preliminary assessment of the potential impacts of climate change on flooding so this can be considered in the management study.

## INFORMATION FOR PRIMARY END USERS

The flood study should provide key information for primary end users, including council and EMQ, so they can fulfil their role in floodplain management based upon the information available until the management study and plan are completed. The required information for each is discussed below.

Information for council should assist in the management of development pending completion of the management study and plan. This should include:

- Hydraulic and hazard categorisation for key flood events; and
- Flood level information in a suitable format for key flood events.
- Information for EMQ should assist in its evacuation and logistics planning. This should include:
- A layman's description of flood behaviour in the study area for the full range of flood events;
- Flood level information within the study area relative to the key flood warning gauges for the location for full range of flood events; and
- Identification of critical evacuation issues, such as the cutting of key evacuation routes and the development islands that can ultimately be inundated and the potential critical timing for their loss.

Public infrastructure providers should also consider this information in protecting and upgrading existing facilities and designing future facilities.

It should be noted that the NSW Department of Environment & Climate Change published "Floodplain Risk Management Guideline: SES Requirements from the FRM Process" in 2007. This document contains a comprehensive listing of data to be provided by a flood study (and Floodplain Risk Management Study) and should be considered in the preparation of the study briefs so that all requirements are covered.

## SUMMARY

The selection of a hydrologic/hydraulic model for a catchment or study area must be based on an understanding of flood behaviour in the area of concern, the catchment characteristics, the data available and the overall aims, objectives and final outcome required from the modelling. Each catchment/study area has unique characteristics that must be taken into account when selecting a model. The type of hydraulic model will also be influenced by the required outcomes of the modelling.

Model selection must be compatible with the requirements of the entire floodplain management process.

All flood models are a conceptualisation of the real world, and thus have inherent inaccuracies. All results require interpretation and thus the modelling should be undertaken by, or supervised by, and experienced flood modeller. Sensitivity analysis of major assumptions and parameters is essential to ensure that the model is robust, representative and suitable for the overall objectives.

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# PRACTICE NOTE

# FLOODPLAIN RISK MANAGEMENT STUDY

## INTRODUCTION

A Floodplain Risk Management Study is a multidisciplinary process that balances the differing social, economic and environmental factors, as well as the flooding issues, to generate recommendations for an appropriate mix of management measures to deal with the flood risk faced by the study area. Some of the factors considered in the management study include:

- Flood behaviour, danger and damage;
- The community costs of flooding;
- Future land-use;
- A comprehensive range of flood management measures;
- The environmental needs of the river and floodplain areas; and
- Environmental and cultural impacts of management measures.

A Floodplain Risk Management Study aims to identify all relevant issues, quantify these issues and evaluate them to assist development of an overall management plan. Like any planning process, completing the management study and subsequent management plan involves discussion and tradeoffs with various groups within the community to gain the overall community's acceptance of the management plan.

As such, the management study involves significant levels of skill in engineering, planning, the sciences (social and environmental), economics and emergency management. The steering of management studies requires a significant effort from the Floodplain Risk Management Committee.

This Practice Note discusses:

- The initial considerations;
- The objectives of the management study;
- The types of risk to be managed;
- Key steps in the management study; and
- Specific issues of concern that need to be considered in the management study.

These discussions are followed by a suggested Contents listing for the Study Report. This can be adapted to suit the specific circumstances of the study area in question.

It is stressed that the management study and the subsequent management plan are integrally linked. The study identifies and assesses issues for input into the decision making

process resulting in the management plan. The management plan preparation process is outlined in Practice Note 'Floodploain Risk Management Plan', which should be read in conjunction with this Practice Note.

## SUGGESTED PROCESS

The Stages and Tasks listed below outline a suggested approach for a Floodplain Risk Management Study. Some steps may change with the specific area under consideration.

***Stage One - Data Compilation and Review***

- Task 1.1 - Inception Meeting
- Task 1.2 - Quality Assurance Plan
- Task 1.3 - Community Consultation
- Task 1.4 – Initial Data Collection and Review
- Task 1.5 - Site Investigation
- Task 1.6 - Identification of Additional Data Requirements
- Task 1.7 - Preparation of Survey Brief and Engagement of Survey Sub-consultant

***Stage Two – Flood Damages and Floodplain Risk Management Options Report***

- Task 2.1 - Prepare Newsletter for Floodplain Risk Management Study
- Task 2.2 – Detailed Flood Risk and Damage Assessment
- Task 2.3 - Assessment of Social Issues
- Task 2.4 - Assessment of Current and Future Land Use Zoning
- Task 2.5 - Assessment of Local Emergency Planning
- Task 2.6 - Assessment of Existing Environmental Factors and Issues
- Task 2.7 - Preliminary Identification of Floodplain Risk Management Options
- Task 2.8 - Flood Damages and Floodplain Risk Management Options Report
- Task 2.10 - Presentation of Report/Workshop on Floodplain Risk Management Options
- Task 2.11 - Community Consultation / Workshop

***Stage Three - Draft Flood Risk Management Study and Flood Risk Management Plan***

- Task 3.1 - Assessment of Selected Floodplain Risk Management Options
- Task 3.2 - Assessment of Environmental and Social Factors of Floodplain Risk Management Options
- Task 3.3 - Economic Assessment of Floodplain Risk Management Options
- Task 3.4 - Assessment of Defined Flood Events
- Task 3.5 - Preparation of Draft Floodplain Risk Management Study Report, with the following general contents:
  - An executive summary;
  - An introduction;

- Details on the study area and data used;
- Detailed description of the risk;
- A description of the flood behaviour, the environment of the floodplain, the social issues identified in the Study, and estimates of the current flood damages;
- An assessment of existing floodplain management measures;
- A description of all options considered in the Study, including Defined Flood Events and revisions to existing works and measures;
- An assessment of all measures on social, economic and environmental bases, as well as flooding, and recommendations as to the most appropriate mix of options to achieve the objectives stated in the Brief;
- Estimates of construction and maintenance costs;
- Estimates of flood damages with mitigation options in place, so that the reduction in flood damages can be assessed;
- The reduction in social impact caused by flooding. This will include a draft program for raising and maintaining flood awareness in the City, both for existing residents and future residents;
- Environmental and social impact of the scheme. The environmental assessment will include the short term effects during construction (noise, traffic etc.) and the long term effects during the project life and opportunities to enhance the floodplain environment;
- Economic evaluation including cost benefit analysis and generation of other economic indicators such as the internal rate of return; and
- Evaluation of the hydraulic performance of the scheme, which will include reporting of flood profiles, discharges and velocities.
- Flood profiles, flood levels and flood inundation and hazard maps of the preferred schemes will also be produced. The report will be accompanied by Appendices (possibly as a separate volume) that will deal with the issues in detail and provide discussion on the specific issues, e.g. vegetation management and erosion control, where these are summarised in the main Report.

- Task 3.6 - Prepare Newsletter on Draft FRMS
- Task 3.7 - Presentation of Draft FRMS/FRMP to Committee

***Stage Four – Public Exhibition of Draft Floodplain Risk Management Study and Plan***

Task 4.1 - Public Exhibition

***Stage Five – Completion of Final Floodplain Risk Management Study and Plan***

Task 5.1 – Consideration of Public Comments and Incorporation of Agreed Changes to FRMS

Task 5.2 - Completion of Contract

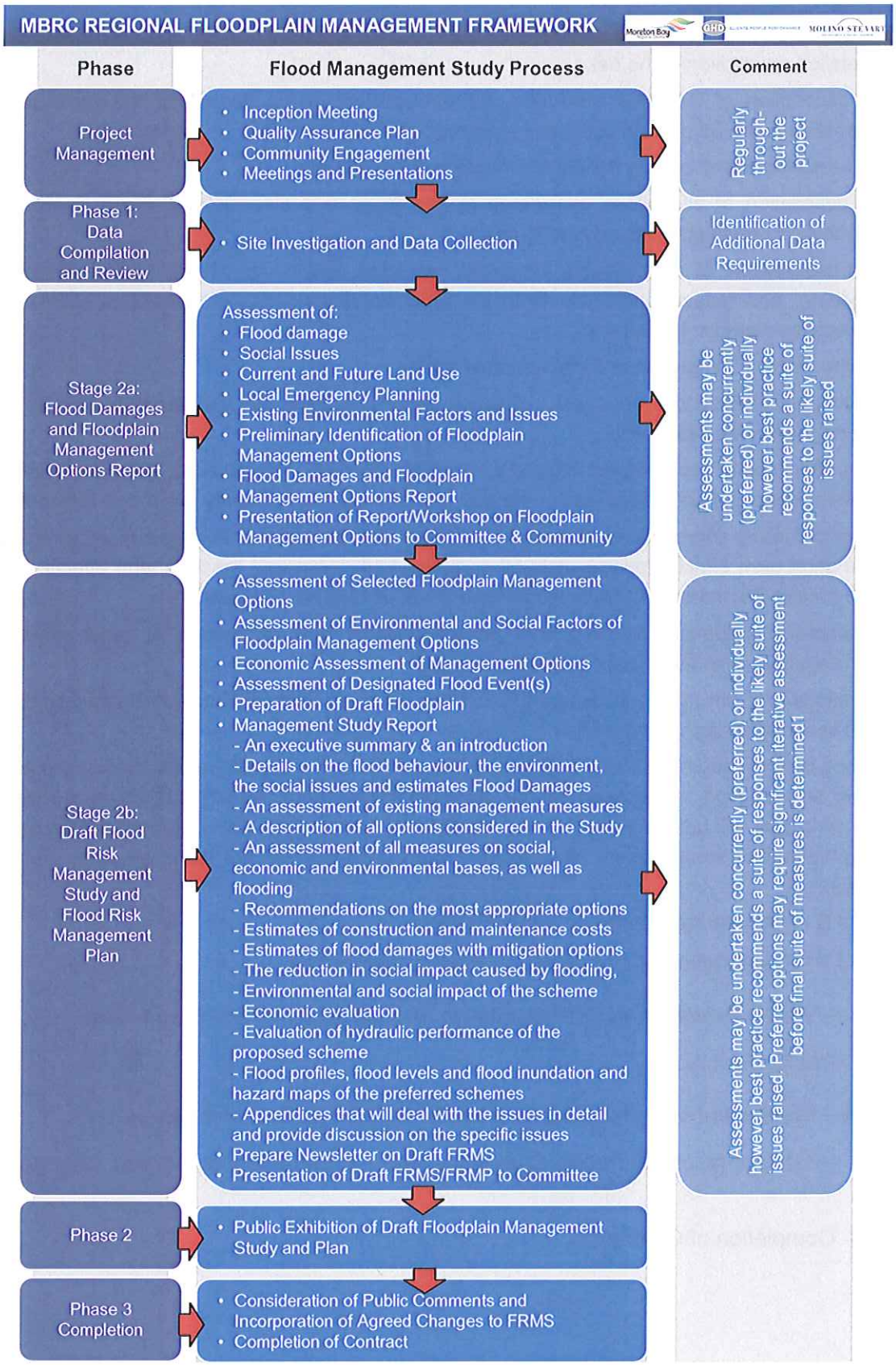


**Figure 1 Flood Risk Management Study flow diagram**

## INITIAL CONSIDERATIONS

Identification of the issues, objectives, available studies and data is essential for the effective scoping of the management study. If this is not done, there is the risk that it will lead to confusion, wasted effort and associated increased costs.

Therefore, prior to the commencement of a Floodplain Risk Management Study, the floodplain management steering committee must formulate management study objectives and an associated brief. It is imperative that the objectives of and issues to be addressed in the management study and subsequent plan be identified and defined at the outset. This enables the full range of issues, including flood problems in existing and potential future development areas, to be effectively considered and the study area to be defined.

Background data and studies can provide valuable input into the management study. These may include current flood related development controls which may identify issues and objectives for the management study. Social, economic, environmental, cultural, and flooding issues need to be considered in assessing management options.

## OBJECTIVES

The objectives of a Floodplain Risk Management Study involve the derivation of an appropriate mix of management measures to effectively manage the full range of flood risk for the specific situation.

These will vary with location and the community concerned but will generally include:

- Examination of council's local flood management policies, strategies and planning instruments to ensure consistency with each other, this framework and the findings of the floodplain management studies;
- Examination of existing warning systems and community flood readiness in relation to EMQ disaster planning requirements;
- Community consultation to provide and gather information, enable participation in the decision making process and gain community acceptance of the management study findings and the subsequent plan;
- Determination of true hydraulic and hazard categories based upon the flood study and risk management principles;
- Detailed analysis of risk using objective criteria (refer Practice Note);
- Identification and assessment of floodplain management measures for existing development areas aimed at reducing the social, environmental and economic loss of flooding on development and the community, both existing and future, over a full range of flood events;
- Identification of potential new development and redevelopment areas within the floodplain for cumulative impact assessment. This provides the basis for identifying relevant development limits, types, scales and controls and/or works necessary to reduce residual flood risk in developable areas to an acceptable level;

- Assessment of the individual and cumulative impacts of proposed management measures for existing and potential future development areas from a social, environmental, land use, flood response and cultural heritage perspective (including minimisation of adverse impacts and maximisation of positive outcomes);
- Examination of the potential to enhance the natural environment as part of floodplain management measures or through modification to existing measures; and
- Identification of modifications required to current policies and planning instruments in light of the results of the investigations.

## FLOOD RISKS TO BE MANAGED

There are three specific types of flood risks that need to be addressed in the management study:

- The existing risk - refers to the existing community, buildings and developments on flood prone land. Such buildings and developments, by virtue of their presence and location, are exposed to an "existing" risk of flooding;
- The future risk - refers to buildings and developments that may be built on flood prone land in the future. Such buildings and developments will be exposed to a "future" flood risk, i.e. a risk that does not materialise until developments occur; and
- The residual risk - refers to the risk associated with floods generally, in areas not protected by measures, e.g., outside a levee, and with those floods that exceed management measures already in place. That is, unless a floodplain management measure is designed to withstand the PMF, it will be exceeded by a sufficiently large flood at some time in the future. It is not a matter of if, but of when.

To meet these broad objectives the management study needs to consider and develop an appropriate and integrated mix of measures to manage these risks.

### Existing Risk

Flood modification measures (usually structural works that modify flood behaviour) are the traditional means of mitigating damage to existing properties at risk. The feasibility, effectiveness, environmental and social impacts and economics of various flood modification options need to be considered. Whilst these measures might reduce flood discharges, levels and risk in the area of interest, such measures may increase them elsewhere. The hydrologic and hydraulic models developed in the flood study are used to assess the impact of structural works on flood behaviour.

Environmental enhancement opportunities available from such works should be considered when contemplating and evaluating flood modification measures. For example, retarding basins can be designed to improve water quality, reduce the need for costly hard river improvement works and may also incorporate wetland areas.

In addition to flood modification measures, property modification measures, including specific land use controls (for example removal of development and flood proofing) and response modification measures such as flood readiness can also be used to reduce existing risk to a more acceptable level.

## Future Risk

Property modification measures, such as land use and development controls, are an effective means of ensuring that future development is compatible with flood risk. The council has responsibility for local land use planning decisions and flooding is one of the key issues to be considered in the planning process for flood prone land. Thus, the council has the major role to play in flood-related planning considerations.

Property modification measures, such as planning measures, are likely to be contentious to the local community as some groups or areas are likely to be disadvantaged whilst others benefit. In these circumstances, the common good of the community as a whole must be the guiding principle. Nonetheless, the steering committee must ensure that issues of equity are addressed. Again it is important that the deliberations and recommendations of the committee be communicated to the local community.

To achieve effective management of future flood risk the management study needs to strategically assess flood risk in future development areas on a cumulative basis as discussed later in this Practice Note.

## Residual Risk

Unless the PMF is adopted as the basis for floodplain management measures, which is most unlikely, a larger flood will occur at some time in the future which will overwhelm these measures. In addition, there will always be properties outside the area "protected" by measures that require assistance in flood times.

Response modification measures, such as, readiness, response and recovery plans are the most effective means to manage residual risk. EMQ guides the preparation of local flood plans (dealing with flood readiness, response and recovery), with the Local EMQ Controller having widespread responsibilities and powers.

The local council has access to many of the resources necessary for response operations (for example manpower, plant and machinery, buildings, etc.). It is essential that a cohesive working relationship is established between EMQ and council to ensure that both planning and operational aspects of floodplain management and flood planning are adequately addressed.

Local flood plans are not management measures that can be formulated and then forgotten. Such plans are aimed at modifying the community's response to the threat and aftermath of a flood. No matter how accurate and timely a flood warning and no matter how well thought out the accompanying defence and evacuation plans, much effort will be wasted unless the community responds effectively.

Thus, there is a very real need to make the community fully flood ready and aware of its responsibilities and to maintain this readiness and awareness by a program of regular re-education of people living in flood prone areas. The more remote in time and experience the community is from the last flood that resulted in significant damage, the more difficult this becomes. Adequate community flood readiness is one of the greatest challenges facing floodplain risk managers. Councils cannot rely on the next major flood to re-educate the community.

The need for effective communication between the council and the community cannot be overemphasised with regard to flood readiness and response measures. The use of specialists in this field to prepare a readiness program, on either a local or catchment basis is recommended.

In some areas works may be necessary to improve the ability of the community to respond. Evacuation access and flood warning systems may need to be upgraded to enable people to be warned effectively and evacuate in a safe manner during flood events.

Flood insurance is also a means of managing residual property risk. This is not available from all insurance companies and can be very expensive for properties susceptible to frequent flooding. While this is not something which could be implemented by Council as part of the Floodplain Risk Management Plan, the Plan may alert individual property owners to its benefits.

## KEY STEPS IN THE MANAGEMENT STUDY

Key steps in the management process include:

- Community consultation;
- Hydraulic and hazard categorisation;
- Detailed analysis of risk using objective criteria (refer Practice Note);
- Strategic assessment of new development areas;
- DFE selection, involving both selection of the flood upon which DFEs are based and freeboard;
- Flood damage assessment;
- Option identification and assessment; and
- Appropriate information for primary end users and the public.

### Community Consultation

Effective community consultation is vital to gaining community acceptance of the findings of the Floodplain Risk Management Study and subsequent plan. Effective community consultation requires consideration of the following aspects:

- Informing the community of the management study and its purpose;
- Assessing the community's level of knowledge, understanding and concern in relation to flood issues and flood readiness;
- Assessing community aspirations in relation to flood problems and any ideas which they have for dealing with it;
- Providing the community with information on alternative management measures and the inherent advantages and disadvantages of these; and
- Providing a mechanism for the community to have input into the selection of appropriate management option(s).

An appropriate methodology should be developed for the specific study area, community and locality. In addition, a number of management options, specifically response modification measures such as flood warning, flood awareness and flood response, rely on community involvement to be effective. It should be noted that effective community consultation is a basic principle of floodplain management.

## Hydraulic and Hazard Categorisation

Hydraulic and Hazard Categorisation provides a better understanding of the variation of flood behaviour and hazard across the floodplain and between different events.

A flood study provides detailed information on flood behaviour for a range of flood events up to and including the PMF. Typical data from a flood study include peak flood levels and velocities, the progression of flooding over the course of the flood event and the identification of any isolated 'islands', etc.

A management study takes this understanding further by providing information of true hydraulic and hazard categorisation as detailed in Appendices G & H. This involves breaking the floodplain down into:

- Areas of varying hazard level for floods of different severities. Provisional assessment is generally based around flow depths and velocities. True hazard also accounts for a range of additional physical factors affecting danger to personal safety, as discussed in Appendices G & H; and
- Areas with different hydraulic functions (which can vary between floods of different magnitudes). These are floodways for flow conveyance, flood storage areas for temporary storage of flood waters during an event and the flood fringe, the remaining area at the edge of the floodplain.

A management study weighs up all of the factors and issues on the basis of merit to determine true hydraulic and hazard categories.

## Detailed Risk Assessment

Refer **Practice Note** "Floodplain Risk Assessment"

## Strategic Assessment of Flood Risk in New Development Areas

Land use planning cannot be effectively undertaken without an understanding of flood risks and the associated consequences. In turn, land use planning controls are an essential element in effectively managing flood risk in new and redevelopment areas.

Therefore the preparation of a management study and subsequent plan involves a realistic appraisal of desired and realisable future land uses. If future land use is not considered and appropriately incorporated in the management plan, the benefits of floodplain management measures implemented to address the existing problem may be dissipated and overwhelmed by future development, both with respect to the type of development and its location. It is essential that council ensure that future planning considerations are fully evaluated and taken into account when undertaking assessments in the management study and in formulating the provisions of a management plan.

### *Impacts of New Development on Flooding*

Development can impact upon flood behaviour (levels, flows and flowpaths) and therefore the flood exposure of other properties (and their inhabitants). Impacts can be due to:

- Blocking by fill of, or buildings on, floodways;
- Removing areas for flood storage within the floodplain, due to filling or levees; and

- Increasing the amount of impervious area in a catchment which, without appropriate management, increases the overall volume and peak runoff from the area.

Impacts need to be considered cumulatively to enable effective management of flood risk.

***Determining Reasonable Flood Related Development Limits***

Indicative flood related development limits can best be determined based upon an understanding of the flood behaviour and the impacts of flooding. There are certain areas where development would reasonably be excluded:

- Areas where development will have significant adverse impacts on flood behaviour. This may be due to blockage of floodways (increasing upstream flood levels or redirecting flows) or filling of flood storage areas (increasing downstream peak flood flows or redirecting flows). Assessment also involves consideration of the cumulative impacts of proposed new areas on flooding;
- Areas where flood hazard is too high and cannot effectively be reduced to acceptable levels by management measures. Emergency management is an important consideration as to whether an area is too hazardous for development due to flooding (e.g., islands); and
- Areas of important flood dependant ecosystems.

Establishing these areas provides for reasonable flood risk related developable limits.

***Flood Compatible Development within Development Limits***

Within the area where development is considered reasonable from a flood risk perspective, decisions need to be made on controls to support development by reducing flood risk to an acceptable level.

This can involve determining:

- The types of development appropriate for the location.
- An appropriate development density (the cumulative impacts of overall development on flooding);
- Appropriate measures necessary to support development; and
- Appropriate management plans for critical infrastructure.

***Managing Residual Risk in New Development Areas***

Even with the above controls, flood risk will still remain in new development areas. This residual risk, and particularly that relating to danger to personal safety, needs to be carefully considered to ensure that this can effectively be managed.

This may require a system of complementary measures such as flood predictions and warnings, and effective external access to facilitate self evacuation of inhabitants.

# SPECIFIC ISSUES OF CONCERN

The following section presents an assortment of isolated but important aspects to be considered in management studies and plans that have come to the attention of practitioners in previous investigations.

## Cumulative Impacts

A common problem for many developing areas is the cumulative impact of developments that have individually small (or even no impact), but which collectively have significant effect on flood behaviour or impact on local flood plans. The most common examples of this are the:

- Blocking of floodways and flow paths by individual developments or levees;
- Loss of flood storage due to filling of floodplain areas for individual developments and the consequential rise in flood levels; and
- Increase over time in the at-risk population living and working on flood prone land and their impacts on emergency management resources or the capacity of evacuation routes.

Whilst it is true that each development by itself may not lead to a significant increase in flood levels, risk, evacuation needs or potential damage, the increase occasioned by the cumulative effects of a number of such developments is often unacceptable.

This is one of the principal reasons why there is a legislative imperative for the preparation of management plans: cumulative effects need to be evaluated as part of the management study before they occur.

## Consequences of Floods Larger Than the Flood Used to Derive the DFE

To effectively address residual flood risk, management studies and plans need to consider the implications and consequences of the full range of flood sizes. This includes frequent floods and floods larger than the flood used to derive the DFE up to and including the PMF event. The emphasis in floods larger than the flood used to derive the DFE is on danger to personal safety and associated emergency risk management. Flood risk management measures that may be appropriate for a certain DFE (typically the 1% AEP flood plus 0.5m freeboard for standard residential development) may be inappropriate for larger floods.

The choice of the DFEs (see Practice Note 'Defined Flood Events') is often a difficult compromise between increasing marginal costs of flood or property modification measures and decreasing marginal benefits of protection.

What this means is not the unthinking acceptance of the limited level of protection provided by, say, flood or property modification measures, but the need to develop additional management measures such as response modification measures to mitigate the danger to personal safety associated with overwhelming flood events. Therefore a range of management measures are necessary to manage the full range of flood risk.

The definition of the floodplain and flood prone land is based on the PMF event and not on the more limited flood planning area. In this way, the community will be more receptive to directions to take action in a flood event than if they thought they were completely protected from flooding by development controls or works.

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The definition of the floodplain and flood prone land is based on the PMF event and not on the more limited flood planning area. In this way, the community will be more receptive to directions to take action in a flood event than if they thought they were completely protected from flooding by development controls or works.

## Infrastructure Protection

Careful consideration needs to be given to the protection of essential infrastructure, such as water supply, gas, sewerage, telephones and electric power, during the onset of a flood to ensure the ready restoration of these services in the flood's aftermath. This will both reduce damage to these public assets and facilitate clean-up and recovery in the post-flood period, thereby minimising social disruption to the community.

Protection activities that could be considered include the building of temporary bunds around sewage treatment plants, water treatment plants, electricity sub-stations, etc., and the uncoupling and removal of electric motors from pumps in the sewerage and water supply systems, etc.

Needless to say, if new or upgraded infrastructure facilities are proposed, all endeavours should be made to locate them in flood free areas, render them flood proof, or ensure that services can be easily restored after a flood.

## Rehabilitation of Areas Degraded by Past Flood Mitigation Works

Rehabilitation of degraded floodplains has significant environmental benefits. Where degraded areas of the floodplain are identified and it is likely they can be attributed to previous works that have excluded necessary flood flows, every effort should be made to incorporate rehabilitation measures into the management study and subsequent plan. Such measures could include allowing natural flows into areas where flow may have been excluded or removal or instigating controlled opening of structures that impede tidal flushing.

When assessing existing flood mitigation works, investigations should be undertaken into their modification, reconstruction, modified operation or removal where positive environmental gains can be made without significantly increasing flood risk.

## Islands

The formation of islands in the floodplain during a flood is a potentially dangerous situation. This is especially so when floods larger than the flood used to derive the DFE totally inundate the island.

People trapped on the island and their rescuers will be placed at undue risk. Thus, the development of land that becomes isolated prior to ultimate inundation needs to be considered with great care.

## Levees

Levees are a structural or flood modification measure. They are a tried and true flood protection measure as long as they are not overtopped and/or do not fail. However, levees are unlikely to be designed to exclude the PMF and therefore provision must be made for their overtopping or failure.

The consequences of levee overtopping must be assessed in some detail and if personal danger and damage levels so require, appropriate measures should be adopted to reduce the effects of any catastrophic failure. These measures include response modification measures (such as flood response and readiness plans) to reduce personal danger and property modification measures (such as land use controls or buffer zones in the area behind

the levee where development is limited to reduce the potential impact of high velocities that may lead to increased flood damages).

The need to consider all the implications of a levee is not restricted to the protection of a development from the impacts of a river; the internal impacts must also be considered. A levee can have significant impacts on local drainage, both overland and piped flows. If these systems are blocked by the levee, there may be significant internal flooding of a town or development, negating any benefit achieved by the levee.

Levees may also have significant environmental impacts, through alienation of floodplains and the flooding needed by flood dependant ecosystems from rivers or by the obstruction of fauna passage.

### Hazardous Industries or Hazardous Storage Establishments

If hazardous industry or hazardous storage establishments are within the study area, the management of the potential public health and environmental (medium to long term, post flood) risks associated with escape of materials due to inundation by floodwaters should be considered and formal management measures and procedures adopted in this regard. Where these measures and procedures cannot adequately address this risk then alternative sites need to be considered. These sites may be within or outside the floodplain, but should be located where these risks can be managed effectively.

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# PRACTICE NOTE

# HYDRAULIC HAZARD

## HYDRAULIC AND HAZARD CATEGORISATION

A hazard is defined as a source of potential harm or a situation with a potential to cause loss. In relation to this Framework, the hazard is flooding which has the potential to cause damage to the community. The degree of hazard and type of flood behaviour across the floodplain over the full range of potential floods needs to be understood by flood prone landholders and by floodplain managers.

To achieve effective and responsible floodplain management, it is necessary to divide the floodplain into areas that reflect, first, the impact of development on flood behaviour and second, the impact of flooding on development and people. Division of flood prone land on these two bases is referred to as 'hydraulic categories' and 'hazard categories' respectively.

In this Framework, hydraulic and hazard categories are used to determine appropriate types of land development in flood-prone areas. As such, the determination of these categories is an essential element in the formulation of a Floodplain Risk Management Plan. This Framework recognises two principal hydraulic categories of flood prone land (floodway and flood fringe) and two hydraulic categories (low hazard and high hazard).

Division of the floodplain on the basis of these two effects produces the following four provisional categories of flood-prone land:

- Low Hazard - Flood Fringe
- Low Hazard - Floodway
- High Hazard - Flood Fringe
- High Hazard – Floodway

These divisions are illustrated in Figure 1.

These categories can be further subdivided. For example flood storage areas, prominent where large amounts of flood water are held back by natural controls, are considered to be a sub-category of the floodway as the development controls applied in the area are basically the same.

Likewise low hazard and high hazard categories can be subdivided into further categories based on the potential impacts on people and property.

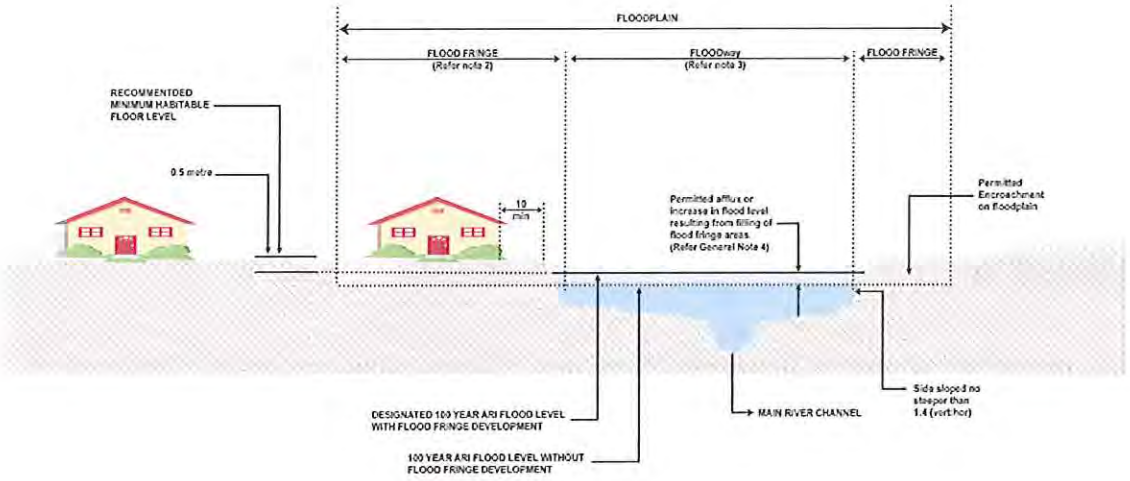


**Figure 1 Floodway / Flood Fringe Illustration**

## PURPOSE OF THE CATEGORIES

At the outset, it should be realised that hydraulic and hazard categories are tools to assist in the preparation of an appropriate Floodplain Risk Management Plan (a strategic planning document). They are not to be used for the assessment of development proposals on an isolated or individual basis. Such ad hoc analysis cannot take into account the cumulative impact of gradual on-going development over time, a key issue to be addressed in a Floodplain Risk Management Plan. Rather, hydraulic and hazard categories are to be used for assessing the suitability of future types of land use and development in the formulation of Floodplain Risk Management Plans.

Both hydraulic and hazard categories need to be determined in the Floodplain Risk Management Study for inclusion in the adopted Floodplain Risk Management Plan.

## DEFINITION OF HYDRAULIC CATEGORIES

For the purpose of this Framework, there are two hydraulic categories of flood prone land:

- Floodways; and
- Flood fringe.

In all but the simplest flow situations, the results of a flood study will be required to determine hydraulic categories. A flood study involves a detailed hydraulic analysis of flood behaviour for a range of flood severities up to the PMF, and generally involves the use of numerical or physical models. A flood study provides details of peak depths and velocities across the floodplain, the pattern and timing of flooding, etc. It is impossible to provide explicitly quantitative criteria for defining floodways and flood storage areas, as the significance of such areas is site specific.

Floodways are those areas where a significant volume of water flows during floods and are often aligned with obvious natural channels. They are areas that, even if only partially blocked, would cause a significant increase in flood levels and/or a significant redistribution of flood flow, which may in turn adversely affect other areas. They are often, but not necessarily, areas with deeper flow or areas where higher velocities occur.

Flood storage areas are those parts of the floodplain that are important for the temporary storage of floodwaters during the passage of a flood. If the capacity of a flood storage area is substantially reduced by, for example, the construction of levees or by landfill, flood levels in nearby areas may rise and the peak discharge downstream may be increased. Substantial reduction of the capacity of a flood storage area can also cause a significant redistribution of flood flows.

Flood fringe is the remaining area of land affected by flooding, after floodway and flood storage areas have been defined. Development in flood fringe areas would not have any significant effect on the pattern of flood flows and/or flood levels.

In determining appropriate hydraulic categories, it is important that the cumulative impact of progressive development be evaluated, particularly with respect to floodway and flood storage areas.

Whilst the impact of individual developments may be small, the cumulative effect of the ultimate development of the area can be significant and may result in unacceptable increases in flood levels and flood velocities elsewhere in the floodplain.

The hydraulic category can thus be summed up as the indication of the impact on flooding by development and a determination of the appropriate flood probability for the category.

## DETERMINATION OF FLOODWAYS

There is no definitive method of deriving floodway limits using the hydraulic model(s) developed for the Flood Study. It is generally an iterative process requiring judgement by an experienced modeller/practitioner. However, as a preliminary guide, the minimum width of any floodway in the planning level flood should be assumed to be the top of bank on each side of the main channel of the flow path.

An iterative method that can be considered in defining the approximate limits of floodways is reducing conveyance by altering cross sections and examining the impacts in relation to whether:

- There is a significant affect on upstream flood levels and/or;
- There is a significant diversion to an existing flow path and/or;
- A significant new flow path or floodway develops due to the change.

## DETERMINATION OF HAZARD CATEGORIES

Hazard categories are provisionally broken down into high and low hazard for each hydraulic category. These can be defined as:

- High hazard - possible danger to personal safety; evacuation by trucks difficult; able-bodied adults would have difficulty in wading to safety; potential for significant structural damage to buildings.
- Low hazard - should it be necessary, truck could evacuate people and their possessions; able-bodied adults would have little difficulty in wading to safety.

The flood hazard relates to how dangerous a site on a floodplain can be (HNFMSC, 2006). It depends on the behaviour of the flood at that location and changes with the probability of the event, generally the rarer the flood the greater the hazard. Hydraulic hazard is independent of what is placed in the floodplain yet it is only meaningful when compared to how depth and velocity would impact on what is placed in the floodplain.

A more comprehensive analysis than the hydraulic hazard categorisation alone is also needed to establish the risks which need to be managed and this can only be made from within the strategic framework of a Floodplain Risk Management Plan. The determination of the risks requires the detailed results of a flood study and the hydraulic hazard categorisation along with an assessment of all the hazard factors, such as flood warning, flood awareness, flood readiness, possible evacuation problems, vulnerability etc.

It is recognised that there are thresholds of hydraulic hazard which have different consequences for different things placed in the floodplain. An accepted practice has been to develop hazard category tables or graphs, and though there are variants on where the thresholds are drawn, they all work on the idea that a certain combination of depth and velocity will have certain consequences for different things exposed to that flood hazard.

Floodplain Risk Management in Australia (CSIRO, 2000) and the NSW Floodplain Development Manual (NSW Government, 2005) each have their own hydraulic threshold behaviour diagrams which have three hazard categories. Figure 2 is used here as its thresholds are related to different types of hazards which one might be interested in although it can be argued where the actual lines between hazard categories are drawn.

The hydraulic hazard categories in the diagram are summarised in the table below.

**Table 1 Revised Hydraulic Hazard Categories**

| ***Low Risk to Life and property*** | | ***High Risk to Life and property*** | | |
|---|---|---|---|---|
| ***H1*** | ***H2*** | ***H3*** | ***H4*** | ***H5*** |
| *No significant life risk*<br>*Property risk only to items which come in direct contact with floodwaters such as building contents* | *Low life risk. Able bodied adults can walk safely.*<br>*Cars can float and precautions must be followed to keep them out of floodwaters* | *Able bodied adults cannot safely walk*<br>*Only large vehicles (trucks) can safely travel.* | *Major life risk*<br>*Light frame buildings (e.g. houses) can fail structurally* | *Extreme life risk*<br>*Majority of buildings could fail* |

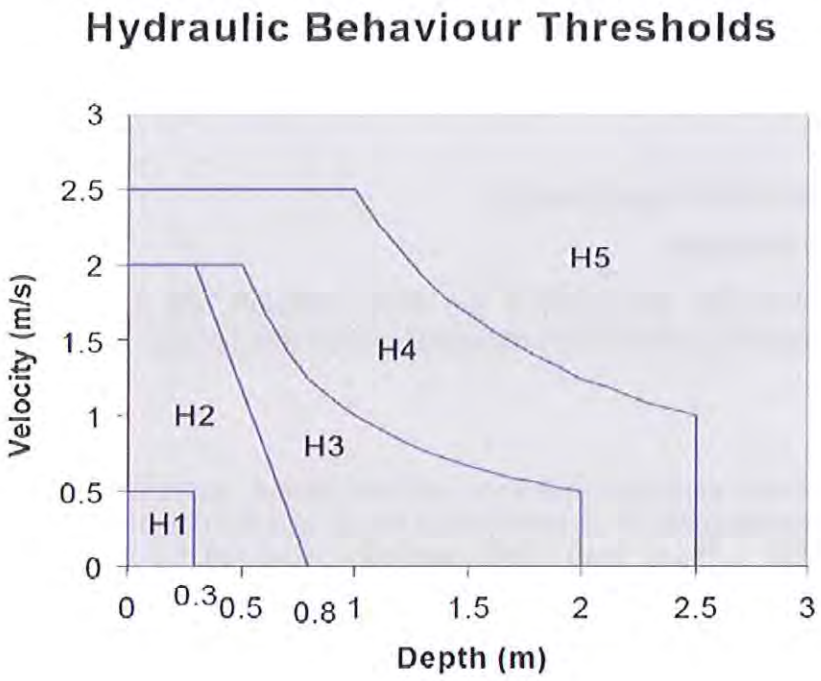


**Figure 2 - Hydraulic Behaviour Thresholds for Newcastle LGA (BMT WBM, 2008)**

The hydraulic hazard thresholds in this diagram are very similar to the hazard categories which are embedded in WaterRIDE which is the software tool being used by MBRC.

Using WaterRIDE it would be very straightforward to map for a design event of a given probability the extent of the various hydraulic hazard areas which can then be used to help with decision making.

Figure 2 is presented as a tool to assist in the development of hazard categories in Floodplain Risk Management Plans. It is not appropriate to use it to determine the hazard implications of individual developments. Flood hazard, like flood hydraulics, needs to be assessed on an integrated and strategic basis across the entire flood prone area, not on an isolated basis associated with individual developments.

## FACTORS WHICH DETERMINE THE FLOOD HAZARD

Provisional flood hazard categorisation based around initial hydraulic evaluations does not consider a range of other factors that influence flood hazard. Therefore provisional hazard categorisation should be used with the following factors to determine true hazard categories:

- Topography
- Effective Flood Access
- Duration of Flooding
- Evacuation Problems
- Effective Warning Time / Rate of Rise of Floodwaters

- Flood Preparedness
- Obstruction and Blockages
- Type of Development
- Vulnerability
- Critical and Cumulative Consequences
- Water Entering Buildings

Other factors, such as the complexity of the stream network and the inter-relationship of flows between streams will need to be considered, where appropriate.

## Topography

Topography can have a significant influence on flood hazard because it will dictate to some extent both the consequences of different sized floods and the options available to mitigate those consequences. There have been systems developed for classifying floodplains according to their topography relative to maximum flood levels (DECC 2007). For Morton Bay Regional Council the following classifications are to be used:

**Connected Flood Free (CFF)** is any land which is higher than the PMF level and in even the PMF would have flood free road access to areas outside of the catchment. In other words flooding cannot isolate this land although it could be indirectly affected through loss of power, telecommunications or water supply.

**Isolated Flood Free (IFF)** are locations outside of the floodplain or within the floodplain with enough land higher than the limit of flooding (i.e. above the PMF) to cope with the number of people in the area. During a flood the area is surrounded by floodwater and fringing properties may be inundated. However, there is an opportunity for people to retreat to higher ground above the PMF and therefore the direct risk to life is limited. The area will require resupply by boat or air if not evacuated before the road is cut. If it will not be possible to provide adequate support during the period of isolation then evacuation should take place before isolation occurs.

**Low Flood Island (LFI)** are areas within the floodplain whose access is cut by floodwaters and this creates a flood island which is lower than the limit of flooding (i.e. below the PMF) or it does not have enough land above the limit of flooding to cope with the number of people in the area. If floodwater continues to rise after it is isolated, the island will eventually be completely covered. People left stranded on the island may drown and property will be inundated. Evacuation should take place from these areas before isolation occurs.

**Rising Road Access (RRA)** are those areas below the PMF level where access roads rise steadily uphill and away from the rising floodwaters. The community cannot be completely isolated before inundation reaches its maximum extent, even in the PMF. Evacuation can take place by vehicle or on foot along the road as floodwater advances. People should not be trapped unless they remain in individual buildings which get surrounded by floodwaters. For example people living in two storey homes may decide to stay only to find themselves trapped by rising floodwaters which in some places may exceed the top of the building.

**Overland Escape Route (OER)** are those areas below the PMF level where access roads to flood free land cross lower lying flood prone land. Evacuation can take place by road only until access roads are closed by floodwater. Escape from rising floodwater is possible by walking overland to higher ground. Anyone not able to walk out must be reached by using

boats and aircraft. If people cannot get out before inundation, rescue will most likely be from rooftops.

While these categorisations are logical and helpful they only consider the PMF and do not take into account the hazard categories which inundate the flooded areas or the duration of flooding. A low flood island covered by H1 flooding in a PMF for two hours may be a very different proposition to a low flood island covered by H3 flooding for a day in a 1% flood.

## Effective Flood Access

The availability of effective access routes from flood prone areas and developments can directly influence personal danger and potential damage reduction measures. Effective access means an exit route that remains trafficable for sufficient time to evacuate people and possessions, or any other appropriate boat-based or air-based means of evacuation.

While this issue is closely related to the issue of topography previously mentioned, there are some specific considerations regarding access. For example problems can occur with cul-de-sac residential developments on rising land where the access road runs downhill from the properties, as the floodwaters rise, road access is cut off. Although this land may be classified as OER from a purely topographic sense, the physical barriers created by the development could turn a cul-de-sac effectively into a LFI.

Access is generally divided into two categories, pedestrian and vehicular. The provision of road access that is trafficable in all weathers will assist in reducing the flood hazard and enhance the effectiveness of emergency services. Pedestrian access is far less effective due to problems with moving the aged, children and disabled. It is essential that the consideration of access routes extend up to the PMF.

This does not mean that access routes have to be above the PMF level but be at a level of flood protection that, in combination with effective warning time, development type and flood duration, provides adequate time for evacuation and reduces risk to acceptable levels in all events including a PMF. Without such access, the risk to personal safety of the entrapped and their rescuers may be unacceptable.

It is also essential that any flood access be designed and constructed to ensure the minimal impact on flood behaviour, i.e., that it does not redirect flows or increase flood levels.

## Duration of Flooding

The duration of flooding or length of time a community, town or single dwelling (for example, a farmhouse) is cut off by floodwaters can have a significant impact on the costs and disruption associated with flooding. For example:

- An extended period of isolation in stressful situations can exacerbate post-event anxiety and trauma-related disorders;
- Shortages of water and food may occur thereby placing high demands on limited emergency services; and
- Medical emergencies may occur with treatment delayed or at worst prevented.

The duration of flooding generally correlates with the rate of rise of floodwater, typically, being longer in larger, flatter catchments and shorter in the smaller, steeper ones.

## Evacuation Problems

The levels of damage and disruption caused by a flood are also influenced by the difficulty of evacuating flood-affected people and property. Evacuation may be difficult because of:

- The number of people requiring assistance;
- The depth and velocity floodwaters;
- Wading problems, which can be exacerbated by uneven ground, fences, debris, localised high velocities, etc.;
- Mobility of people – children, the aged, disabled people and the ill are less able to evacuate through floodwaters than healthy adults;
- The distance to flood-free ground;
- The inability to contact emergency services;
- Bottlenecks, i.e., the large number of people and great volume of goods that have to be moved over roads which cannot cope with the increased volume of traffic;
- The time of day and existing weather conditions (dark, rain, wind, etc.); and
- The lack of suitable evacuation equipment such as boats, heavy trucks, helicopters, etc.

Consideration of the impact on evacuation strategies of increased occupation of the floodplain is one of the key tests of cumulative impact in preparing management plans.

In addition, special circumstances may require specific evacuation needs from particular types of development such as aged, disabled and childcare facilities, mobile homes and caravan parks, isolated houses, schools, hospitals, and community centres.

An increase in the hydraulic hazard category for these development types is often necessary due to the requirement for:

- Additional and different resources to evacuate; and
- Additional effective warning time.

This may well mean that these development types are precluded from an area of the floodplain satisfactory for normal residential development.

## Effective Warning Time / Rate of Rise of Floodwaters

The effective warning time or actual time available for people to undertake appropriate actions is always less than the total warning time available to the emergency services. This is because of the time needed, firstly, to alert people to the imminence of flooding, and to then have them begin effective property protection and evacuation procedures.

Total available warning time is determined largely by catchment characteristics. The larger the catchment and the slower the rate of rise of floodwaters, the longer is the available warning time. In contrast, warning times for small steep catchments are often less as there is often no available warning time, as the catchments respond too quickly. In some cases, little or no advice may be available as to the expected height of floodwaters (especially for small catchments or river reaches affected by ocean tides).

## Flood Preparedness

Flood preparedness greatly influences the time taken by flood-affected people to respond in an effective fashion to flood warnings. In communities with a high degree of flood preparedness, the response to flood warnings is prompt, efficient and effective. The community as a whole knows what to do on receipt of a flood warning, people as individuals know how to respond, residents and property owners have developed personal evacuation plans and can implement them effectively on receipt of a flood warning. The formulation and implementation of plans for the evacuation of people and transportation of possessions promote flood preparedness.

## Obstructions and Blockages

An important factor that tends to increase the depth of flooding, and hence the overall degree of flood damage, is the presence of obstructions to the movement of floodwaters. Such obstructions include buildings, embankments and bridges, areas built up by land-fill, and the blocking effect of inappropriate trees, shrubs, fences and debris. The increase in flood levels depends upon the velocity of the floodwaters and the degree to which they are obstructed. However, appropriate trees and shrubs have long term ecological benefits that must be taken into consideration when assessing the flood impacts.

Floating debris can accumulate on open fences and railings or block culverts and bridge crossings. This not only increases the depth of flooding upstream but in some instances can cause floodwaters to find an alternative pathway.

Obstructions to flow can be accounted for in model by adopting appropriate roughness factors or blocking out that part of the flow path for the known obstruction. The problem presented by blockages is that the amount of blockage can vary between events. Engineers Australia is currently developing a guideline for the consideration of blockages in flood modelling.

## Type of Development

The degree of hazard to be managed is also a function of the type of development and resident mobility. This may alter the type of development considered appropriate in new development areas and change management strategies in existing development areas.

The following factors can affect the initial hydraulic assessment of hazard:

- The existence of special evacuation needs;
- Level of occupant awareness;
- Isolated residential development;
- Hazardous industries or hazardous storage establishments;
- Potential for damage and danger to personal safety; and
- Development over watercourses.

## Vulnerability

Another consideration in assessing consequences is vulnerability. This is taken into account to some extent in the hazards diagram which recognises that there are thresholds above

which all people are vulnerable to flooding or all timber framed buildings are vulnerable to flooding. But all people and all timber framed buildings are not the same.

Children, the elderly or people with a disability will be more vulnerable than an able bodied adult which is what the hazard diagram is based upon. Isolation through flooding will be more of an issue for those with medical conditions which may require emergency access than those in good health.

Likewise, a light framed building which has plywood as frame bracing (as occurs in many modern brick veneer homes) will be more vulnerable to structural failure than one with a water resistant bracing system.

## Critical and Cumulative Consequences

The consequences will also differ depending on the use to which a building is put. For example, the consequences for a community will be different if the hospital is closed due to flood damage than if a commercial operation is closed, at least in the short term. Note that while opportunity costs and benefits may arise by a short-term closure, the total closure and loss of a commercial operation may have significant consequences for a more remote town.

Finally, the issue of cumulative consequences must also be taken into consideration. If one home is flooded during a major storm event, the consequences are different at a societal level than if 1,000 buildings are flooded even if the chance of them being flooded are the same. If the 1,000 flooded buildings are scattered along the Qld coast the consequences at the local level are likely to be tolerable because by and large local communities and facilities would continue to function and with some external resources would be able to help those affected recover. If however the flooded buildings were all at the one location resources would be more stretched.

## Water Entering Buildings

There are also consequence thresholds not covered by the hazards diagram. For example above floor flooding in a building will create a certain amount of damage whether the floodwaters are H1, H2 or H3 flooding. Similarly, it can assumed that all contents left in a single storey building will be lost should above floor flooding depth reach close to ceiling height.

## Storm Tide Hazards

Special mention has to be made for Storm Tide Hazards due to their mechanisms that are distinctively different to riverine flooding mechanisms. The State Coastal Management Plan suggested that storm tide hazard severity zones are defined as follows:

- □Low – The inundation depth is less than 1m with wave heights less than 0.9m, and the product of depth x velocity is less than $0.3m^2/s$.
- □High – Most residential structures will incur moderate to severe damage. The inundation depth is 1m or more with breaking waves of 0.9m or higher, and/or peak flows with a product of depth x velocity of $0.3m^2/s$ or greater.

Were the threshold line between low and high according to the State Coastal Management Plan to be plotted in Figure 2 it would extend the boundary between medium and high out to

the 1m depth and have an unlimited velocity cap but would have much the same curve in between as the boundary between medium and high in Figure 2.

In light of the above, it is suggested that the tables developed for all floods for acceptable, tolerable and unacceptable limits and potential risk mitigation options are modified for storm tide.

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# PRACTICE NOTE

# FLOODPLAIN RISK ASSESSMENT

## INTRODUCTION

The management of a hazardous natural phenomenon such as flooding involves balancing the relative costs and benefits of using the floodplain. By applying risk management techniques to an appropriate detailed understanding of the full range of flood behaviour in the location, robust long term management decisions regarding the floodplain can be made with some confidence.

The correct application of risk management principles is critical to the success of the floodplain management process. This approach looks at how often floods will occur, the consequences of floods, the vulnerability of the community and its resilience to recover from flood events (refer Figure 1). It then seeks answers through management measures such as:

- reducing the likelihood;
- Benefit increase to match the risk; or
- Reducing the consequences flooding.

This Practice Note provides a general introduction to the risk management approach and its application to the floodplain management process. It is not a comprehensive guide to risk management and AS/NZS 4360:2004 Risk Management and ISO 13000:2009, Risk Management – Principles and guidelines on implementation provides a detailed guide for following a risk management process.

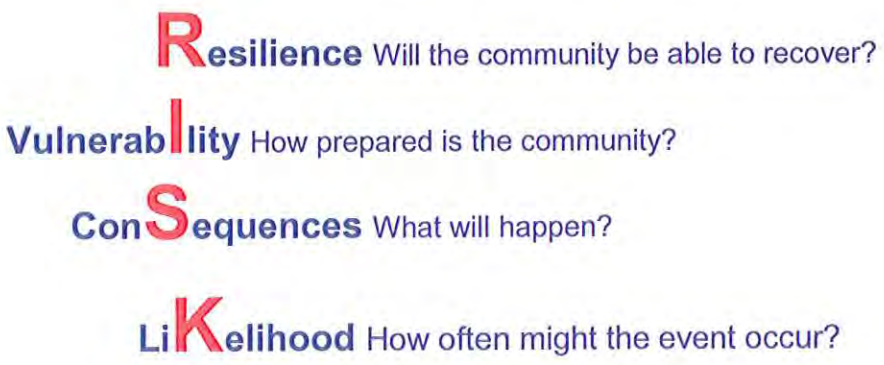


**Figure 1 Risk Management Questions**

## TERMINOLOGY

- Risk is the chance of something happening that will have an impact. It is measured in terms of likelihood and consequences;
- Risk exposure arises from the possibility of economic, financial or social loss or gain, physical damage or injury or delay;
- Risk analysis is a systematic process of identifying risks, estimating their likelihood and evaluating potential consequences;
- Risk consequences are the impacts from the event occurring;
- Risk likelihood is the probability of an event occurring; and
- Risk management is the set of activities concerned with identifying potential risks, analysing their consequences and devising and implementing responses. This involves management of risks associated with natural and built assets and agricultural uses on the floodplain. In the floodplain context this is done so as to ensure optimal use of the floodplain (considering economic, social, environmental and cultural impacts) whilst controlling flood losses to an acceptable level.

## A RISK MANAGEMENT MODEL

A risk management model involves four interrelated activities:

- Establishing the context of how risk management will be applied to flooding;
- Identification of the risk to be managed (flood) and the area requiring investigation;
- Analysis of the risk which addresses questions such as "What might go wrong?" and
- Risk management or treatment looks at the answers to that question, and seeks to resolve the issue, "What should be done about the problem?"

The floodplain management process, described in this framework, is a particular example of risk management and is in accordance with the guidelines set out in AS/NZS 4360:2004, as illustrated in Figure 2.

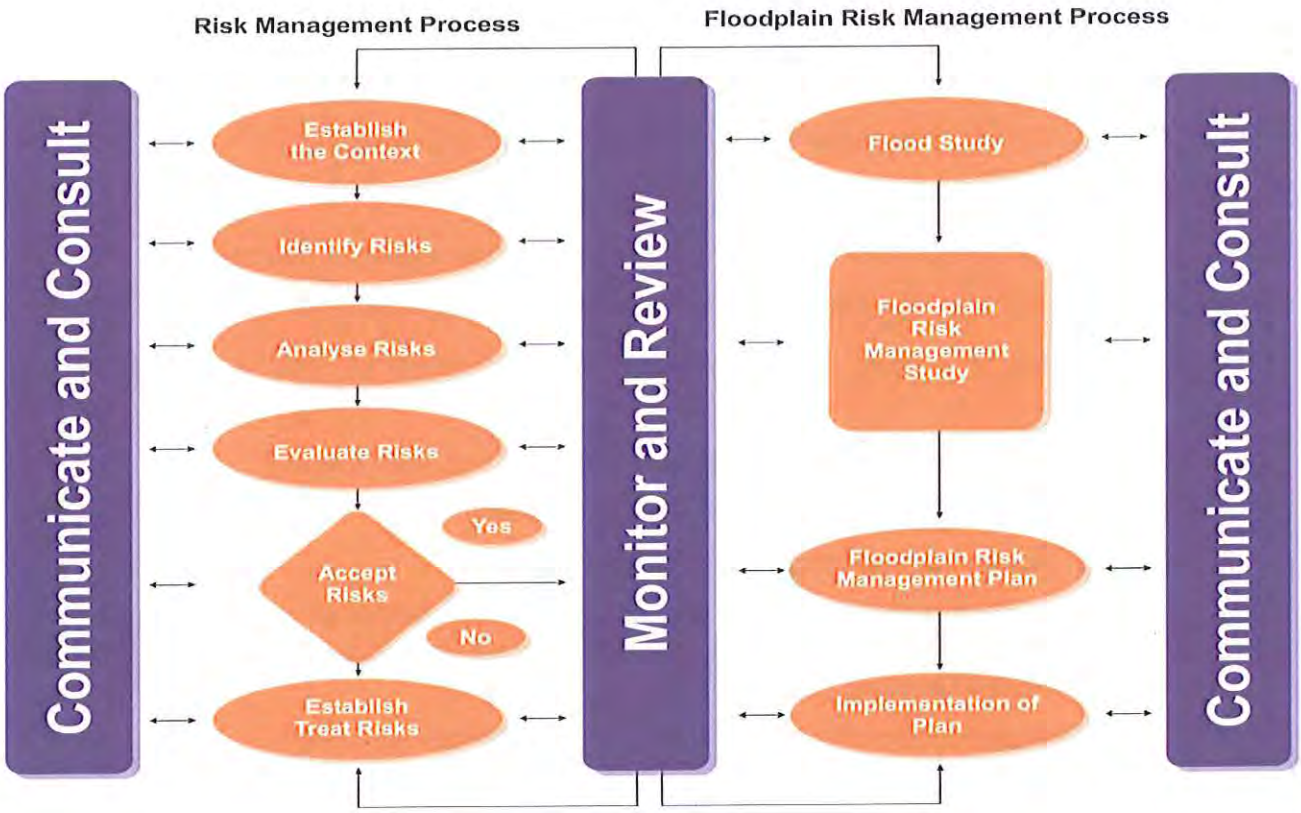


**Figure 2 Risk Management Process**

## RISK ANALYSIS

There are many risk management issues that are relevant in the preparation of Floodplain Risk Management Plans and local flood plans. This Practice Note presents some of the issues (not a comprehensive list) in question form.

Floodplain management has an impact on many different users of the floodplain including:

- Residents of and visitors to the floodplain;
- Investors and businesses in the floodplain, especially those providing a service or employment;
- The environment, including native species and ecological communities; and
- Those who wish to cross the floodplain.

Background studies should provide an estimate of community flood preparedness by asking the following questions:

- What is the recent flood history?
- How many of the residents have experienced a flood?

- Is there an effective warning system and plan for responding to the flood event?
- Is there an effective community information program?

The Floodplain Risk Management Study raises the following questions:

- What use of the floodplain is considered desirable?
- What are the costs and benefits of various floodplain management measures?
- Will the community support the proposed floodplain management measures?

The risk analysis for existing or proposed uses of the floodplain will include questions such as:

- When will that part of the floodplain be used, even during flood events?
- What inconvenience during floods will the users accept?
- What risk will the owners or operators accept?
- Is there an alternative use for this site that is more compatible with the flood risk or is there an alternative site that is as convenient for users when there is no flood, but is less vulnerable to the effects of flooding?
- What limitations and conditions might be applied to the development?
- What is the chance of and the consequences of a flood larger than that used to derive the DFE occurring in relation to both safety of people and property damage?
- What are the consequences of a levee overtopping, of floodwaters entering a residential subdivision or of floodwaters entering a commercial or industrial area, or farmland?
- What are the consequences of floodwaters cutting roads, or water, sewerage, electricity and telephone services?
- What is the effectiveness of warning message distribution and how well will warning messages be understood?
- Will effective action result from the warning messages?

These questions are relevant for better risk management of existing development in the floodplain and when development of part of the floodplain is being considered. This is not a complete list. The Floodplain Risk Management Study will need to raise these and other questions relevant to the particular floodplain.

Flood events with less chance of occurring in a year than the flood event used to derive the DFE will eventually happen. When they happen the consequences can be very diverse in different floodplains.

## RISK ASSESSMENT AND TREATMENT

Risk analysis examines both likelihood and the consequences of an event. It should be followed by:

- Assessment of the consequences: Are they acceptable? and
- Treatment: How can the consequences be mitigated?

As an example, the consequences of dams overtopping when the design flood is exceeded is generally recognised, and upgrading of dams is carried out to limit losses to more acceptable levels. Application of similar considerations to the floodplain is part of floodplain management.

The direct cost of flood damage to a small number of commercial or industrial premises may exceed the direct cost of flood damage to a large number of residential properties. But the commercial and industrial operations may be better able to recover their costs and return to business as usual. The social cost of flooding of residential areas may be orders of magnitude greater than the social cost of floods through a shopping centre or an industrial estate.

## RESILIENCE STRATEGY

Conventionally, emergency management consists of four components:

- Prevention;
- Preparation (or Planning);
- Response; and
- Recovery.

This system is referred to as the PPRR system of emergency management and must form the basis for the development of and implementation of a resilience strategy for the area being investigated. It should be noted that:

- PPRR are components rather than phases of the resilience strategy. The four components are not sequential stages of an emergency operation. For example, in managing flood emergencies, it is common for recovery operations to commence while flood response operations are still in train.
- Flood prevention (or mitigation) activities can only be comprehensively, objectively and effectively defined via the floodplain risk management planning process.
- Flood prevention activities are aimed at reducing existing flood risk and controlling future flood risk.
- Flood preparation, response and recovery activities are largely aimed at managing residual risk.

Thus, while the flood emergency planning system, which forms part of the overall resilience strategy for an area, embraces the four PPRR components, prevention/planning can only be effectively undertaken via the floodplain risk management planning process, which is described in detail in this Framework.

## PROBABILITY

We have become confident at modelling the behaviour of a design flood with a given probability but it is important to understand some underlying assumptions behind that event.

For example, to estimate flooding in a small catchment, one or two critical durations will be selected and rainfall intensity of a selected probability for that duration will be distributed

evenly over the whole catchment using a prescribed temporal distribution. For larger catchments a spatial and temporal rainfall distribution may be chosen which will give flood peaks of the same probability at all points along the river. Other methods will be used for other types of flooding and other purposes.

What must be remembered is that real events will not behave in exactly the same way as design events. A design event with a peak of a given probability may be suitable for estimating the probability of above floor flooding but in a real flood the duration of the water above a particular level may be quite different from that of the design flood and the probability of isolation different from that which would be suggested if the design flood were used.

Also, if H3 (refer Practice Note 'Hydraulic Hazard') flooding will sweep a person off their feet it does not necessarily mean they will lose their life. In every major flood where there is a fatality in Australia there are usually many more near misses and rescues. The probability that someone will be in the floodwaters in the first place is often a function of the time of day and the duration of the flooding.

From a life safety point of view alone there are therefore several risks that need to be considered. The first is the risk to life if they stay put in a flood. The second is the risk of orderly evacuation failure. The probability of this happening is not only dependent on the probability of the flooding but a whole lot of other factors such as the probability of roads remaining open, the probability of orderly evacuation, the probability that people will be willing and able to evacuate.

Should they not evacuate, then when the floodwaters arrive they may try and leave the building or they may try to shelter in a higher part of the building. The probabilities of them doing either of these will depend on the nature of the flooding, the type of building they are in, the terrain surrounding the building, the distance to flood free shelter and their own beliefs and attitudes. The consequences of choosing one or the other will depend on the nature of the flooding (depth, velocity, rate of rise and duration) and their personal vulnerability. All of these will vary from location to location and flood to flood, and person to person. It is therefore almost impossible to reduce life safety risk to a single number.

It will not be practical to include all of the above explicitly within a risk framework but they can be taken into account implicitly in some of the assumptions which are made or variables which are used.

There is one final consideration in this discussion. The major cause of death in floods in Australia is persons being swept away in vehicles when trying to cross flooded causeways, bridges or roads. Whilst it is difficult to control all such crossings, the identification of high to extreme hazard crossings within the studies may give rise to the use of heavier road closure barriers at these locations as it does appear that normal road signs have limited effect in flood times. It may also serve a purpose if roads in undulating country are inspected during rainfall events as isolated yet very intense rainfall may create a high risk situation in an unexpected location.

## Acceptable, Tolerable and Unacceptable Risks

It is not possible to eliminate all risks. Individuals and society accept certain levels of risk. If we were unwilling to accept the risk of dying while travelling we would not travel. However, what we will accept for individual events can be very different to what we will accept for multiple events.

For example in Qld in 2009, 316 people died in 281 separate motor vehicle accidents. This equates to about 0.66 fatalities per 100 million vehicle kilometres travelled (DoT 2010). In the 2009-2010 financial year 59,000 million passenger kilometres were travelled in Australia on scheduled domestic air flights (DIT, 2010). If we were to conservatively assume that there is an average of two people per motor vehicle and we multiplied the Qld road fatality rate to domestic air flights we would get an annual fatality rate of 390. That would be approximately equivalent to one Boeing 747 crashing in Australia every year and killing everyone on board.

As a society, we would clearly find that rate of large plane crashes unacceptable and the safety measures in place for large jet planes are considerable. While we don't necessarily think that 316 people dying each year on Qld roads is acceptable, we tolerate this road toll and do all that is reasonably practical to bring this toll down.

Appendix E of Floodplain Risk Management in Australia (CSIRO, 2000) refers to a diagram showing the number of fatalities plotted against probability of flooding with zones of acceptable risk, unacceptable risk and a middle zone which is labelled "reduce risk according to ALARP principles" where ALARP stands for "As Low As Reasonably Practical". The guideline cautions against simply using the limits shown in the diagram because they have been derived from graphs for man made hazards such as dam failures or industrial accidents. However, the idea of acceptable risks, unacceptable risk, and what could be described as "tolerable risk" in between is a useful concept to consider and it can be applied to more than just life safety risks.

For example if the 1,000 flooded buildings discussed in the preceding section were at the fringes of a major city, the consequences may be more tolerable than if they are part of a small town of only a few thousand dwellings. If they are in the main commercial district of a town or city, the consequences may be unacceptable.

These cumulative and strategic aspects of flood risk have been recognised across nations. For example,

- The Dutch have levees which protect rural areas from floods with about a 1 in 1,450 chance per year while the major cities of Rotterdam and Amsterdam have protection from a 1 in 10,000 year event.
- In NSW, levees to protect towns have a range of levels of protection, ranging from 1% AEP plus 1.0m freeboard in western areas to 10%AEP with limited freeboard where social and economic factors limit the capacity to construct larger levees.

## Current, Future and Residual Risk

The aforementioned approach can be used to identify the risk for the existing catchment with all of its current topography, development, access, preparedness, vulnerability, etc. However, the risk profile will change over time as development, preparedness and access change.

For example a new urban development will increase the risk while risk mitigation measures introduced to mitigate the current risk reduce the risk. In either case any risk assessment methodology needs to be sufficiently robust to account for current and future risks.

Another term which is often used is residual risk (or continuing risk). This is the risk which remains after all risk mitigation measures are implemented. Unless the residual risk is

tolerable or acceptable then further risk mitigation measures should be implemented until it is.

## A FLOOD RISK ASSESSMENT APPROACH

Using the aforementioned logic, it is possible to develop a risk table which shows what combinations of hazard and probability are acceptable, tolerable and unacceptable. The following is a generalised table in which "acceptable risk", "tolerable risk" and "unacceptable risk", which have the following definitions:

**Acceptable risk** – individuals and society can live with this risk without feeling the necessity to reduce the risks any further. This is coloured green in the table

**Tolerable risk** - –society can live with this risk but believe that as much as is reasonably practical should be done to reduce the risks further. Note that individuals may find this risk unacceptable and choose to take their own steps, within reason, to make this risk tolerable. This is coloured yellow.

**Unacceptable risk** – individuals and society will not accept this risk and measures must be put in place to bring them down to at least a tolerable level. This is coloured red.

| | Low Hazard | Medium Hazard | High Hazard |
|---|---|---|---|
| Low Probability | | | |
| Medium Probability | | | |
| High Probability | | | |

The following set of tables has been developed for each type of flood risk which needs to be considered for any type of flooding in MBRC. The hazard is defined using both the hydraulic hazard category and, where relevant for that particular type of risk, the other hazards which contribute to the overall hazard rating.

Practice Note 'Floodplain Risk Management Options' explains how options which can be used to mitigate the flood risks are identified using the risk tables. The options either make the risks acceptable or tolerable or make tolerable risks more tolerable and how this differs for current and future risks.

***Risk of Isolation***

| Event range | Maximum hazard category of surrounding floodwater | | | | | | |
|---|---|---|---|---|---|---|---|
| | H1 | H2 | | H3-H5 | | | |
| | | <24 hrs | >24 hrs | <24 hrs | | >24 hrs | |
| | | | | Non vulnerable population | Vulnerable population | < 1,000people | > 1,000people |
| 1,000 - PMF | | | | | | | |
| 100-1,000 | | | | | | | |
| 50 to <100 | | | | | | | |
| >10 to <50 | | | | | | | |
| 10 | | | | | | | |

***Risk to Road Access****

| Event Range | Road Type | | | | | | |
|---|---|---|---|---|---|---|---|
| | Collector Road | Distributor Road | Sub Arterial | Arterial | Highway | Motorway | Critical Evacuation Route |
| 1,000 - PMF | | | | | | | |
| 100-1,000 | | | | | | | |
| 50 to <100 | | | | | | | |
| >10 to <50 | | | | | | | |
| 10 | | | | | | | |

* this needs further discussion, particularly in relation to duration of H2 or greater flooding and pavement failure and time to restore road to functional

***Risk to Life - all residential buildings in the floodplain***

| Event range | Maximum hazard category of floodwater surrounding residential building | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | H1 | H2 | | H3 | | | H4 | | H5 |
| | | <24hrs | >24hrs | <2hrs | >2hrs but <24hrs | >24hrs | <24hrs | >24hrs | |
| 1,000 - PMF | | | | | | | | | |
| 100-1,000 | | | | | | | | | |
| 50 to <100 | | | | | | | | | |
| >10 to <50 | | | | | | | | | |
| 10 | | | | | | | | | |

***Risk to Life - all commercial buildings in the floodplain***

| Event range | Maximum hazard category of floodwater surrounding commercial building | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | H1 | H2 | | H3 | | | H4 | | H5 |
| | | <24hrs | >24hrs | <2hrs | >2hrs but <24hrs | >24hrs | <24hrs | >24hrs | |
| 1,000 - PMF | | | | | | | | | |
| 100-1,000 | | | | | | | | | |
| 50 to <100 | | | | | | | | | |
| >10 to <50 | | | | | | | | | |
| 10 | | | | | | | | | |

***Risk to Property - applies to all residential property***

| Event Range | Above Floor Flooding | Ground floor ceiling depth flooding | | H4 | | H5 |
|---|---|---|---|---|---|---|
| | | Two storey dwelling or second floor and above in unit block | Single storey dwelling or ground floor in unit block | Multistorey flood resistant unit block | All other dwellings | |
| 1,000 - PMF | | | | | | |
| 100-1,000 | | | | | | |
| 50 to <100 | | | | | | |
| >10 to <50 | | | | | | |
| 10 | | | | | | |

***Risk to Property - applies to all commercial and industrial property***

| Event Range | Vehicle parking and flood resistant materials/stock storage | Above floor flooding – ground floor | | H4 | H5 |
|---|---|---|---|---|---|
| | | multi storey building | Single storey building | | |
| 1,000 - PMF | | | | | |
| 100-1,000 | | | | | |
| 50 to <100 | | | | | |
| >10 to <50 | | | | | |
| 10 | | | | | |

*Risk to Critical Infrastructure*

*To be done*

Similar approaches can be taken to critical infrastructure (electricity substations, water/sewerage treatment plants, emergency service centres, telephone exchanges, hospitals) with varying levels of risk tolerance depending on the population which they serve, i.e. a 1 in 100 chance of losing a zone substation may be OK but a 1 in 1,000 chance of losing a transmission substation may be more appropriate and a regional substation may need to be outside the PMF. Consideration of whether premises or populations which are not directly flood affected are impacted by loss of service may also come into these considerations as would the time required to restore services following flooding.

## CONCLUSION

Floodplain management is an application of risk management principles. Effective floodplain management recognises that floodplains are a valuable natural resource and that their management requires a balance of the costs against the benefits of using the floodplain.

Some communities may decide to accept a greater flood risk, because there are significant benefits from occupying the floodplain. Other communities may see little advantage in remaining at risk to flooding and accept the cost and benefits of management measures including mitigation works.

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***Risk to Property from Storm Tide - applies to all residential property***

| *Event Range* | *Above Floor Flooding* | *Ground floor ceiling depth flooding* | | *High hazard storm surge* | | *H5* |
|---|---|---|---|---|---|---|
| | | *Two storey dwelling or second floor and above in unit block* | *Single storey dwelling or ground floor in unit block* | *Multistorey flood resistant unit block* | *All other dwellings* | |
| *1,000 - PMF* | | | | *3* | *2 or 3* | *3* |
| *100-1,000* | | | *1 or 3* | *3* | *2 or 3* | *3* |
| *50 to <100* | *1* | | *1 or 3* | *3* | *2 or 3* | *3* |
| *>10 to <50* | *1* | *3* | *1 or 3* | *3* | *3* | *3* |
| *10* | *1 or 3* | *3* | *3* | *3* | *3* | *3* |

Potential Risk Mitigation Options

11. Voluntary house raising of single storey dwellings of suitable construction
12. Building reinforcement for storm surge resistance
13. Voluntary purchase

***Risk to Property from Storm Tide - applies to all commercial and industrial property***

| *Event Range* | *Vehicle parking and flood resistant materials/stock storage* | *Above floor flooding – ground floor* | | *High Hazard Storm Surge* | *H5* |
|---|---|---|---|---|---|
| | | *multi storey building* | *Single storey building* | | |
| *1,000 - PMF* | | | | *3* | *3* |
| *100-1,000* | | | | *3* | *3 or 4* |
| *50 to <100* | *1* | | *2* | *3* | *4* |
| *>10 to <50* | *1* | *4* | *4* | *4* | *4* |
| *10* | *4* | *4* | *4* | *4* | *4* |

Potential Risk Mitigation Options

14. Barriers to prevent vehicles, stock or equipment from leaving the site
15. Storage area for stock and equipment above 1 in 100 level in areas where there is sufficient warning time to relocate stock
16. Building reinforcement for storm surge resistance
17. Voluntary purchase

# PRACTICE NOTE

# FLOOD DAMAGES

## INTRODUCTION

A flood is a traumatic experience for many victims. Not only is there damage to material goods and possessions, there is the sense of personal loss and despondency caused by the destruction of memorabilia (family photographs and documents) or loss of pets. There is the stress caused by additional and at times quite large financial outlays, both public and private, to replace flood damaged possessions.

A flood can be a terrifying experience for all ages, and many suffer nightmares for a considerable time after the event. There is the stress caused by families having to function in a different way; children may have to live in temporary accommodation or they may have to attend different schools.

This Practice Note introduces various categories of flood damage and briefly describes the ways in which flood damage is measured and estimated. The importance of local councils collecting flood damage data after a flood event is discussed and council's responsibilities in this area are outlined. The necessity to consider flood damages in the long term strategic planning of future land use decisions is also discussed.

While this Practice Note concentrates on the human environment of the floodplain that may be damaged by flooding, there is also the need to consider the environmental costs and benefits of flooding and floodplain management measures. This is because whilst floods usually cause damage to human activity they may also be beneficial to the flood dependant ecosystems of the floodplain. Environmental costs and benefits may be difficult to quantify, and are treated as intangible costs and benefits. They are, however, a real and essential factor in the overall economic assessment of floodplain management measures.

### How Much Flood Damage Is There?

The estimated average annual cost of flooding in Australia is in excess of $400 million per year. The data used to derive these figures (AWRC, 1992) are uncertain, especially data concerning the cost of local overland flood damage (probably highly under-estimated), damage to rural enterprises (farms) and rural infrastructure (roads, railways, etc.) and flood damages to the ecology of an area. This is a long-term average and it must be stressed that individual floods may have damages beyond this average (e.g. Queensland 2010/2011).

To improve floodplain management, and more importantly, to allow the effectiveness of management measures to be assessed, more reliable flood damage data are needed at all government levels. Local councils are in the best position to gather this data.

# FLOOD DAMAGE CATEGORIES

There are numerous categories or types of flood damage. Figure 1 shows the inter-relationship of various damage types commonly used in floodplain management studies.

## Tangible and Intangible Damages

The most basic division of flood damages is into tangible and intangible damage categories.

Tangible damages are financial in nature and can be readily measured in monetary terms. They include the damage or loss caused by floodwaters wetting goods and possessions (direct damages) and the loss of wages and extra outlays incurred during clean-up operations and in the post-flood recovery period (indirect damages).

Intangible damages do not have a ready conversion to financial values however intangible damages are real and represent a significant cost to flood affected persons, a cost that can be quite long lived. They can include the increased levels of emotional stress and mental and physical illness caused by the flood episode. Most floodplain management studies acknowledge intangible damages but do not attempt to quantify them as it is difficult, if not impossible, to quantify intangible damages in financial terms.

However, it may be possible to approximately dimension the problem, by, for example, estimating how many flood-affected people may require additional medical treatment for depression or the ecological cost of the loss of a local environmental feature.

| | ***Direct***<br>*Actual Contact with Flood Water* | ***Indirect***<br>*Disruption Caused by the Flood* |
|---|---|---|
| ***Tangible***<br>*Financial* | *Building contents cleaning, and repair or replacement of goods*<br>*Damage to cupboards walls, doors and repair or replacement of structural items*<br>*Contents of sheds, urban infrastructure and vehicles*<br>*Removal of flood debris and removal of discarded items* | *Costs for people undertaking post-flood clean-up*<br>*Loss of wages, loss of sales, loss of production, loss of crops, alternative accommodation*<br>*Unavailable services*<br>*Opportunity Costs* |
| ***Intangible***<br>*Social and Environmental* | *Loss of Life / Injury*<br>*Ill health*<br>*Loss of Memorabilia* | *Inconvenience*<br>*Worry*<br>*Ill health* |

**Figure 1 Types of Flood Damage**

## Direct and Indirect Damages

The two basic categories of tangible damages are direct and indirect damages:

- Direct damages are caused by floodwaters wetting goods and possessions, thereby either damaging them irreparably or reducing their value. Some items might be capable of repair, whilst other items will be damaged beyond repair. In the first case, the direct damage is equal to the cost of repairs plus the loss in value of the repaired item. In the second case, the direct damage is equal to the pre-flood value of the item or its replacement cost.
- Indirect damages are the additional financial losses caused by the flood. These can include the extra cost of food and accommodation for evacuees (i.e. the additional cost above normal costs in a non-flood situation). It also includes any loss of wages by employees, the loss of actual and prospective production or sales by flood-affected commercial and industrial establishments, and opportunity cost to the public caused by the closure or limited operation of public facilities.

**Direct Damage Categories**

The direct damage to a property is commonly divided into three categories:

- Contents damage;
- Structural damage; and
- External damage.

Contents damage refers to damage to the contents of buildings, e.g., in the case of residential properties, damage to carpets, furniture, etc.

Structural damage refers to damage to the structural fabric of buildings, e.g., damage to foundations, walls, floors, doors and windows, etc. Note that structural damage also includes damage to built-in fittings. (Because they are not removable, these items are regarded as part of the structure of a building).

External damage includes damage to all items external to buildings. A common and significant form of external damage is damage to parked motor vehicles.

**Indirect Damage Categories**

Indirect damage can be conveniently divided into three categories, clean up costs, financial costs and opportunity costs.

Clean up costs can be treated as an indirect cost (as in this Practice Note) or as a category of direct costs. Much of the cost of clean up operations arises from the time spent by people in this activity. They are either foregoing wages or other more satisfying activities when participating in clean up operations. However, when public agencies / utilities are employed in a broad scale clean-up, these costs can be both tangible and directly associated with the flood event.

Financial costs refer to all other actual expenses suffered by people and businesses in the flooded area, either directly or indirectly. These include loss of wages, sales, and production and alternative accommodation.

Opportunity costs refer to the absence or reduced levels of service provided by public authorities and facilities, such as school closures, limited telephone facilities. Opportunity costs are imposed on the general public, including those owning properties outside the floodplain.

**Sector Costs**

Tangible flood damage costs, both direct and indirect, can be classified into different land use sectors, such as residential, commercial, industrial, public institution, public utility, recreational, primary production and others. Typically, in most urban flood damage studies, only three or four sectors are recognised, these are residential, commercial, industrial (or commercial/industrial combined) and public properties. Rural studies, however, require a broader range of issues to be covered.

### Emotional, Mental & Physical Health Costs

A flood imposes a range of intangible damages on flood victims. These include the emotional, mental and physical ill health of the victims. Although it is impossible to fully measure these costs in financial terms, they are discussed in some detail here in view of their significance to victims and to the post-flood recovery of the community.

## ACTUAL AND POTENTIAL DAMAGES

There are a further two categories of flood damage that are generally applied to tangible damages, namely actual and potential damages.

Actual damages are the damages caused by an actual flood. Potential damages are the maximum damages that could eventuate should such a flood occur. In assessing potential damages, it is assumed that no actions are taken by the flood affected population during the flood event to reduce damage, such as lifting or shifting items to flood free locations and moving motor vehicles.

Typically, damage reduction factors are used to convert potential damage estimates to actual damage estimates. Two important parameters affecting damage reduction factors are the length of the effective flood warning period and the flood preparedness of the affected population. The longer the effective warning period, the more time is available for evacuating goods and possessions. The more prepared the population, the more effective these measures will be.

## COLLECTION OF FLOOD DAMAGE DATA

A flood provides an opportunity to gather data concerning actual flood behaviour and flood damage. Surveys of actual flood damage should be undertaken as soon as practical after a flood has occurred. The data can be used to confirm the effectiveness or otherwise of management measures already in place. They also provide essential information for future flood studies and Floodplain Risk Management Plans.

### Local Council Responsibilities

Local councils are in an excellent position to coordinate the collection of local data to assist in future flood investigations.

Collection of relevant basic flood damage data is neither a lengthy or costly procedure. There are two basic steps associated with an actual flood damage survey. The first step involves identifying, where practicable, every property and/or every building which was inundated by flood waters and recording the depth of inundation or the level to which flood waters rose. The second step involves recording in detail, the extent of damage, for some or all of the buildings and properties. The two basic steps may be conducted together, within days of the

flood reaching its peak, or the second step may be conducted some weeks after flood waters have receded, but while memories are still fresh. Some data on buildings in the flooded areas may be readily obtained from council records within 24 hours of a flood, and used in discussions with the owners or occupiers of flooded premises.

### Urban Flood Damage Data

Basic flood damage data to be collected from urban areas (irrespective of whether the damage is caused by local overland or mainstream flooding) relate to the number and type of flooded properties and depths of flooding within buildings and across grounds. No estimates of flood damage or flood loss per se are required. Each urban property that is partially or fully covered by floodwaters needs to be included in the survey, irrespective of whether or not buildings are flooded above floor level.

Note that some data need to be assessed subjectively usually on a comparative basis, such as building size. A quick inspection of house sizes will provide broad guidelines for 'small', 'medium' and 'large' dwellings. Similarly, house style will provide a reasonable guide to building age.

### Rural Flood Data

Basic flood damage data to be collected from rural areas relate to crop and stock losses on a farm-by-farm basis. These losses also include agistment costs and fodder and feed costs. Coordination between the local council and state authorities is necessary to collect data on rural infrastructure damage.

In the case of rural flood damage, the farmer is asked to estimate the value of his losses. Rural flood surveys may take longer than urban surveys because of the larger areas involved.

## ESTIMATION OF FLOOD DAMAGE COSTS

The flood damage data collected, when combined with data collected under similar situations and circumstances elsewhere, is generally used to estimate the cost of flooding for a specific urban or rural area.

To compare the benefit and effectiveness of proposed mitigation measures, it is necessary to:

- First estimate flood damage which would be caused by different sized floods which might occur now;
- Secondly estimate the reduced flood damage which would be caused by those floods after specific mitigation measures were implemented; and
- Estimate potential damage costs for proposed new development areas considering likely development conditions.

### Potential Damage

Flood damage studies are frequently necessary for areas that have no recent records of damage in an actual flood. Potential damages should be measured, in areas that have not

been subject to a recent flood and associated damage survey and in areas that have been flooded.

In a potential damage survey, a sample of representative properties is first identified and then damages to these properties are determined, either by questionnaire or through personal inspection by a trained valuer. This is different from some actual damage questionnaire surveys, in which property owners estimate their own damages. Damage reduction factors are used to convert potential damage estimates to actual damage estimates.

## Stage-Damage Curves

Actual and potential flood damage data can be presented as stage-damage curves for different property types. Such curves relate contents damage to depth of flooding above floor level. These curves are generally derived on the basis of numerous damage studies undertaken throughout Australia (Water Studies, 1986). Stage-damage curves can be derived for residential, industrial, commercial, rural and public properties.

The NSW Government has published "Residential Flood Damages" as part of a series of Floodplain Risk Management Guidelines – this document provides more up-to-date stage-damage curves. These data should be assessed for local conditions before being adopted.

## Computer Models and Property Counts

To determine the flood damage over a specific urban area it is necessary to know the number of flooded properties, the type of flooded properties and the depth of flooding above floor level. The number of flooded properties can be determined from flood studies, flood maps, aerial photographs or from a street by street inspection.

It is generally very difficult to discriminate property types from aerial photographs. Knowledge of flood levels and floor levels throughout the flooded area will enable flood depths over the floor to be calculated for each building. Floor level data may be obtained either from council plans or by measuring floor height above ground level, with ground levels estimated from contour maps. The appropriate stage-damage curve allows the damage to be estimated for each property. A computer model or a spreadsheet is typically used to combine all these data and estimate the flood damage for different flood levels up to and including the PMF (PMF). Similar procedures are used to estimate flood damage costs for rural areas.

## Accuracy and Reliability

To obtain consistent and reliable estimates of flood damage requires care and experience. Even so, such estimates are necessarily approximate. For properties of the same type, there is typically a widespread variation in damage from property to property. Stage-damage curves reflect average damages.

Thus, when using stage-damage curves to assess damage in an unsurveyed property, the estimate is necessarily approximate. However, if the sample of surveyed properties has been chosen correctly, the total damage estimate for all flooded properties will be much more reliable. Further inaccuracies creep into damage estimates from uncertainties in flood, ground and floor levels. Again, if the estimation procedures are correctly chosen, there should be no gross bias in the total damage estimate. To ensure that these uncertainties are

minimised the damage assessment should be carried out by an experienced practitioner and sensitivity testing undertaken.

## AVERAGE ANNUAL DAMAGE

Over a long period of time, a flood liable community will be subject to a succession of floods. In many years, no floods may occur or the floods may be too small to cause damage. In some years, the floods will be large enough to cause damage, but the damage will generally be small because the floods are small to medium sized.

The average annual damage (AAD) is equal to the total damage caused by all floods over a long period of time divided by the number of years in that period. (It is assumed that the development situation is constant over the analysis period).

All of these cost factors have to be weighed up and evaluated in determining the relative economics of possible mitigation measures. Suffice it to say that the AAD provides a consistent means of evaluating the physical economic benefits of different mitigation measures. It should not be forgotten that unless the intangible damages and the environmental impacts of the various measures under consideration are also included in the assessment, then the end result of the assessment will not truly reflect the costs and benefits of the proposal.

### Determination of AAD

We do not know the actual sequence of floods that will occur at a particular flood liable community. However, we do know that on average, the 20 year average recurrence interval (ARI) event will occur once every twenty years (an annual exceedance probability (AEP) of 5%), the 50 year event will occur on average once every 50 years (an AEP of 2%), etc. Further, by examining a range of floods, we can estimate the potential and actual damages caused by floods of different severities. The variation of flood damage with the annual likelihood of occurrence of the flood (AEP) can then be plotted, as shown in Figure 2. Figure 2, indicates that in this particular situation flood damage only commences at the 10% AEP flood event and the more extreme the flood, i.e. the lower the AEP, the greater the flood damage. The AAD for the situation depicted in Figure 2 is equal to the area under the damage – annual likelihood of occurrence curve.

The AAD for floods up to the 5% AEP flood is determined from the area under the damage curve (Figure 2) to the right of this point. This equates to \$5,000 (½ x \$200,000 x 0.05), i.e. floods up to the 5% AEP event contribute \$5,000 to the AAD. The total area under the damage curve (Figure 2) for all events up to and including the PMF is \$50,000, this is the total AAD.

## FUTURE FLOOD DAMAGES

It is important that the question of flood damages related to future developments on flood prone land, urban or rural, is also considered in the formulation of a Floodplain Risk Management Plan.

This type of investigation should consider future land use scenarios, projected lot sizes, occupancy rates and estimated flood impacts.

Flood level information from the flood study and the stage damage curves (from damage studies for existing development) can be used to assess the viability of the range of land use proposals under consideration and provide a sound basis for the long-term, strategic management of the flood prone land.

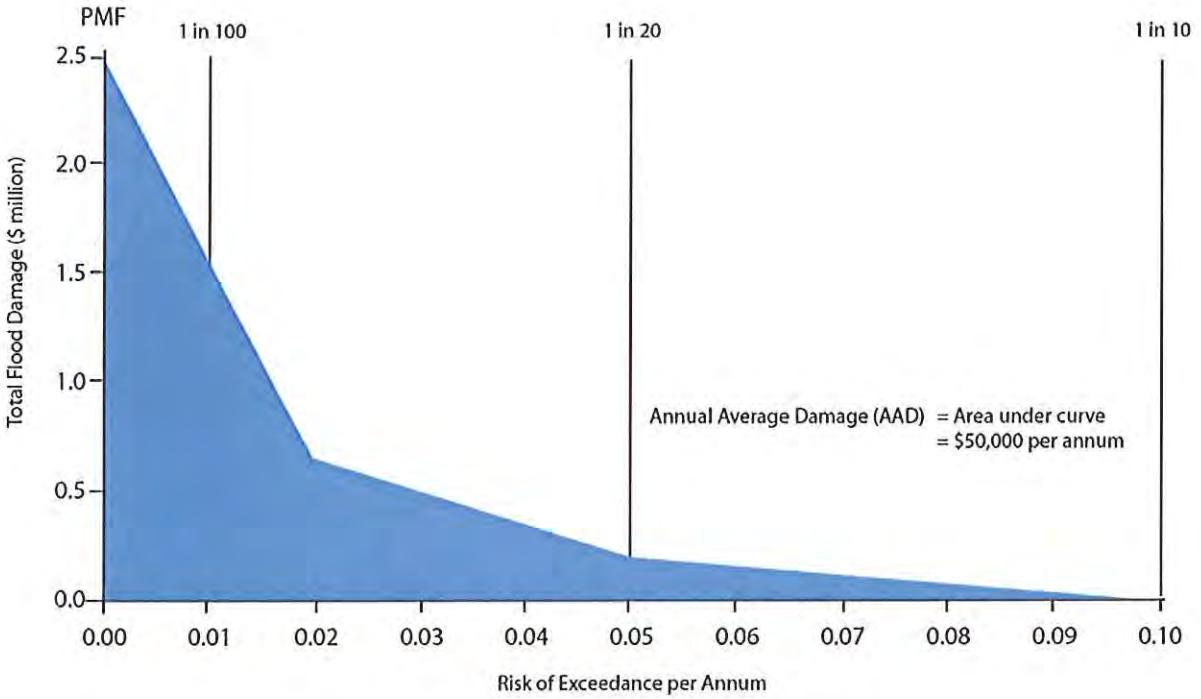


**Figure 2 Flood Damage Calculation Curve**

## ADDITIONAL CONSIDERATIONS

Studies in the early 2000's associated with the Hawkesbury-Nepean Floodplain Risk Management Strategy have addressed the financial effects of flooding on owner-occupier households. This is particularly important as the AAD estimated may not, probably does not, reflect the ability of the household to pay for the damages or the time taken to pay for such a loss.

The study concluded that the "younger" households with dual or high salaries can withstand financial losses more readily than those on lower or constrained incomes, e.g. pensions. Those who are already economically and socially disadvantaged are particularly vulnerable to the hardship caused by flood damages.

Thus consideration of the "ability to pay" and the location of "affordable" housing (usually on the floodplain) must be part of the economic and social considerations and precautionary measures, such as more appropriate localities or flood resistant structures, should be part of the decision making process.

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# PRACTICE NOTE

# PLANNING CONSIDERATIONS

## INTRODUCTION

The MBRC (MBRC) area covers 2037 square kilometres and has a population of 371,000 which is projected to be 515,000 persons by 2031. MBRC is a growing residential area, with substantial rural, rural residential, commercial and industrial areas. The region's proximity to Brisbane and major transport infrastructure make it easy to access, a benefit that has attracted numerous new residents and businesses. The region's strong economic performance provides competitively priced sites and an array of business and investment opportunities.

## LEGISLATION

The current MBRC Planning Schemes were established under the Integrated Planning Act 1997 (IPA), since replaced by the Sustainable Planning Act 2009 (SPA). The Integrated Planning Act 1997 provided the framework for Queensland's planning and development assessment system by balancing community well-being, economic development, and protection of the natural environment.

The main elements of the IPA framework were:

- Integrated Development Assessment System (IDAS) - one system for all development related assessments by local and state governments
- Master planned areas
- State planning policies
- Regional planning
- South East Queensland regional planning
- Infrastructure planning
- Dispute resolution.

The replacement for the IPA is the Sustainable Planning Act which came into effect in December 2009. This new legislation seeks to achieve sustainable planning outcomes through:

- managing the process by which development takes place;
- managing the effects of development on the environment; and
- continuing the coordination and integration of local, regional and state planning.

The purpose of the Act is to seek to achieve ecological sustainability in three ways:

- managing the process by which development takes place including ensuring the process is accountable, effective and efficient and delivers sustainable outcomes;
- managing the effects of development on the environment (including managing the use of premises); and
- continuing to coordinate and integrate planning at local, regional and state levels .

State planning instruments are statutory instruments under the Statutory Instruments Act 1992. If there are any inconsistencies between the provisions of a state planning instrument and a local planning instrument, the state planning instrument prevails to the extent of the inconsistency.

There are four state planning instruments:

- state planning regulatory provisions
- regional plans
- state planning policies
- standard planning scheme provisions .

State planning regulatory provisions (SPRP) are a statutory instrument that advance the purpose of the Act by:

- providing regulatory support for regional planning or master planning
- providing for a charge for the supply of infrastructure
- protecting planning scheme areas from adverse impacts.

A regional plan provides an integrated planning policy for a designated region by identifying outcomes and how to achieve those outcomes.

A state planning policy (SPP) is an instrument that advances the purpose of the Act by declaring the state's policy on a matter of state interest.

The standard planning scheme provisions (SPSP) is an instrument that advances the purpose of the Act by providing for a consistent structure for planning schemes and standard provisions for implementing integrated planning at the local level.

The SPSP will be progressively reflected in local government planning schemes as new schemes are made under the Act . Existing Integrated Planning Act 1997 planning schemes are not required to be consistent with the SPSP .

New planning schemes made under the SPA must be updated to reflect changes to the SPSP made over time .

## LOCAL PLANNING INSTRUMENTS

A local planning instrument is any of the following:

- a planning scheme
- a temporary local planning instrument
- a planning scheme policy

A planning scheme is an instrument made by a local government that advances the purposes of the Act by providing an integrated planning policy for the local government's planning scheme area .Planning schemes are usually made by local governments however, the Minister also has powers to make and amend planning schemes .

Local governments must review their planning schemes every ten years . Planning schemes should be based on a 20 year planning horizon and, in local government areas with a regional plan, updated after the regional plan is updated .

A planning scheme must:

- appropriately reflect the standard planning scheme provisions (note: this does not apply for an IPA planning scheme)
- identify the strategic outcomes for the planning scheme area
- include measures that facilitate achieving the strategic outcomes
- coordinate and integrate the matters, including the core matters, dealt with by the planning scheme, including any state and regional dimensions of the matters
- include a priority infrastructure plan
- if land in the planning scheme area is a declared master planned area, include a structure plan for the master planned area .

Each of the following are core matters for the preparation of a planning scheme:

- land use and development
- infrastructure
- valuable features .

## STATE PLANNING POLICY 1/03

State Planning Policy 1/03 (SPP1/03) sets out the State's interest in ensuring that the natural hazards of flood, bushfire, and landslide are adequately considered when making decisions about development.

Under the Integrated Planning Act 1997 (IPA), the SPP has effect when development applications are assessed, when planning schemes are made or amended and when land is designated for community infrastructure.

The SPP applies to development involving the:

- actions or activities described in paragraph A1.1 of Annex 1; and
- community infrastructure described in paragraph A1.2 of Annex 1.

In addition, the SPP addresses development that has the potential to increase the extent or severity of natural hazards, but this aspect of the SPP applies only when planning schemes are being made or amended.

The SPP generally applies throughout Queensland.

The SPP requires the identification of natural hazard management areas within which minimising risks to the community should be a key consideration in development assessment

and the preparation of planning schemes. Until natural hazard management areas are identified in planning schemes, the natural hazard management areas outlined in Annex 3 should be used for development assessment.

In relation to certain important types of community infrastructure, the SPP aims to ensure that they are able to maintain operation during and immediately after major natural hazard events wherever practicable. The SPP applies to these types of community infrastructure anywhere in Queensland, not only within natural hazard management areas.

This SPP is now subject to a review process under the overall direction of the Department of Community Safety (DCS). This review is scheduled to take some 18 months and to be finished September 2013, as the current SPP expires 2 September 2013.

## THE LOCAL SITUATION (NEEDS FURTHER WORK!!!)

MBRC (MBRC) operates under three separate Local Planning Schemes – this reflects its history as an amalgamation of the previous Councils of Caboolture, Pine Rivers & Redcliffe in 2008.

It is understood that the Caboolture Local Planning Scheme does not reflect the provision of SPP 1/03 for flooding whereas the Local Planning Schemes for Pine Rivers & Redcliffe reflect the requirements to a greater or lesser degree.

Generally, the Scheme's flooding overlay or selection of DFE is based on specific studies for specific development scenarios. As such, they tend not to account for all activities within the catchments/sub-catchments throughout the area and do not reflect the cumulative impact of developments that may, on their own, not constitute any flooding issue however, when taken together, the developments may lead to significant impacts.

It is understood that MBRC is commencing the process of reviewing its Planning Schemes, using more recent and comprehensive studies to support the flooding decisions.

## DUTY OF CARE

Community leaders are always asked to make decisions about where to allow behaviour that is associated with some risk, because there are many benefits from allowing that behaviour. The use of motor vehicles is an obvious example and the use of the floodplain is another. The risk of incurring damage or losses in flood time increases in those parts of the floodplain that are more susceptible to flooding.

Reducing the use of the floodplain can lower the flood damage bill. However, the benefits from using the floodplain for rural or urban or recreational purposes are also reduced. Those that use the floodplain and those who allow the use, must recognise that whatever DFE has been adopted there is still some risk and they need to accept responsibility for being careful. Each needs to be conscious that flood events bigger than the DFE can occur and it is a matter of when, not if, they will occur.

As with other planning decisions, councils have a duty of care in advising property owners, occupiers and developers on the extent and level of flooding and in making decisions with regard to an appropriate DFE. Because of the importance of such decisions, councils should document and carefully explain the basis of selecting an DFE.

# PRACTICE NOTE

# DEFINED FLOOD EVENTS

## INTRODUCTION

The selection of a Defined Flood Event or Events (DFE(s)) is an important tool in the management of flood risk. They are derived from a selected flood event (an historic flood or flood of certain AEP) and a freeboard. DFEs do not, however, ensure that development is located in areas where it will not have significant adverse impacts on flooding nor do they address personal safety issues. These issues need to be considered strategically in management studies and managed through appropriate land use restrictions in Planning Instruments.

## PURPOSE OF DFE

Since the codification of a floodplain management strategy began back in the 1980's, the practitioners have struggled to come up with an acceptable term that covered the desired limit of flooding from a land use point of view.[1]

The selection of a DFE is an iterative process that considers flood behaviour and land use attributes in determining areas and conditions for development. Historical practice has generally seen the adoption of a single DFE for development control. This tended to focus on the 1% AEP event and resulted in the popular perception that this event defined the limit of flooding. This perception precluded assessment of risk levels associated with rarer floods that may be more critical for a particular location. This is one reason that best practice requires consideration of the full range of flood risk in setting an DFE for purposes including:

Development control measures to aid in managing future flood risk; and

Design levels for mitigation works to manage existing flood risk.

The selection of the appropriate DFE is based upon a detailed understanding of flood behaviour across s the full range of floods, their likelihood of occurrence and the associated consequences in terms of danger to personal safety and social, economic, environmental and cultural issues.

## SELECTING DFE

A Floodplain Risk Management Study involves determining appropriate land uses and densities and selecting both the flood events and freeboards upon which DFEs for different purposes are based.

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[1] Queensland uses Defined Flood Event (DFE) however Flood Planning Level (FPL) is the current NSW terminology which is also gaining some credence in WA.

Therefore decisions on DFEs are based upon a detailed understanding of flood behaviour across the full range of floods, their likelihood of occurrence and the associated consequences in terms of danger to personal safety and social, economic, environmental and cultural issues.

## DFE FOR DEVELOPMENT CONTROL

Flood risk can be managed strategically through a combination of:

- Appropriate zonings and controls to ensure that development is restricted to areas where it will not significantly impact on flood behaviour in the flood event used to derive the DFE, and that development type, scale and controls result in manageable residual risk;
- Adopting DFEs for new development (minimum fill and floor levels) to reduce the likelihood of properties and buildings flooding and associated damages to an acceptable level; and
- Effective management of personal safety in rare events.

Therefore development controls, including DFEs for future development, aim to reduce the likelihood that properties and buildings flood and reduce the exposure of people to dangerous flood situations.

As it is generally not feasible, either socially or environmentally or economically desirable to safeguard development against the PMF, a residual risk remains from rare flood. The selection of a flood event upon which a DFE is based is therefore essentially a matter of balancing:

- The social, economic, environmental and cultural costs of restricting land use in flood prone areas; against
- The social, economic, environmental and cultural benefits of a reduction in the frequency, inconvenience, damage and danger to people caused by flooding.

The relevance of these issues varies with location in the floodplain and between different types of development. What may be appropriate for one land use may be inappropriate for another land use, or for the same land use elsewhere with a different flood risk exposure. The latter should be addressed by appropriate land use restrictions.

In general, the minimum floor level for standard residential development would be the 1% AEP flood event plus a freeboard (typically 0.5m) with minimum fill levels at the 1% AEP flood level.

Higher DFEs may be necessary for aged care facilities and other types of developments with particular evacuation or emergency response issues.

Consideration should also be given to using the PMF as the DFE when siting and developing emergency response facilities such as police stations, hospitals, SES headquarters, and critical infrastructure, such as major telephone exchanges and substations, if possible.

The decision on appropriate DFEs for commercial and industrial developments relates more to economic benefits versus costs as discussed in Practice Note 'Defined Flood Events'. Therefore, there is greater potential for DFEs for these developments to be based on event more common that the 1% AEP flood.

However, danger to personal safety for personnel, clients, etc still requires careful consideration, particularly where more frequent events are used as the basis for DFEs.

## DFE FOR MITIGATION WORKS

A DFE for a mitigation work to protect existing development from flooding, such as a levee, needs to consider the range of issues outlined below, and additional issues relating to freeboard.

The DFE for mitigation works may be different from the DFE for development due to a range of factors which vary with location. These include the economics of the works, financial and technical feasibility, potential environmental impacts, physical limitations of the site, community concerns, potential impacts elsewhere in the floodplain and the height floods can rise to relative to ground levels in the area.

In most circumstances, overtopping or failure of works including levees can result in catastrophic damage and undue danger to personal safety. An asset management plan with fail-safe maintenance program is essential for all levees together with sound local flood plans to address the inevitable overtopping provided for in most levee designs.

Unless a levee is designed to exclude the PMF, considerable care must be taken to inform residents that it will be overtopped at some time in the future and to clearly explain to residents the purpose of and need for a local flood plan to address levee overtopping or failure. Without this understanding the community may have a false sense of security which may increase danger to personal safety.

## FACTORS INFLUENCING DFE

DFEs are made up of the selection of an appropriate flood event and an associated freeboard. Whilst an appropriate DFE for new residential development is generally based upon the 1% AEP flood, there are a range of factors which are assessed in selecting the flood event upon which the DFE is based, as discussed below. There is also a range of factors that affect the selection of freeboard, generally 0.5m for residential development.

### Risk to Life

Risk to life issues relate to the consequences of the full range of floods including the flood used to derive the DFE and rarer floods (see Appendices G & H). Selection of the flood event upon which the DFE is based and associated development controls, such as minimum fill and floor levels, need to ensure that risk to life is effectively managed for the full range of floods. A flood larger than that used to derive the DFE will result in increased risk to life and property as:

- Water enters buildings or overtops levees built at the DFE and may result in the need for evacuation;
- High hazard or flow conditions may develop in areas where floodwaters simply pond in the flood event used to derive the DFE; and
- Significant access problems may develop. This is not a serious issue in a floodplain with continuously rising roads leading out of it. However, any flood which cuts access and isolates parts of a community can cause serious additional danger to personal safety.

This is a particular problem where there is a large flood range between the flood used to derive the DFE and the PMF.

These issues need consideration in the development of specific areas of land, the type and scale of such developments and in selecting DFEs for mitigation works and development control. These considerations need to address the cumulative impacts of future development, particularly for emergency planning and response.

### Flood Behaviour

Flood behaviour is more likely to impact upon areas for development or the location of mitigation works rather than a final decision on DFEs.

The cumulative impact of the full extent of development (fill, buildings and fences) which could occur as a result of selecting a particular flood as the basis for the DFE requires strategic assessment along with the potential impact of flooding on development. Mitigation works to reduce flood risk for existing development may also impact upon flood levels elsewhere in the floodplain. These impacts need consideration in assessment of mitigation options.

### Social Issues

Social issues that need consideration include availability and demand for land, existing extent of development, current DFEs and risk exposure, land values and social equity and flood duration. All may impact upon decision on DFEs.

## ECONOMIC FACTORS

The economic factors in selecting DFEs for mitigation works and development controls are different, as discussed below.

### Future Development

A key consideration in new development cases is the ability of people to financially recover from severe flood events. This is an area where residents generally have less flexibility than businesses.

This consideration has led to residential development having the DFE based upon the 1% AEP flood with freeboard (typically 0.5m). Considering a reduction in the DFE for new residential development below this level is not a simple balance between different levels of flood damage and development costs. It has significant social equity implications as damages will be borne by future residents whilst any cost savings related to lower fill levels are made by developers of the land.

The greater flexibility of business in managing risk and recovering financially from flooding means DFEs for industrial and commercial development may be based upon a more frequent flood event. An acceptable level of risk may become a business decision for the owner or occupier. This allows for trade-offs between council's responsibility to present and future owners and occupiers and the latter's natural preference to accept the risk and potential damages as a business cost to lower initial set up costs. However, financial risks alone should not guide the setting of DFEs for business premises; the risk to life must also be considered.

### Mitigation Works

The economics of selecting the flood upon which the DFE for protection works is based relates to the benefit of works in reducing flood damages to private property and community infrastructure relative to the estimated life cycle cost of the mitigation works. Different DFEs for protection works will have different reductions in flood damages and costs of works and therefore benefit, as the level of service to the community will change.

## ENVIRONMENTAL ISSUES

It may be possible to choose an DFE to meet multiple objectives. For example, areas immediately adjacent to the watercourse (riparian zone) may also have a high conservation value and be below the proposed DFE. By ensuring this land is not developed inappropriately, valuable habitat areas may also be conserved. However, land use limits are a more appropriate tool for this purpose.

## CULTURAL ISSUES

DFEs are unlikely to result in significant impacts on cultural issues. These are more likely to be effected by location of protection works or new development areas. However, the DFE of a protection work, such as a levee may impact on cultural site(s). Where this is a key issue for the site, it may need consideration in balance with flood risk management objectives.

## FREEBOARD

Freeboard is the difference between the flood event upon which the DFE is based and the DFE itself. The purpose of freeboard is to provide reasonable certainty that the reduced risk exposure provided by selection of a particular flood as the basis of a DFE is actually provided given the following factors:

- Uncertainties in the estimates of flood levels. These can arise from a relatively short database of past floods and past storm surges in coastal waters, together with uncertainties and simplifications in the models used to predict flood discharges and flood levels;
- Differences in water levels across the floodplain because of 'local factors' not determined in floodplain modelling, though this can be minimised through the use of TUFLOW as a modelling tool;
- Increases in water level as a result of wave action are also not determined in floodplain modelling. Wave action can be of two types. Wind-induced waves across fetches of open water and waves induced by boats and vehicles moving through flooded areas;
- Changes in rainfall patterns and ocean water levels as a result of climate change. This issue should be addressed through sensitivity modelling based on predicted changes;
- The cumulative effect of subsequent infill development of existing zoned land. In effect, freeboard acts as a factor of safety which should never be relied on to manage risk in events larger than the flood used to derive the DFE. In the majority of circumstances a freeboard of 0.5m would be acceptable for new residential development controls.

These can all add to general freeboard requirements meaning that a larger freeboard is used for earthen levees than for development control purposes or for a levee constructed of concrete.

It should be noted that the Building Code of Australia does not, at present, specify a freeboard for any structures that may be affected by flooding. There is a review of this possible requirement currently in progress.

It should also be noted that the freeboard may vary from location to location and for different applications. For example, a residential property may have a freeboard of 0.5 metres for habitable floors however, if two storeys, the downstairs area may have no freeboard if it is non-habitable and readily cleaned after a flood. A similar situation may apply for commercial and industrial properties where requirements such as access militate against a freeboard and measures such as flood insurance and internal flood response plans can minimise the damage from a flood.

# PRACTICE NOTE

# FLOODPLAIN RISK MANAGEMENT PLAN

## INTRODUCTION

A Floodplain Risk Management Plan is the formalisation of an effective floodplain management process. It is based on a comprehensive and detailed evaluation of all factors that affect and are affected by the use of flood prone land. It represents the considered opinion of the local community on how to best manage its flood risk and its flood prone land. It also provides a long-term path for the future development of the community.

The management plan may apply to the whole local government area or a specific area of the floodplain. Therefore different management plans may apply in different parts of a local government area.

The Floodplain Risk Management Study and plan are integrally linked. The study provides for the assessment of options that form the basis for the considerations and decisions in the management plan. The management study and the plan (usually draft) are often completed in one consultancy. This Practice Note:

- Describes the objectives of the Floodplain Risk Management Plan;
- Indicates the issues to be considered in plan preparation;
- Discusses community involvement in review of the management plan; and
- Discusses preparation of the plan and its adoption.

## SUGGESTED PROCESS

The Floodplain Risk Management Plan is a distillation of the findings within the Floodplain Risk Management Study. Provided the issues listed Practice Note 'Floodplain Risk Management Study' are included in the Management Study, the Plan will require minimal new work or investigations.

- Floodplain Risk Management Plan would have the following general contents:
- Introduction, setting out Context of Plan, its Background and what the Report is all about;
- The Need for the Plan, setting out Background, Objectives, a description of the Study Area, a summary of the Flood Data and details of Major Floods;
- Proposed Management Measures
  - Flood Modification Measures
  - Property Modification Measures
    - Local Planning Instruments, Defined Flood Events and Hydraulic & Hazard Categories

- Response Modification Measures
- General

- Costs, Priorities & Implementation Plan
    - Costs, Funding Requirements, Priorities and Implementation Plan
- Recommended Measures and Priorities
- Finalisation of the Management Plan - 'Adopted Management Plans'

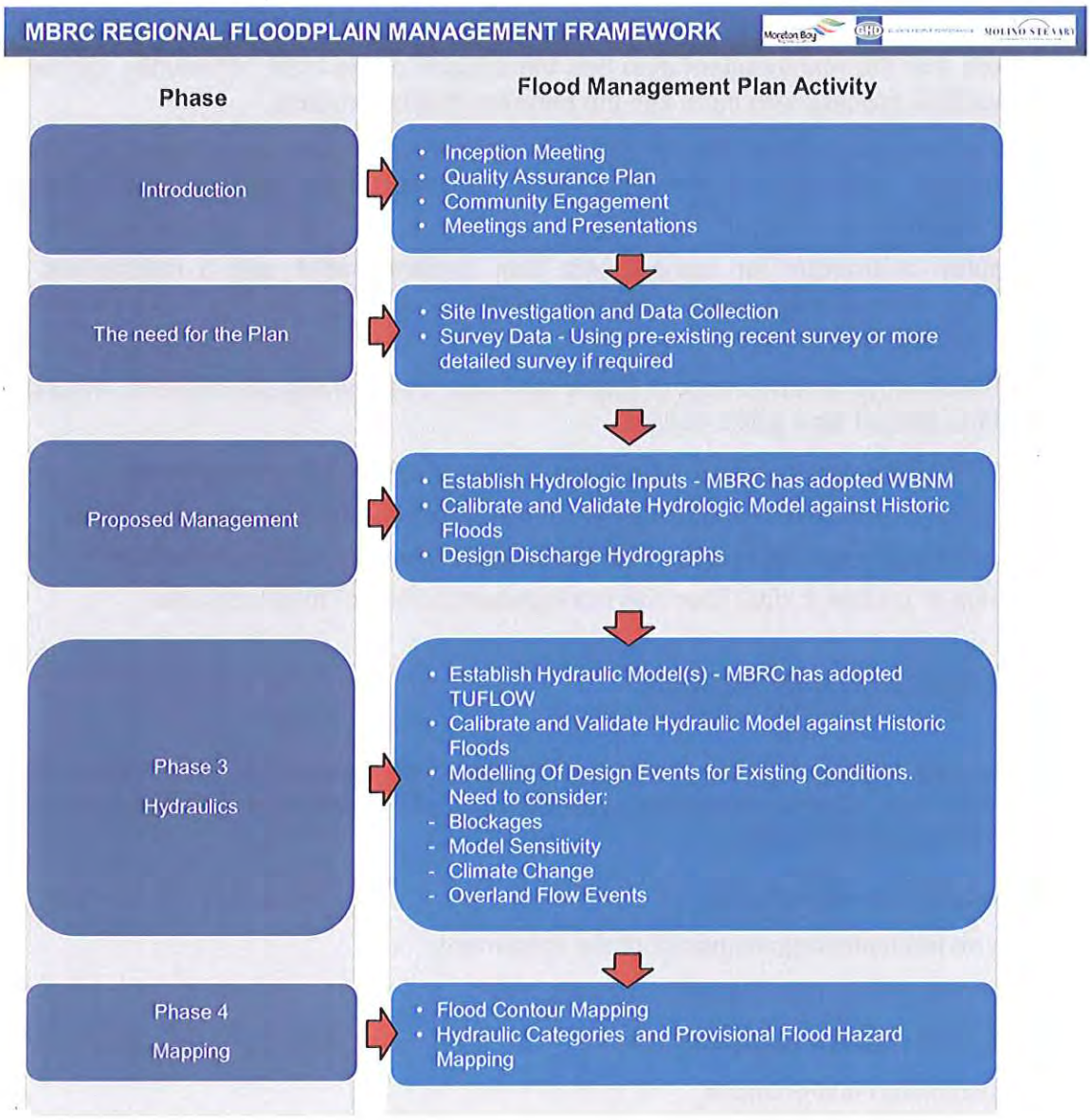


**Figure 1 Flood Risk Management Plan suggested structure**

## OBJECTIVES

Management plan objectives are:

- To meet the objectives of the MBRC floodplain management strategy by describing how flood risk in specific areas is to be managed using a coordinated mix of measures that address existing, future and residual risks;
- To ensure the management plan is fully integrated with the local flood and catchment plans, council's existing corporate, business and strategic plans, existing and proposed planning instruments and meets council's obligations under the relevant legislation;
- To ensure that the management plan has the support of the local community, gathered by an inclusive process with input into the decision making process;
- To ensure actions arising out of the management plan are sustainable in social, environmental, cultural and economic terms and maximise positive and minimise negative impacts;
- To establish a program for management plan implementation and a mechanism for funding the management plan including priorities, staging, funding, responsibilities, constraints, and monitoring;
- To enable effective management of future land use, by providing the relevant inclusions in the management plan which outline:
  - The limits of development due to hazard and adverse impacts upon other properties;
  - The types and scales of development appropriate within these development limits; and
  - The conditions necessary to support the development types and scales outlined; and
- To develop or update a local flood risk management policy for the study area.

## CONSIDERATIONS IN PLANS

The following major elements need to be considered in the preparation of a management plan, where relevant. These elements are derived through the data collection and studies as part of the management process:

- Collection of flood related data;
- Impacts on the hydrologic response of the catchment;
- Extent of flood prone land (as defined by the PMF);
- Hydraulic and Hazard categories;
- Social description and analysis;
- Environmental impacts and opportunities for enhancement and protection of heritage sites and places;
- Land use, existing and potential, related controls and potential development;
- Economic analysis;
- Management measures (property, flood, and response modification measures);

- DFEs for differing purposes;
- Links with other plans, particularly the local flood emergency plan;
- Provisions of the relevant legislation and policies;
- Performance measures against which the progress and success of the management plan can be measured and reviewed;
- An implementation strategy including consideration of long term issues such as ongoing community education and awareness; and
- Monitoring and review.

## COMMUNITY INVOLVEMENT IN MANAGEMENT PLAN REVIEW

The community as a whole should be involved in the formulation and implementation of a management plan. Community consultation is a necessary element of the floodplain management process.

To conform to the principles of this framework, it is necessary that councils actively involve representatives of the community, particularly owners of flood prone land, in the preparation of the management plan and review of its effectiveness.

In developing management plans, communities should clearly understand that certain areas of land will need to be set aside to facilitate floodplain management, for example, as floodways or flood storage areas. These areas can be used for many flood compatible purposes, but should remain capable of fully performing their floodplain management role. Irrespective of any statutory requirements, the management plan should be exhibited and public comment should be sought and taken into account before it is finalised and adopted by council.

## FINALISATION OF THE MANAGEMENT PLAN - 'ADOPTED MANAGEMENT PLANS'

A management plan is never truly finished.

Social and economic circumstances change and flooding behaviour may be substantially altered by future measures adopted in other areas of the catchment. A management plan represents the 'best' appraisal of existing and likely future circumstances at the time it is 'adopted'. For this reason, we do not speak of 'final' but rather of 'adopted' management plans, that is, plans that have been adopted for the immediate future. Management plans should be reviewed regularly (say every 10 - 15 years or after each major flood, or where circumstances change that impact on the relevance of the management plan) to ensure that their provisions remain appropriate.

It is essential that the adopted management plan is complementary to the local flood emergency plan. Existing, future and residual flood risk cannot be effectively dealt with if this does not occur, or if EMQ is left out of the overall management process. Review of either plan should not be undertaken without reference to the other plan and the relevant authority. Changes in the Floodplain Risk Management Plan should be reflected in the local flood risk management policy.

# IMPLEMENTATION

Management studies and plans provide an informed basis for decision making by the local councils to enable flood risk to be effectively managed to an acceptable and understood level.

However, the completion and adoption of a management plan itself does not manage flood risk. This relies on implementation, which is a critical step in the management process. The objective of implementing the management plan is to manage the full range of flood risk through a range of measures and in accordance with the implementation schedule outlined in the management plan.

Implementation is best overseen by a reduced steering committee and undertaken in accordance with a priority for management measures developed in the management plan. This is based upon:

- How soon they can be implemented;
- Resourcing required;
- The constraints that exist (including financial and physical);
- How these can be addressed; and
- How effective the measures are.

Therefore, low cost measures that can be readily implemented and are effective in reducing damage or personal danger are likely to have a high priority.

## Information Provision to the Public

The community needs to be made aware of their risk of flooding and has a right to access information held by public authorities about flooding. The necessary information relates to:

- The affectation of their current property and prospective future property and associated development controls;
- What to do during a flood event; and
- Provision of an avenue for further discovery of information and interpretation for the individual property.

This can be provided through:

- Public education to raise general and specific awareness of flood affectation;
- Approvals issued by councils for land sale provide information in relation to whether council has policies to restrict development of the property for a range of reasons, including flooding;
- Planning controls and the local floodplain management policy, to provide additional information on development constraints; and
- Access to council staff for further discussion.

### Public Education

Changes in people's response to a flood can reduce flood losses and thus people who use the floodplain need to be ready for floods. However, education of the public is a difficult task as unless people have actually experienced a flood, they tend to be sceptical when they are informed that there can be floods in their area. Thus, as experienced people move out of the floodplain area they take their knowledge with them and those who replace them add to the increasing number of people who may have little direct experience or awareness of flooding.

The tendency to ignore that an area is flood prone can be aggravated by flood mitigation measures, effective planning controls and other complementary floodplain management measures. This is particularly the case where levees are built. Levees traditionally engender a false sense of security by implying that all future floods will be excluded from the area. The more successfully these measures reduce the losses in frequent flooding, the fewer the number of people in the community who have experienced a flood.

A residual flood readiness campaign will be necessary to try to ensure the community remains aware of its risk and ready to act. For those people who are unprepared for a flood, the shock of being flooded can affect their physical as well as their mental health. Indeed, people who have suffered from a flood often find that the social impacts are worse than the financial losses. Further, those who are unprepared suffer more than those who accept that a consequence of deriving benefit from the floodplain is that they may have to cope with one or more floods while they occupy that floodplain.

Public education is therefore an essential element in implementation of a management plan. This is an ongoing task which must be kept alive, for example, through local media and Council activities commemorating flood events and, regular advice from council to affected residents. It needs to be targeted to all areas of flood prone land, not just the area below the DFE, and consider the ramifications of the PMF event.

### Development Controls

Management of development of flood prone land is through a combination of land use restrictions and development controls. These are ideally included within a combination of the relevant Planning Instruments.

## INTERACTION WITH THE LOCAL FLOOD EMERGENCY PLAN

Implementation of management measures can impact on the emergency management planning for floods documented in the local flood plan. Changes in flood behaviour, or flood warning systems, or critical levels for evacuation can impact upon flood response and associated planning. Therefore, it is important that emergency managers be informed of any such changes, as and when they occur, so adjustments, as necessary, can be made to the local flood plan.

A key outcome of the management plan is the formulation of a local flood emergency plan or update of an existing plan. In essence, such a plan would be a succinct written summary of council's Floodplain Risk Management Plan. As such, the plan would serve as a comprehensive introduction to the local community on flooding matters and the management of flooding and its consequences.

An important component of the policy would be council's views on the use and development of flood prone land. Emergency plans, should be reviewed with the flood management plan

and risk management measures implemented under the plan should be reflected in the emergency plans.

Attachment 1680907-1

**Flood Event January 2011**
**Moreton Bay Regional Council - damage cost estimates**

| Service Type | Road, Park or Building Location | Details of Defect / Work Required | Estimated Cost |
|---|---|---|---|
| Parks | Sweeney Reserve - Old Dayboro Road | Replace 2 x dog dispensers and bollards | $1,000 |
| Parks | Sweeney Reserve - Old Dayboro Road | Replace 1 x Park Name Signage | $2,000 |
| Parks | Sweeney Reserve - Old Dayboro Road | Replace various informational signage destroyed by flood waters. | $2,000 |
| Parks | Sweeney Reserve - Old Dayboro Road | Replace 1 x Kompan Swing Element | $4,000 |
| Parks | Sweeney Reserve - Old Dayboro Road | Replace 3 bench seats | $4,500 |
| Parks | Sweeney Reserve - Old Dayboro Road | Replace roof panels from picnic shelter | $5,000 |
| Parks | Sweeney Reserve - Old Dayboro Road | Replace 1 x Kompan water activity play element, unable to assess until trees and vegetation removed from on top of equipment | $5,000 |
| Parks | Sweeney Reserve - Old Dayboro Road | Repair 1 x double swing gate. Unable to assess full extent of damage until trees and vegetation have been removed from on top of equipment. | $5,000 |
| Parks | Sweeney Reserve - Old Dayboro Road | Canoe ramp has erosion and damage to timberwork requiring repair. Unable to assess extent of damage until trees and vegetation have been removed from on top of infrastructure. | $5,400 |
| Parks | Sweeney Reserve - Old Dayboro Road | Replace 1 x Kompan play unit. | $7,000 |
| Parks | Sweeney Reserve - Old Dayboro Road | 2 x Playground rubberised animals washed away - to be replaced. | $7,000 |
| Parks | Sweeney Reserve - Old Dayboro Road | Replace 3 water bubblers | $8,000 |
| Parks | Sweeney Reserve - Old Dayboro Road | Replace 3 x Kompan Spika Elements | $8,000 |
| Parks | Sweeney Reserve - Old Dayboro Road | Bollards and continuous rail fencing to be replaced. Unable to assess requirements until trees and vegetation have been removed from on top of infrastructure. | $10,000 |
| Parks | Sweeney Reserve - Old Dayboro Road | Playground rubber softfall - to be replaced. | $10,000 |
| Parks | Sweeney Reserve - Old Dayboro Road | Removal of rubble from play area, demolition, removal and replacement of damaged infrastructure. | $10,000 |
| Parks | Sweeney Reserve - Old Dayboro Road | Replace 5 x 240 lt gossi litter bins and concrete slabs | $12,500 |
| Parks | Sweeney Reserve - Old Dayboro Road | Replace 1 x Kompan Galaxy play combo unit, unable to assess until trees and vegetation removed from on top of equipment | $15,000 |
| Parks | Sweeney Reserve - Old Dayboro Road | Replace 1 x Peddle Power Velositron and surrounding fencing | $17,000 |
| Parks | Sweeney Reserve - Old Dayboro Road | Playground bark softfall x 176 m3 @$110 - to be replaced. | $19,360 |
| Parks | Sweeney Reserve - Old Dayboro Road | Replace 1 x Kompan double slide element | $20,000 |
| Parks | Sweeney Reserve - Old Dayboro Road | Replace 1 x Kompan Multigoal | $25,000 |
| Parks | Sweeney Reserve - Old Dayboro Road | Exercise Equipment - 3 x Play rope Exercise Elements damaged and requiring repair / replacement. Unable to assess full extent of damage until trees and vegetation have been removed from on top of equipment. | $25,000 |
| Parks | Sweeney Reserve - Old Dayboro Road | Replace timber boat and walkway/bridge. | $30,000 |
| Parks | Sweeney Reserve - Old Dayboro Road | Replace 11 x picnic table / seat settings | $33,000 |
| Parks | Sweeney Reserve - Old Dayboro Road | Replace 1 x Corocord Net Play Element, unable to assess until trees and vegetation removed from on top of equipment | $35,000 |
| Parks | Sweeney Reserve - Old Dayboro Road | Replace 4 Landmark shelters | $60,000 |
| Parks | Sweeney Reserve - Old Dayboro Road | Replace 3 timber octagonal shelters | $60,000 |
| Parks | Sweeney Reserve - Old Dayboro Road | Replace 5 x Christies BBQ | $60,000 |
| Parks | Sweeney Reserve - Old Dayboro Road | Replace dog off leash cyclone wire fencing - 416 lineal metres | $70,000 |
| Parks | Sweeney Reserve - Old Dayboro Road | Remove fallen vegetation. | $80,000 |
| Parks | Pine Rivers Park - Gympie Road | 2 x bollards need reinstating | $200 |
| Parks | Pine Rivers Park - Gympie Road | 10 lm of continous rail fencing needs repair at BMX jumps. | $500 |
| Parks | Pine Rivers Park - Gympie Road | 1x 240 lt gossi bins and concrete slabs damaged and washed away. | $2,500 |
| Parks | Pine Rivers Park - Gympie Road | Playground bark softfall to be replaced. | $20,000 |
| Parks | Pine Rivers Park - Gympie Road | Replacement of shelter. | $15,000 |
| Parks | Pine Rivers Park - Gympie Road | Playground rubber softfall to be cleaned and impact tested. | $5,000 |
| Parks | Pine Rivers Park - Gympie Road | Re-engineering of eroded bank and removal of hyacinth and other storm debris from park. | $70,000 |
| Parks | Bunya Crossing Reserve - Dugandan Rd | Revegetation and reinstatement of eroded embankments.Rock protection, reinstating gravel carpark, road and replacing bollards and other drainage infrastructure. | $50,000 |
| Parks | Bunya Crossing Reserve - Dugandan Rd | Infrastructure - missing and damaged bollards, some with footings exposed. To be replaced. | $2,000 |
| Parks | Bunya Crossing Reserve - Dugandan Rd | River sand/rock/sludge to be removed from lower grass area of the park and car park. | $5,000 |
| Parks | Mathew Hawthorne Park - Lancewood Drive | Flying Fox Rubber softfall 210m/2 @ $203.00. Price for replacement of entire rubber surface as decomposed granite pavement sub grade washed away. Under Review | $42,630 |
| Parks | Stanton Reserve - Tanager St | Revegetation and reinstatement of eroded banks. | $5,000 |
| Parks | Stanton Reserve - Tanager St | Removal of trees and storm debris from parkland. Levelling of eroded sections of the park. | $15,000 |
| Parks | Kim Grayson Park - Country Club Drive | Removal of storm debris from grassed areas in park. | $300 |
| Parks | Kim Grayson Park - Country Club Drive | Removal of tree and other storm debris from creeks. | $500 |
| Parks | Arlington Park - Arlington Drive | 1 x Megatoy swing damaged and removed by crews. New swing needs reinstating. | $3,000 |
| Parks | Camden Park - Bringelly Street | Playground bark softfall x 25 m3 @$110. | $2,750 |
| Parks | Tarnee Park - Tarnee St | Playground bark softfall x 10 m3 @$110. | $1,100 |
| Parks | William Scott Park - Bunya Road | Off leash fence - intall new cable wire and general repairs. | $4,000 |
| Parks | William Scott Park - Bunya Road | Removal of trees and other storm debris from creek line. | $1,800 |
| Parks | Alfredson Park - Collins Rd | Removal of tree debris in park land. | $600 |
| Parks | John Bray Park - Kensington Way | Removal of fallen trees. | $2,500 |
| Parks | Hideaway Estate - Conondale to Lindsay Rd | Reinstate soil and mulch along pathway from Conondale to Lindsay Rd through to natural area. Re-establish10 cubic M soil & 20cubic M mulch. | $700 |
| Parks | Bill Madders Playground - Corvus St | Playground bark softfall x 30 m3 @$110 | $3,450 |
| Parks | Winn Rd and Old School Rd Cnr | Removal of tree down on edge of road. | $700 |
| Parks | Road Reserve - Cedar Creek Rd | Clearing tree debris from road (assisting R&D). | $260 |
| Parks | Andy Williams Park - Cedar Creek Rd | Removal of several trees down, approx 2hrs work for tree crew | $1,500 |
| Parks | Road Reserve - Thompson Rd | Removal / chipping of branches down adjacent to Dakabin Train Station . | $200 |

**Flood Event January 2011**
**Moreton Bay Regional Council - damage cost estimates**

| Service Type | Road, Park or Building Location | Details of Defect / Work Required | Estimated Cost |
|---|---|---|---|
| Parks | Apex Park - Mt Samson Rd | Shelter has gone; BBQ damaged, benches missing. To be reinstated. | $20,000 |
| Parks | Apex Park - Mt Samson Rd | Removal of fallen trees and removal of storm debris in the park. | $10,000 |
| Parks | Henry Bradley Park - Laidlaw Street | Supanova, clean and reinstate | $700 |
| Parks | Henry Bradley Park - Laidlaw Street | Spica bearing replacement | $925 |
| Parks | Henry Bradley Park - Laidlaw Street | Playground bark softfall x 98m3@$110 | $10,780 |
| Parks | Henry Bradley Park - Laidlaw Street | Removal of tree and storm debris around creek area | $500 |
| Parks | Old Plumbers Workshop Hall - Williams Street | All softfall has been washed away - to be replaced. Pool car park has silt and debris through it - to be cleaned. Small trees uprooted and lost all mulch from gardens - debris to be removed and damaged infrastructure reinstated. | $2,500 |
| Parks | Dayboro - Office - Williams Street | Removal of storm debris in rear yard of property and repairs to fence damage. | $500 |
| Parks | Louisa Williams Park - Williams Street | Replacement of mulch washed out of garden beds. | $500 |
| Parks | Dayboro - Cottage - Williams Street | Mulch gone from all gardens - to be replaced. | $1,500 |
| Parks | Williams Street | This park has lost a footbridge and is lodged under the other bridge - demolition and reinstatement required. An amount of debris to be removed. All mulch gone from gardens and requiring replacement. | $6,000 |
| Parks | Lions Park - Williams Street | Debris over parkland, park sign down, mulch gone from gardens - to be reinstated. | $500 |
| Parks | North Pine River - Williams Street | Assist SES/Police with road closures (7.30am till 6.30pm). Labour and signage. | $1,200 |
| Parks | Railway Street Park - Railway Street | Removal of storm debris over parkland and adjacent culvert crossing. Repair damage to neighbouring fenceline and salvage a boat that has been deposited in this adjoining property - origins unknown. | $500 |
| Parks | Roderick Cruise Park | Corocord Climbing net loose at footing. | $400 |
| Parks | Roderick Cruise Park | Drainage in playground needs reinstating. | $2,000 |
| Parks | Roderick Cruise Park | Rubber pad underneath swing requires replacement. | $7,554 |
| Parks | Roderick Cruise Park | Playground bark softfall x 120m3 @$110 | $8,050 |
| Parks | Road Reserve - Laceys Creek | Remove fallen trees and flood debris. | $17,500 |
| Parks | Dohles Rocks Foreshore - Dohles Rock Road | Kopper log barrier needs repair: 2 x 3.6 lm kopper log tops and 2 x posts. | $150 |
| Parks | Dohles Rocks Foreshore - Dohles Rock Road | Aerate and sieve sand for foreign particles - Sivtech | $450 |
| Parks | Kumbartcho CC - Bunya Pine Cout | Pressure clean and sterilise surface area covered with slime | $3,500 |
| Parks | Rivergum Drive Park - Rivergum Drive | Reinstate / repair undermined concrete footpath. | $3,500 |
| Parks | Bowman Park - Lily St | Playground bark softfall x 5 m3 @$110 | $550 |
| Parks | Mimoora Park - Basand St | Playground bark softfall x 10 m3 @$110 | $1,100 |
| Parks | Murlac Park - Montague St | Playground bark softfall x 8 m3 @$110 | $880 |
| Parks | George Willmore Park - Ferny way | Playground bark softfall x 80 m3 @$110 | $8,800 |
| Parks | Pyang Park - Pyang St | Playground bark softfall x 10 m3 @$110 | $1,100 |
| Parks | Balstrup Park - Duffield Road | Playground bark softfall x 40 m3 @$110 | $4,600 |
| Parks | Kingfisher Park - Allison Drive | Playground bark softfall x 10 m3 @$110 | $1,100 |
| Parks | Road Reserve - Old Gympie Rd | Remove / chip branches down on Old Gympie Rd between Ann St and Vinney Av | $200 |
| Parks | Road Reserve - Cnr of Hipathites Rd & Mount Samson Rd | Remove tree across road | $800 |
| Parks | Road Reserve - Basin Rd | Remove / chip fallen trees and flood debris | $17,500 |
| Parks | Road Reserve - Dales Rd | Remove / chip fallen trees and flood debris | $17,500 |
| Parks | Road Reserve - Pringles Rd | Remove / chip fallen trees and flood debris | $17,500 |
| Parks | Mick Hanfling Park - Torrens Rd | Remove / chip branches down in Mick Hanfling Park near picnic shelters | $300 |
| Parks | Road Reserve - Narangba Rd | Pick up and chip branches down various locations on Narangba Rd between Gair Rd & Torrens Rd | $200 |
| Parks | Lawnton Pocket Rd - AFL | Repair electric pumps and replace the electronic switchboard system which supports pumping system. Floodwater over irrigation pumps - AFL & Junior AFL fields. | $3,500 |
| Parks | Leis Park - Leis Parade | 1 x sliprail needs repair | $500 |
| Parks | Leis Park - Leis Parade | 30 lm of playground concrete edging missing - to be reinstated. | $1,550 |
| Parks | Leis Park - Leis Parade | 1 x picnic settings damaged @ $3000 each - to be repaired. | $3,000 |
| Parks | Leis Park - Leis Parade | Playground bark softfall x 105 m3 @$110 - to be reinstated. | $3,600 |
| Parks | Leis Park - Leis Parade | 1 x 5 lm swing gate needs repair/replacement | $4,000 |
| Parks | Leis Park - Leis Parade | Playworks Whizzer needs repair to bearing | $4,436 |
| Parks | Leis Park - Leis Parade | 1 x shelter needs timber repairs | $5,000 |
| Parks | Leis Park - Leis Parade | Playworks ski style swing damaged and needs repair | $7,500 |
| Parks | Leis Park - Leis Parade | 120 lm of bollards need repair and replacement | $8,000 |
| Parks | Leis Park - Leis Parade | 1 x Christies BBQ damaged beyond repair - to be replaced. | $12,000 |
| Parks | Leis Park - Leis Parade | 360 lm of Kopper log fencing requires repair and replacment (Bollard Costing as replacement) | $24,000 |
| Parks | Leis Park - Leis Parade | Playworks climbing net washed out and moved off footings - to be replaced. | $15,000 |
| Parks | Leis Park - Leis Parade | Remove trees and storm debris from parkland. Reinstate internal roadways. Undertake bulk earthworks to return grades of the parkland. | $100,000 |
| Parks | Paisley Park - Gympie Rd | Remove and chip debris along school fence. | $1,500 |
| Parks | Ron Thomason Park - Todds Rd | Pressure clean concrete footpath covered in mud. | $400 |
| Parks | Stephen Lawn Park - Bray Rd | Remove approx.100 cubic metres soil/sand piled in park, needs to be removed, many truck loads of debris and trees to be removed. | $6,000 |
| Parks | Road Reserve - Rusty's Lane | Remove and chip trees fallen across road. | $400 |
| Parks | Road Reserve - Lindsay Road | Undertake emergency response to remove and chip tree across Road - Lindsay Road . | $200 |
| Parks | Road Reserve - Mt Brisbane Road | Undertake emergency response to remove and chip trees across road: 3 separate landslips. | $600 |
| Parks | Road Reserve - Mt Pleasant Road | Undertake emergency response to remove and chip trees across road. | $600 |
| Parks | Road Reserve - Brays Rd | Remove split tree on Brays Rd. | $200 |

**Flood Event January 2011**
**Moreton Bay Regional Council - damage cost estimates**

| Service Type | Road, Park or Building Location | Details of Defect / Work Required | Estimated Cost |
|---|---|---|---|
| Parks | Road Reserve - Ogg Rd | Undertake emergency response to remove and chip tree across road. | $400 |
| Parks | Road Reserve - Pine River Drive | Remove and chip branches down (near bus stop) on Pine River Dr. | $200 |
| Parks | Road Reserve - Pine River Drive | Attend to After Hours Call Out (assist Police) - Tree across road. | $400 |
| Parks | Roderick Cruice River Tce Park - Avonlea Street | Salvage shipping container in river. Heavy vehicle recovery to winch out and Council float to Burpengary depot. | $700 |
| Parks | Creekside Park | Alphatonia Ct to Lookout Place - Reinstate pathway edge back fill with soil. Re-mulch Gardens. Re-stake trees. Numerous trees down in water way restricting water flow. Est. 10cubic m soil & 50 cubic m mulch. | $3,100 |
| Parks | Creekside Park | Between Hideaway Cl & RiverOak way - Re-instate rock and geofabric cloth in drain way. Parkland from Hideaway Close along Riveroak Way. | $450 |
| Parks | Creekside Park | Hideaway Close - Back fill with Rock (2cubic metre) and soil (2 cubic metre) Parkland off Hideway Place Narangba. Creek bank erosion. | $1,200 |
| Parks | Greenways Park | Magenta Cr to Cootamundra Dr - Re-instate soil fill & mulch along path edge. 1x foot bridge edge board replace. Greenways Park Narangba Pathway MagentaCr to Cootamundra Dr. | $150 |
| Parks | Greenways Park | Ridgeview Dr - Re-instate fill around headwall Re-instate fill along pathway. Est. 6cubic M soil & 20cubic M mulch. 2 x photos of pathway bridge & 2 x photo of pathway behind 69 Ridgeview Dr. Narangba | $750 |
| Parks | MacDonald Dr Reserve - Macdonald Dr | Replace rock fill and garden edging. Parkland/Lake along Macdonald Dr Narangba. | $260 |
| Parks | RiverOak Way - Golden Wattle to Wanderer Ct | Re-instate soil fill and mulch pathway from golden Wattle to Wanderer Ct | $500 |
| Parks | Road Reserve - Oakey Flat Rd | Remove tree in creek: Shultz Bridge (assisting R&D) | $220 |
| Parks | Stony Creek Reserve - Creekside Drive | Re-instate Garden edging and mulch Re-instate rock and GEO fab cloth. Stony Creek Reserve of Creekside Dr & Riveroak way. | $1,200 |
| Parks | Merv Ewart Reserve - Youngs Xing Rd | Remove and chip large fallen trees at the Youngs Crossing end of the Park. | $15,000 |
| Parks | Mungarra Reserve | Affleck Crescent - 2 x picnic settings damaged @ $3000 each | $6,000 |
| Parks | Mungarra Reserve | Affleck Crescent - 70 lm of dog off leash fencing remove and repair | $40,000 |
| Parks | Mungarra Reserve | Affleck Crescent - 3 x bench seats need replacing around lake @1500 each | $4,500 |
| Parks | Mungarra Reserve | (Colby Place) - Carmody Court - Canoe ramp requires reinstating | $6,000 |
| Parks | Mungarra Reserve | Affleck Crescent - Reinstatement of the skate ramps | $8,000 |
| Parks | Mungarra Reserve | Midson Avenue to Afflect Avenue - Collect branches & flood damaged trees on bicycle pathways | $2,200 |
| Parks | Mungarra Reserve | Young's Crossing to Afflect Avenue - Collect branches & flood damaged trees on bicycle pathways | $2,200 |
| Parks | Mungarra Reserve | Affleck Crescent - Remove and chip trees down on the entrance road and debris around the boom gate. Clear other trees down through the park. | $8,000 |
| Parks | North Pine Country Park - Dayboro Rd | Remove and chip many trees down around the rear car park area. | $30,000 |
| Parks | Road Reserve - 17 Washbrook Cr | Emergency response to attend tree down (cnr of Markwell Court & Washbrook Cr) | $400 |
| Parks | Road Reserve - Old Gympie Rd | Collect branches & flood damaged trees in Wyllie Park | $880 |
| Parks | Wyllie Park | Exercise Equipment - Anzac Avenue - Clean service equipment and rubber reinstate footings where required | $4,400 |
| Parks | Wyllie Park | Anzac Avenue - Reinstate and repair fence along riverbank. | $12,000 |
| Parks | Wyllie Park | Gympie Rd - Remove and chip numerous trees down (Tree Crew). Revegetate and reinstate the river bank that has eroded. Pressure clean silt on paths and over shelters and seats, mulch gone from gardens (Wes Porter). | $10,000 |
| Parks | Youngs Crossing Road | Remove and chip trees fallen and damaged along this area near the crossing itself and on the embankment . | $5,000 |
| Parks | Uralba Park - Westwood Drive | Playground sand softfall x 10 m3 @ $120 | $1,150 |
| Parks | Uralba Park - Westwood Drive | Playground infrastructure damaged and requires repair and replacement. | $6,000 |
| Parks | Uralba Park - Westwood Drive | Remove and dump large rocks, covered over grass surface of park. | $2,500 |
| Parks | Uralba Park - Westwood Drive | Reinstate creek line wash outs. | TBA |
| Parks | Undambi Rotary Reserve - Mt O'Reilly Road | Reinstate / revegetate bushland and creek line area small amout of trees/mulch/creek batters washed away. | $350 |
| Parks | Undambi Rotary Reserve - Mt O'Reilly Road | Repair minor wash outs in open grass area to be reinstated. | $500 |
| Parks | Road Reserve - Basin Rd | Remove and chip tree down front entrance of cemetery. | $800 |
| Parks | Bob Bell Park - Learmonth Street | Playground sand sof tfall to be cleaned. | $5,000 |
| Parks | Odempa Park - Gray St | Playground bark softfall x 10 m3 @$110 to be reinstated. | $1,100 |
| Parks | Peter Campbell Park 2 - Ebon Court | Playground bark softfall x 50m3 @$110 to be reinstated. | $5,750 |
| Parks | Pitonga Way - Dixon Street | Repair / reinstate the concrete footpath that has fallen into river. Reinstate severe embankment erosion, requires engineering solution. | $50,000 |
| Parks | Rob Akers Reserve - Lawnton Pocket Rd | Pressure clean mud covering entire area. Remove minor amounts of debris with job trucks and a loader when drier. | $3,000 |
| Parks | Road Reserve - 11 Grant Street | Collect and dispose of tree debris. | $800 |
| Parks | Belair Estate | Repair / reinstate 20m deco path | $19,000 |
| Parks | Belair Estate | Reinstate / repair birdcage, footpath , and remove and chip storm fallen trees and debris | $30,000 |
| Parks | Kendall Rd. Park - Kendall Road | Sand x 10mtr | $1,100 |
| Parks | Moleny Plce | Eroded areas,Remulch/Stabilise | $29,000 |

**Flood Event January 2011**
**Moreton Bay Regional Council - damage cost estimates**

| Service Type | Road, Park or Building Location | Details of Defect / Work Required | Estimated Cost |
|---|---|---|---|
| Parks | Verge Plce Pk | Replace / repair damaged Trees | $4,500 |
| Parks | Arboretum | Signs to be replaced | $6,000 |
| Parks | Arboretum | 600m3 mulch to be replaced. | $30,600 |
| Parks | Arboretum | Backfill electrical trench. | $5,000 |
| Parks | Arboretum | Remove and chip fallen trees and storm debris - open areas | $5,000 |
| Parks | Arboretum | Replace / reinstate safety fence pipe over river | $15,000 |
| Parks | Arboretum | Replace 100m footbridge safety rail | $35,000 |
| Parks | Arboretum | Remove boat/trailer/horse float and other storm debris | $25,000 |
| Parks | Arboretum | Remove silt/ debris/ trees from footpaths | $40,000 |
| Parks | Bert Webster Park - Park Street | Replace sand x 10mtr | $1,100 |
| Parks | Centenary Lakes | Floodwaters damaged fences - Athletics - 4' high chain wire fence and gates destroyed adjacent to Athletics long jump pit. | $10,000 |
| Parks | Centenary Lakes | Netball courts covered in a thick layer of silt and mud | $35,000 |
| Parks | Centenary Lakes | Little Athletics, 2 x shot put wire fences plus 152 m chain wire fence and posts plus 150 x 1 m rubber coating on track, silt to be removed, replace 60m3 of sand | $40,000 |
| Parks | Centenary Lakes | 1,000 m3 mulch to replace wash away | $51,000 |
| Parks | Centenary Lakes | Replace flood damaged fence around veladrome | $1,100 |
| Parks | Centenary Lakes | Replace flood damaged fence at BMX track | $1,700 |
| Parks | Centenary Lakes | Friendship Pk Soft fall bark 20m3 | $2,200 |
| Parks | Centenary Lakes | Replace 96mtr of fence behind netball courts | $3,700 |
| Parks | Centenary Lakes | Fountain pump pull out and clean river pumps, pull and clean x 3 | $4,000 |
| Parks | Centenary Lakes | Floodwater over irrigation controllers - Rugby League - Replacement of 16 station 'scorpio' of Irrenet irrigation system need to be replaced. | $4,700 |
| Parks | Centenary Lakes | Floodwater over irrigation controllers -Netball - Replacement of 16 station 'scorpio' of Irrenet irrigation system need to be replaced. | $4,700 |
| Parks | Centenary Lakes | Floodwater over irrigation controllers -Athletics - Replacement of 16 station 'scorpio' of Irrenet irrigation system need to be replaced. | $4,700 |
| Parks | Centenary Lakes | Floodwater over irrigation pumps - Netball - Replace damaged electric pumps and replace the electronic system which supports pumping system | $5,000 |
| Parks | Centenary Lakes | Floodwater over irrigation pumps - Athletics - Replace damaged electric pumps and replace the electronic system which supports pumping system | $5,000 |
| Parks | Centenary Lakes | Replace sand 50m3, Apex Pk plus excavation,removal and dumping of contaminated softfall | $5,500 |
| Parks | Centenary Lakes | Tennis Crts 20m fence , debris | $7,000 |
| Parks | Centenary Lakes | Flood damage to rubber soft fall around exercise equipment | $9,400 |
| Parks | Centenary Lakes | River pumps, pull and clean x 3 | $12,000 |
| Parks | Centenary Lakes | Replace 485 mtr. Bollards around car parks | $13,100 |
| Parks | Centenary Lakes | Mud on buildings,paths,starter ramp and tunnel, roads on the BMX track need repair | $25,000 |
| Parks | Centenary Lakes | Reinstate the riverwalk footpath ,mud, trees, debris and infrastructure | $18,000 |
| Parks | Centenary Lakes | Centenary Lakes Footpath, mud to be removed. | $20,000 |
| Parks | Centenary Lakes | Remove mud and debris from fences (pressure clean) | $30,000 |
| Parks | Centenary Lakes | Remove silt, replace footpath road base, 50m x 1.2m x100mm tree removal. Apex Park, | $30,000 |
| Parks | Centenary Lakes | Replace / reinstate 110 m arc mesh fence and posts replace footpath from entrance Centenary Lake to Elliott St , lakeside Morayfield Road | $70,000 |
| Parks | Linfield Dve Park - Linfield Drive | Silted sandpits - Replace sand x 20 mtr | $2,200 |
| Parks | Platypus Creek Park - Julie Drive | Bark x 60mtr plus excavation,removal and dumping of contaminated softfall | $6,600 |
| Parks | Ruby Park - Paulsen Street | Silted sandpits - Replace sand x 10mtr | $1,100 |
| Parks | Reserve adjacent to Weir | Remove and chip tree and storm debris, signs,2 x 2 m rails missing | $15,000 |
| Parks | Beach Park - Beach Road | Replace mulch / bark x 20mtr | $2,200 |
| Parks | Twinview Park - Twinview Road | Silted sandpits - Replace sand x 5mtr | $550 |
| Parks | Devine Ct | Cricket & Soccer -Floodwater over irrigation pumps - Cricket/ Soccer - Replace damaged electric pumps and replace the electronic system which supports pumping system | $5,000 |
| Parks | Arthur Allan Park - Kirkaldy St | Repair 12m deco path Arthur Allan Pk | $4,000 |
| Parks | Oxley Avenue - Athletics, Cricket & school usage | Floodwater over irrigation pumps - Athletics, Cricket & school usage - Repair electric pump and replace the electronic system which supports pumping system. | $3,500 |
| Parks | Redcliffe beaches | Removal of storm debris deposited on Redcliffe beaches from Brisbane River | $500,000 |
| Parks | McGahey Street - AFL | Floodwater over irrigation pumps - AFL - Repair damaged electric pump and replace the electronic system which supports pumping system. | $3,500 |
| Parks | Bilinga Crt. Park - Bilinga Court | Replacement of Sand x 20mtr | $2,200 |
| Parks | Bestman Rd East | Cricket/ Junior AFL - Floodwater over electronic swithboard - Cricket/ Junior AFL - Repair damaged electric swithboard which supports pumping system. | $1,500 |
| Parks | War Vet's Park - D'Aguilar Highway | Bark x 5mtr - to be reinstated. | $550 |
| Parks | Campbells Pocket Rd - Athletics, Hockey & Cricket | Replacement / repair of 100 metres of 65mm 'main pressure' main line polyethyline pipe with fittings. Pipe transversed creek from the pumping equipement to the storage tanks. Pipe has been destroyed. | $5,000 |
| Parks | Campbells Pocket Rd - Athletics, Hockey & Cricket | 2 x Bore pump switchboardsand 2 x associated pressure tanks | $5,900 |
| Parks | Campbells Pocket Rd - Athletics, Hockey & Cricket | Reinstate creek access point to allow crossing to service pumps and allow tractors access to mow and maintain parkland. Replacement of 10 cubic metres of rock placement and shaping | $10,000 |
| Parks | Ironbark Dr Park - Ironbark Drive | Bark x 30m3 - to be reinstated. | $3,300 |
| Parks | Tilney Park - Coronation Avenue | Sand x 10m3 - to be reinstated. | $1,000 |
| Parks | Rugby League - Neurem Rd | Floodwater over irrigation comtrollers - Rugby League grounds - Replacement of 16 station 'scorpio' of Irrenet irrigation system need to be replaced. | $4,700 |

**Flood Event January 2011**
**Moreton Bay Regional Council - damage cost estimates**

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|---|---|---|---|
| Parks | Touch & Cricket - Neurem Rd | Floodwater over irrigation comtrollers - Touch fields - Replacement of 16 station 'scorpio' of Irrenet irrigation system need to be replaced. | $4,700 |
| Parks | Rugby League - Neurem Rd | Floodwater over irrigation pumps - Rugby League grounds - Replace damaged electric pumps and replace the electronic system which supports pumping system | $5,000 |
| Parks | Touch & Cricket - Neurem Rd | Floodwater over irrigation pumps - Touch football Cricket grounds - Replace damaged electric pumps and replace the electronic system which supports pumping system | $5,000 |
| Parks | Burpengary Equestrian Centre - Rowley Rd | Undertake Soil Testing for assessment of E coli levels. | $500 |
| Parks | Riding For The Disabled (MBRC) | Playground Softfall washed out 80 m3 @ $110 - to be replaced. | $8,800 |
| Parks | Cartmill Centre of Burpengary Riding for the Disabled Inc - Kilkenny Dve | Undertake Soil Testing for assessment of E coli levels. | $500 |
| Parks | Greenways Park | Removal of Flood debris from gardens and reinstate mulch | $13,000 |
| Parks | Hedges Ave Park | Reinsate flood affected gardens | $6,500 |
| Parks | New Settlement Road | Reinsate flood affected gardens | $3,500 |
| Parks | Sandstone Point | Sandstone Point has a track down the escarpment to the beach. The boxed in deco needs topping up | $6,000 |
| Parks | Grogan Rd Park | Repair track damage, still partly flooded, tracks have been closed needs further inspection once it dries out. | $20,000 |
| Parks | Mungarra Reserve | Removal and chipping of trees over concrete pathway. Repair / reinstatement of concrete pathway. Removal of trees within planting area and replanting and mulching required | $35,000 |
| Parks | John Oxley Reserve | Remove and chip fallen trees, Repair bitumen pathways and repair damage and remove mud on Boardwalk | $6,000 |
| Parks | Dave Burton Park | Repair Rec Trail erosion | $6,000 |
| Parks | Laurie Smith Gardens | Repair Rec Trail erosion | $6,000 |
| Parks | Edward Alison Park | Remediation of silted areas. Remove and repair damaged trees. Repair park access road also damaged. | $8,000 |
| Parks | Doug Stevens Park | Remove and chip trees down over pathways. Remediate erosion on Rec Trail (blue metal and approaches to boardwalks) | $10,000 |
| Parks | Sargents Reserve | Trees down on causeways, erosion to approaches to causeways | $10,000 |
| Parks | Bunya Riverside | Repair erosion of pathway, remove water over rec trail and remove and chip trees and logs over recreation trail. | $20,000 |
| Parks | Samford - CSIRO | Repair / reinstate pathway erosion. | $12,000 |
| Parks | Trentham Park | Grading and slashing of Blue Metal Track | $7,500 |
| Parks | Domrow Rd - North | Repair / remediation of erosion of Blue metal and pathway | $7,500 |
| Parks | Pony Club Rec Trail | Repairs to slope and erosion on hills | $7,500 |
| Parks | Remington Place | Repairs / remediation of erosion. | $7,500 |
| Parks | Mt Mee Rd Rec Trail Under bridge | Repairs to erosion caused on causeway. | $10,000 |
| Parks | Rush Creek Bridge | Undertake desilting and erosion control on possible missing part of trail | $30,000 |
| Parks | Dayboro - Dayboro Rd Rec Trail near Forbes Creek | Grading and drainage of blue metal track. | $8,000 |
| Parks | Days Rd Rec Trail | erosion | $20,000 |
| Parks | Sheep Station Ck Con Park | Removal and chipping of trees down and repairs to track damage | $20,000 |
| Parks | Apex Park - Mt Samson Rd | Repairs to track damage, replanting of areas damaged by overland flow. | $17,000 |
| Parks | Neilson Road Rec Trail | Remove and chipping of fallen trees. Repairs / remediation of eroded recreation trails. | $15,000 |
| Parks | Gympie Rd -Bald Hills Flats | Reinstallation of mulch on large garden area along the Bald Hills Flats. | $16,885 |
| Parks | Old Northern Rd - Keong Rd | Reinstatement of mulch into garden beds and levelling of turfed areas. | $8,250 |
| Parks | Greenways Park | Remove and reinstate damaged section of footpath and bridge | $9,000 |
| Parks | Dayboro | Repairs to fencing surrounding perimeter of soccer fields | $7,000 |
| Parks | Mount Pleasant | Fire Trail damage 3 x crossings, major concrete, pipe or rock needed. | $50,000 |
| Parks | Townsend Rd Reserve | Fire Trail damage 1 x crossings, pipe or rock needed, erosion on trail. | $15,000 |
| Parks | Brian Burke Reserve | Fire Trail damage 3 x crossings, pipe or rock needed, erosion on trail. | $30,000 |
| Parks | Dean Drive Reserve | Fire Trail damage 3 x crossings, pipe or rock needed, erosion on trail. | $30,000 |
| Parks | Retreat Court Reserve | Fire Trail damage 1 x crossings, pipe or rock needed, erosion on trail. | $8,000 |
| Parks | Yarral - Yarral Reserve | Fire Trail damage 1 x crossings, pipe or rock needed, erosion on trail. | $10,000 |
| Parks | Dawn Road Reserve | Fire Trail damage 2 x crossings, pipe or rock needed, erosion on trail. | $20,000 |
| Parks | Hepatitis Road Reserve | Fire Trail damage 2 x crossings, pipe or rock needed, erosion on trail. | $10,000 |
| Parks | Eatons Crossing Rd Rec Trail | Rec Trail erosion, grading needed. | $6,050 |
| Parks | South Pine Rd Reserve | Removal of tree debris - reinstatement of Cashs Crossing Rec Trail | $800 |
| Parks | Youngs Crossing Reserve | Replace cultural heritage interpretive marker. | $960 |
| Parks | Mt Glorious Rd Rec Trail opp Sunset Grove | Rec trail - repair/ construction creek crossing with pipes, headwalls & erosion. | $7,390 |
| Parks | Mt Glorious Rd Rec Trail | 3x creek crossings | $7,000 |
| Parks | Valray Place Rec trail | Rec trail - repair/ construction creek crossing with pipes, headwalls & erosion. | $7,210 |
| Parks | Jagerra Crt/ Hills rec Trail | Repair 2x crossings | $10,802 |
| Parks | Greggs Rd Rec Trail | Repair rec trail & 3x crossings | $9,000 |
| Parks | Glorious Drive Rec Trail | Trail bog spots & erosion | $4,000 |
| Parks | Alison Booker Reserve | Fire trail erosion | $5,000 |
| Parks | Dayboro - Dayboro Rd - Rd Rec Trail various spots | Bog spots & erosion | $3,000 |
| Parks | Narangba Road Reserve | Fire trail erosion | $8,000 |
| Parks | Gibson Court Reserve Rec Trail | Large section of trail washed away | $20,000 |
| Parks | Rafting Grounds - Short St | Playground - fencing washed away ~ 20m | $1,300 |
| Parks | Westbourne Park | Playground bark softfall x 15 m3 @$110 - reinstate | $1,650 |
| Parks | Beech Drive Park | Playground bark softfall x 36m3 @$110 - reinstate | $3,960 |
| Parks | Henry Clench Park | Forpark slide damaged with large log on top of element | $1,500 |

**Flood Event January 2011**
**Moreton Bay Regional Council - damage cost estimates**

| Service Type | Road, Park or Building Location | Details of Defect / Work Required | Estimated Cost |
|---|---|---|---|
| Parks | Brian Daley Park | Repair trail & creek crossings x 2 | $14,945 |
| Parks | Douglas Franklin Reserve | Rec trail erosion & subsidence | $20,000 |
| Roads | Leis Park - road to boat ramp | Replace/ repair | $30,000 |
| Roads | Laidlaw Rd | Pavement Fails - 41m2 | $4,100 |
| Roads | Ladies Rd | Shoulder slip | $40,000 |
| Roads | Cedar Creek Rd - near 202 | Slip previously part of Cedar Creek Rectification 7022307W | $60,000 |
| Roads | Cedar Creek Rd - opposite 760 | Slip previously part of Cedar Creek Rectification 7022307W | $3,000 |
| Roads | Cedar Creek Rd - near 703 | Slip previously part of Cedar Creek Rectification 7022307W | $10,000 |
| Roads | Wirth Rd - 7th Crossing | Causeway washed away. | $40,000 |
| Roads | Wirth Rd - 8th Crossing | Causeway washed away. | $40,000 |
| Roads | Wirth Rd - 9th Crossing | Causeway washed away. | $40,000 |
| Roads | Robbs Rd - 5 sites | Pavement Fails - Total 3990m2 - 240m2 + 636m2 + 672m2 + 624m2 + 1818m2 | $179,550 |
| Roads | Clark Rd - 1 site | Pavement Fails - 360m2 | $300,000 |
| Roads | Bleakley Park East - Sandy Cr - off Strathford Ave | Rock protection around bridge abutment slipped away from main bank leaving a gap of about .5m | $15,000 |
| Roads | Laceys Creek Rd - 1220 | Crossing washed away - filled with gravel for resident's access. | $70,000 |
| Roads | Lawnton Pocket Rd | Stabilisation Programme - 600lm | $180,000 |
| Buildings | Buchanans Park | BBQ - Single Plate: Repair - Wash Out and Clean Control Boxes, element and plate. Spray all components with Electraclean & CRC. Power up and Test. Replace Faulty Components as required. | $3,000 |
| Buildings | Buchanans Park | Electrical Switchboards(2): Repair: - Wash Out and Spray all components with Solvent& CRC. Power Up and Test. Replace Circuit Breakers with new as necessary | $3,500 |
| Buildings | Riding For The Disabled (MBRC) | Toilets: Remove Mud and Sludge, Replace cisterns and components as required. All Buildings, Switchboards - Wash Out and Spray all components with Solvent& CRC. Power Up and Test. Replace Circuit Breakers with new as necessary. Sewerage Pumping Station: Clean and remove debris. Repair / replace electronic components for telematry. Power up and Test. | $11,051 |
| Buildings | Station Street - #184 - MBRC | Roof Leaks - Remove sheets, Application of sealants replace sheets: , A/C Duct - Remove and replace wet sections - (Tenanted Leased Premises) | $4,600 |
| Buildings | Centenary Lakes | Hexagon toilets: remove mud and sludge; replace cisterns and components as required. All building switchboards: wash out and spray all components with Solvent & CRC. Power up and test. Replace circuit breakers with new as necessary. | $4,000 |
| Buildings | Centenary Lakes | Tennis Club - Toilets: Remove Mud and Sludge, Replace cisterns and components as required. All Buildings, Switchboards - Wash Out and Spray all components with Solvent& CRC. Power Up and Test. Replace Circuit Breakers with new as necessary. | $5,000 |
| Buildings | Caboolture | Caboolture Rugby League Football Club - Repair field lighting: wash out and clean control box. Wash out and clean (6) poles. Spray all components with solvent and CRC. Power up and test. Replace faulty items as necessary. | $8,000 |
| Buildings | Centenary Lakes | Sewer pump station (SPS)(2): remove and clean debris . Repair and replace electronic components and telematry as necessary. Power up and test. | $9,000 |
| Buildings | Centenary Lakes | Caboolture Netball Association - Replacement of Internal cupboards / fittings. | $10,000 |
| Buildings | Centenary Lakes | Tennis Club - Replacement of internal cupboards / fittings. | $10,000 |
| Buildings | Centenary Lakes | Electrical pumps (River / Fountain / Circulation). Wash out and clean control boxes. Spray all components with solvent & CRC. Power up and test. Replace faulty items as required. | $10,000 |
| Buildings | Centenary Lakes | Little Athletics - Replacement of Internal cupboards / fittings. | $12,000 |
| Buildings | Centenary Lakes | Caboolture Netball Association - Building Removal of Sludge - Mud by use of pressure cleaners | $0 |
| Buildings | Centenary Lakes | Little Athletics - Building Removal of Sludge - Mud by use of pressure cleaners | $0 |
| Buildings | Centenary Lakes | BMX Club - Building - Removal of Sludge - Mud by use of pressure cleaners | $0 |
| Buildings | Centenary Lakes | Tennis Club - Building Removal of Sludge - Mud by use of pressure cleaners - Excluding the Tennis Courts | $0 |
| Buildings | Centenary Lakes | Little Athletics - Electrical Switchboards, Field Poles and Canteen. Wash out and clean Control Boxes (8) Wash out and Clean Switchboard in Canteen. Spray with Solvent and CRC. Power and Test. Replace Faulty Components | $0 |
| Buildings | Centenary Lakes | BMX Club - Electical Switchboards: Wash and Clean Switchboards. Wash and clean sub-boards. Wash and clean Pole Control Boxes. Spray all components with Solvents and CRC. Power up and Test. Replace Faulty Items as required. | $0 |
| Buildings | Centenary Lakes | Tennis Club - Electical Switchboards: Wash and Clean Switchboard. Wash and clean poles. Spray all components with CRC. Power up and Test. Replace Faulty Items as required. | $0 |
| Buildings | Centenary Lakes | Electical Switchboards: Wash and Clean Switchboards. Spray all components with Solvents and CRC. Power up and Test. Replace Faulty Items as required. | $0 |
| Buildings | Centenary Lakes | BMX Club - Toilets - Remove Mud and Sludge, Replace cisterns and components as required. All Buildings, Switchboards - Wash Out and Spray all components with Solvent& CRC. Power Up and Test. Replace Circuit Breakers with new as necessary. | $9,000 |

**Flood Event January 2011**
**Moreton Bay Regional Council - damage cost estimates**

| Service Type | Road, Park or Building Location | Details of Defect / Work Required | Estimated Cost |
|---|---|---|---|
| Buildings | Centenary Lakes | BBQ Double Plates (5) Wash Out and Clean Control Boxes, elements and plates. Spray all components with Electraclean & CRC. Power up and Test. Replace Faulty Components as required. | $15,000 |
| Buildings | Centenary Lakes | Main Electrical Switchboard: Wash out and clean Switchboard, Srpay board with solvent. Spray components with CRC. Remove all components and Soak in Solvent. Test all Components. Reinstall all components which pass. Replace Faulty Items. Power up and Test. Replace electrical Faulty Items. | $100,000 |
| Buildings | Centenary Lakes | BMX Club - Replacement of Internal cupboards / fittings. | $12,000 |
| Buildings | Centenary Lakes | Southbound side of road oppos entry to Apex Park - Signage frame and skin - permanent sign to promote Urban Country Music Festival plus various banners | $6,000 |
| Buildings | Caboolture Pool | Replacement & repair of damaged shade sails. | $5,200 |
| Buildings | Caboolture Pool | Water quality: back wash as necessary. Add chemicals as required to obtain set levels. | $3,000 |
| Buildings | Depot Park | Toilets: remove mud and sludge; replace cisterns and components as required. All building switchboards: wash out and spray all components with Solvent & CRC. Power up and test. Replace circuit breakers with new as necessary. | $400 |
| Buildings | Sheepstation Creek | Toilets: Clean pipework free of sludge. Apply Solvents to valves. Reset and replace as necessary. | $650 |
| Buildings | Devine Ct | Dog Obedience - (MBRC) - Electrical swichboards, light tower control gear. Wash out and clean control boxes; wash out and clean switchboards. Spray with Solvent and CRC. Power and test. Replace faulty components. | $225 |
| Buildings | Toorbul Caravan Park | Sewerage treatment farm (EPA). Remove excess sludge and effluent. Test for quality. Adjust as necessary. Test pump for serviceability. Wash and clean switchboards, replace indicator lights as necessary. Power up and test. | $3,000 |
| Buildings | Cruice Park | Toilets & hydraulics; remove excess effluent and sludge . Pressure clean facility. Wash and clean electrical pumps and switchboards. Spray with solvents and CRC. Power up and test. Replace faulty components as necessary. | $2,500 |
| Buildings | Woodford Showgrounds | BBQ - Single plate (2): wash wut and clean control boxes, elements and plates. Spray all components with Electraclean & CRC. Power up and test. Replace faulty components as required. | $3,400 |
| Buildings | Woodford Showgrounds | Toilets, all buildings, switchboards, lighting control gear. Wash and clean switchboards. Wash and clean sub-boards. Wash and clean pole control boxes. Spray all components with Solvents and CRC. Power up and test. Replace faulty items as required. Check all cisterns and test. Replace items as necessary. Pressure clean buildings. | $31,200 |
| Buildings | Archer Street | TOILETS: Presure clean to remove mud and sludge | $700 |
| Buildings | Saleyards (MBRC) | Toilets Presure clean to remove mud and sludge | $700 |
| Buildings | Sweeney Reserve - Old Dayboro Road | Removal of sludge from building. Mud to be removed from all park Buildings & Facilities' assets. | $5,000 |
| Buildings | Sweeney Reserve - Old Dayboro Road | Two Toilet blocks - one with minor damage & one major damage requiring - REBUILD TOILET BLOCK - Replace roof structure /side screens doors/partitions/toilets. | $50,000 |
| Buildings | Sweeney Reserve - Old Dayboro Road | Repair damaged shelters throughout park. | $60,000 |
| Buildings | Sweeney Reserve - Old Dayboro Road | BBQ'S - replace single plate. | $3,000 |
| Buildings | Sweeney Reserve - Old Dayboro Road | BBQ'S - three (3) double plates to be replaced. | $4,000 |
| Buildings | Leis Pde - Park | Building Removal of Sludge - Mud to all park B&F assets | $1,000 |
| Buildings | Leis Pde - Park | Septic system | $2,000 |
| Buildings | Leis Pde - Park | BBQ'S - Double Plate | $8,000 |
| Buildings | Leis Pde - Park | REBUILD TOILET BLOCK - Replace brick side screen/ door/partition/toilet | $10,000 |
| Buildings | Leis Pde - Park | Shelter to BBQ area | $4,000 |
| Buildings | Pine Rivers Park | Toilets & sewer pump station to be repaired. | $1,200 |
| Buildings | Pine Rivers Park | Building: removal of mud | $5,000 |
| Buildings | Pine Rivers Park | Main swichboard to stage area / lighting structures / bollards | $55,000 |
| Buildings | Dayboro - Pool | Pool plant room to be checked and repaired as needed. | $2,000 |
| Buildings | Dayboro - Pool | 25 metre pool concourse | $2,000 |
| Buildings | Dayboro - Pool | 25 metre pool concourse | $5,000 |
| Buildings | Dayboro - Pool | 25 metre and toddler pools to be repaired. | $6,000 |
| Buildings | Dayboro - Pool | Replacement of Heating units | $100,000 |
| Buildings | Dayboro - Pool | Heating units to be repaired / replaced. | $4,000 |
| Buildings | Dayboro - Art Gallery | External wall sheeting to be repaired and repainted. | $600 |

**Flood Event January 2011**
**Moreton Bay Regional Council - damage cost estimates**

| Service Type | Road, Park or Building Location | Details of Defect / Work Required | Estimated Cost |
|---|---|---|---|
| Buildings | Dayboro - Art Gallery | External footpath to be repaired. | $1,000 |
| Buildings | Dayboro - Credit Union | Office / meeting room carpet to be replaced. | $6,000 |
| Buildings | Dayboro - Council Assets | Electrical testing at Dayboro Poo l / Council Depot / Credit Union building / Hay Cottage / Tourist info building / Art Gallery to check damage after inundation. | $3,000 |
| Buildings | Mt Glorious Rd | LED early warning sign to be replaced. | $2,000 |
| Buildings | Morayfield Sports and Leisure Centre | Repair roof leaks: remove roof sheeting, application of sealants, replace roofing screws . | $2,600 |
| Buildings | Woodford Community Hall | Repair Roof Leaks: Remove roof sheeting, application of sealants, replace roofing screws | $6,000 |
| Buildings | Hasking Street #2 and King Street #33 | Repairs to roof leaks, vent awnings, box gutters, window seals. Replace window seals,. | $12,000 |
| Buildings | Woodford Touch Football Club | Electrical swichboards, light tower control gear; wash out and clean switchboards, sub boards and control boxes. Spray with solvents and CRC. Power up and test. Replace Items as necessary. | $8,000 |
| Buildings | Roxberg Toilet Block | Toilets - repair: pressure clean to remove sludge. Replace damaged fitments. | $1,500 |
| Buildings | Beachmere Activity Centre | Repairs to tiled roof - water leaks: replace damaged tiles and flashings. Repair damaged downpipes. | $4,800 |
| Buildings | Bribie Island Recreation Ground,156-206 First Street | Flood waters undermined irrigation pump house slab resulting in shed slipping down bank & pump house unsafe to enter. Inlet pipe broken & pump burnt out. | $5,200 |
| Buildings | Banner Poles Opposite Centenary Lakes | | $5,201 |
| | Overtime for call centre operators because of the emergency | | $100,000 |
| | Recovery Taskforce Operations - see F0381 | | $15,000 |
| Roads | Kerbside Cleanup | Kerbside cleanup throughout the shire. (First two days was under 7022548W) | $75,000 |
| Parks | Harland Rd Trail | Rec trail damage | $30,000 |
| Roads | Jimna Court | Rectification of road and retaining wall. 7023733W | $1,750,000 |
| Roads | Mt Nebo Rd - Two upslope slip sites - Waste Transfer Stn & Jolly's Lookout | Remove fallen and loose rock and stabilise batters using combination of rock bolts, shotcrete and rockfall mesh and anchors. Engage consultants PB, call design & construct tender, award contractor - remedial works to both sites. - Complimentary Works also proposed. | $550,000 |
| Roads | Bellthorpe Range Rd - Bri 35 Running Creek NO2 US | Debris against guardrails, damaged section of asphalt surface 2m2 . Remove by machine , traffic control. Was 7023629W | $3,000 |
| Roads | Bellthorpe Range Rd | Engineering consultancy investigation & design, major clearing, rock gabion walls, reinstatement of drainage, pavement & guardrail to be replaced. Proj# 41096 was 7022471W | $4,200,000 |
| Roads | Emergency Operations | General Flood number for all at initial event | $100,000 |
| Roads | Bridge - Laceys Creek Rd - bridge over North Pine River | Short term work to make trafficable and safe: place approx 1,000m3 rock in total. Approx 200m3 needed for eastern bridge abutment, 400m3 along 100m length of western approach where shoulder has scoured away, and 200m3 adjacent to western abutment. | $220,000 |
| Roads | Laceys Creek Rd | Repair gravel causeways, repair scours, remove slips. | $160,000 |
| Roads | O'Brien Rd | Reinstate gravel pavement on bridge. | $36,064 |
| Roads | W James Rd | Reinstate causeway and road. - Complimentary Works also proposed. | $132,000 |
| Roads | Mt Nebo Rd - Slip below Waste Transfer Station | Emergency work, remove rockfall, install barriers, close lane, engage consultants for geotechnical investigation and report. | $120,000 |
| Roads | Cedar Creek Rd - (Recification Maintenance) -Stabilisation sites 7 - Parsons Brinckeroff engaged to provide geotech designs 23/06. | Asphalt recification, pipe replacement and maintenance, pavement maintenance, scour protection, landslippage. ~~Guardrail bridge on approcheds~~ **does not include bridges. - Complimentary Works also proposed.** | $1,500,000 |
| Roads | Bellthorpe Range Rd | Geotechnical advice on stability. Clear debris to allow access on 18/01/11. 7022308W / & Project # 41096 | $100,000 |
| Roads | Mt Brisbane Rd - bridge over North Pine River | Remove logs, patch road, remove slips. | $30,000 |
| Roads | J Lindsay Rd - Stabilisation sites 1 | Gravel - Repair washed out crossings - make safe works started on 19/01/11- pavement repairs required. | $188,000 |
| Roads | Old North Rd | Rock / asphalt (AC) protection to crossings, Armco guardrail replacement - made safe. Quote for reinstatement works to follow. | $20,000 |
| Roads | Morayfield Rd - near skate bowl | Replace damaged fence - quotation accepted. | $450 |
| Roads | Delaney Creek Rd | Gravel - Rock/AC protection to crossings, slip repairs started on 14/01/11. | $87,500 |
| Roads | Mt Nebo Rd - Slip near Jollys Lookout | Emergency work, remove rockfall, install barriers, close lane, engage consultants for geotechnical investigation and report. | $200,000 |
| Roads | Newman Lane | Rock/AC pavement protection to crossings, medium slip repairs - made safe on 13/01/11. | $50,000 |
| Roads | Rose Creek Rd | Pavement replacement - works started on 14/01/11, completed 17/01/11. RC | $8,000 |
| Roads | Old Gympie Rd | Gravel - Made safe then replace pavement and rock protection. Work started on 13/01/11. | $19,905 |
| Roads | Hamilton Rd | Repair pipes - sink hole. Works started on 13/01/11 completed 17/01/11. RC | $3,000 |
| Roads | Visentin Rd | Fence replacement - quote received. Work started on 20/01/11. RC | $6,000 |

**Flood Event January 2011**
**Moreton Bay Regional Council - damage cost estimates**

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|---|---|---|---|
| Roads | Brown Rd | Repair major pavement failure - further investigation required. Made safe on 13/01/11. WOR | $90,000 |
| Roads | Stanton Rd - Stabilisation sites 3 | Major pavement failure - make safe works started on 13/01/11. | $450,000 |
| Roads | Rasmussen Rd - Stabilisation sites 2 | Gravel - Pavement/drainage replacement - works started on. 14/01/11 | $180,000 |
| Roads | Dewhurts Rd | Gravel - Crossings/pavement repairs - works started on 13/01/11. | $13,100 |
| Roads | Perkins Rd | Gravel - Crossing/pavement repairs - works started on start 20/01/11. | $11,278 |
| Roads | Fletcher Rd - Stabilisations sites 2 | Major pavement reconstruction - make safe works started on 13/01/11. | $148,000 |
| Roads | Newlands Rd - 1,000m2 | Pavement/crossings repair - reinstatement works started on 14/01/11. | $100,000 |
| Roads | W Lindsay Rd | Gravel - Pavement replacement - started 14/01/11. | $12,640 |
| Roads | Basin Rd | Rock/gravel to 5 crossings to allow access. Reinstate - 2x750 pipes. | $80,000 |
| Roads | Derrick Rd | Erosion behind headwall. To be repaired. | $2,500 |
| Roads | Cove Rd | Gravel - Pavement/drainage/AC pavement repairs - work started on 14/01/11. | $12,000 |
| Roads | Theodore Rd | Reinstate causeway and road surface. | $19,972 |
| Roads | Kobble Creek Rd - Stabilisation sites 1 | Reinstate causeways and road. | $80,000 |
| Roads | Pringles Rd | Reinstate road. | $110,000 |
| Roads | McNamara Rd - (Browns Crossing) | Repair concrete causeway and adjacent road surface. | $23,341 |
| Roads | Wirth Rd - 1st Crossing | Has been made trafficable to 2nd crossing but will need more permanent repairs. Repair concrete crossing. | $70,000 |
| Roads | Wirth Rd - 3rd Crossing | Half the concrete crossing is missing but has been made safe and trafficable. Crossing to be reinstated. | $15,000 |
| Roads | Wirth Rd - 5th Crossing | Concrete crossing completely washed away. Has been made safe and trafficable. Crossing to be replaced. | $25,000 |
| Roads | Wirth Rd - 6th Crossing | Approach to crossing partly washed away. Has been made safe and trafficable but still needs some scour protection. Crossing to be repaired. | $10,000 |
| Roads | Mt Pleasant Rd | Repair road surface: 396m2. | $41,585 |
| Roads | Mt Pleasant Rd | Repair slip adjacent to bridge near Henzell Rd. | $8,000 |
| Roads | Mt Samson Rd | Repair water damaged pavement, scoured shoulders, repair slips, +PF - 100m2 | $60,000 |
| Roads | Dayboro Streets | Repair road pavement surface that was washed away. | $30,000 |
| Roads | Sweeney Reserve - Old Dayboro Road | Reinstate pavement and asphalt surfacing. | $70,000 |
| Roads | Gravel Roads | Individual roads repaired - Elizabeth Rd, Bray's Rd, Junction Rd, Wagner Rd - Griffin; Theodore Rd, Neilson Rd, Cooper Rd - Kurwongbah; Bond Rd - King Scrub; Brockhurst Rd - Ocean View; Austin Rd - Mt Mee; Rahes Rd, Charles Rd, Stratton Rd, Sorden's Dvwy, Mt Brisbane Rd - Mt Pleasant; Farrow Rd - Samsonvale; Baker Rd, Wirth Rd, Rowe Rd - Laceys Creek. | $228,000 |
| Roads | Goat Track | Highvale - Mt Nebo - Geotechnical advice and work arising from geotechnical advice including removal and stabilisation of slips, stabilsation of road batters, reinstatement of road pavement and bridge approaches. | $500,000 |
| Roads | Broads Rd | Reinstate water damaged and scoured pavement. | $40,000 |
| Roads | Gravel Roads | Grading gravel roads - Hammermister Rd, Brown's Rd - Mt Glorious; Foggs Rd, Basin Rd, Nixon Rd - Mt Samson; Burns Rd - Samford Valley; Scheldt Rd Wights Mt; Branch Creek Rd - Clear Mt; Old School Rd - Cashmere. | $180,000 |
| Roads | Leis Pde - with Rehab job | Design, repair road and concrete barriers. | $60,000 |
| Parks | Queens Beach North and South, Suttons Beach, Margate Beach, Scotts Point, Woody Point | Removal of flood debris from shoreline. Also see Redcliffe Beaches 30664.099 . | $50,000 |
| Roads | Old Cove Rd | Pavement/drainage/AC pavement repairs. Works started 14/01/11. | $5,000 |
| Roads | Whiteside Rd | Repair water damaged pavement. | $124,000 |
| Roads | Blackburn Road | Reinstatement of material behind culvert headwalls. Make safe works carried out on 14/01/11. | $3,200 |
| Roads | Neurum Rd | Reinstatement of material behind culvert headwalls. | $3,000 |
| Roads | Carmichael Court | Reinstatement of material behind culvert headwall. Make safe works carried out on 14/01/11. | $1,144 |
| Roads | King Rd | Reinstatement of pavement and bitumen seal. | $15,000 |
| Roads | Dances Rd | Reinstatement of pavement and bitumen seal. RC | $5,000 |
| Roads | Mt Nebo Rd - Slip near Jollys Lookout Stage 1 | Water filled barriers, warning signs. Do not touch slope debris. | $10,000 |
| Roads | Old North Rd | Replacement of damaged guardrail. | $28,462 |
| Roads | Caboolture River Rd | Reinstatement of pavement and bitumen seal. +PF 135m2 complete | $10,000 |
| Roads | Gap Rd Booroobin | Engineering consultancy, major embankment shoring and reinstatement of pavement & bitumen seal. Investigation, geotechnical advice & design options & costings pending. #41027 was 7022470W | $1,000,000 |
| Roads | Sellin Rd | Reinstatement of pavement and bitumen seal; repair land slip. Reinstatement work started on 18/01/11. | $8,049 |

**Flood Event January 2011**
**Moreton Bay Regional Council - damage cost estimates**

| Service Type | Road, Park or Building Location | Details of Defect / Work Required | Estimated Cost |
|---|---|---|---|
| Roads | Old North Rd - over Yellow Creek culvert | Scour around steel pipe to be repaired. Geotechnical advice required. Corrugated steel culvert needs assessment for structural adequacy, soluble soils around pipe culvert have subsidied leaving severe cracking to road pavement & surface. - Complimentary Works also proposed. | $250,000 |
| Roads | Del Roso Rd | Drainage repairs required. Make safe works commenced on 14/01/11. | $3,000 |
| Roads | Morayfield Rd | Replace damaged fence - Centenary Lakes - make safe works complete on 14/01/11. Quote for reinstatement works to follow. | $5,000 |
| Roads | Caboolture river pathway | Caboolture Sth - Arboretum - Repair damaged fencing to walkway - made safe on 13/01/11. Quote for reinstatement work to follow. | $10,000 |
| Roads | Railway Pde - pathway (under QR) | Replace damaged/washed out pathway. Quotation for reinstatement works accepted. RC | $6,237 |
| Roads | Glanville Rd | Pavement/drainage/AC pavement repairs - made safe on 13/01/11. | $4,000 |
| Roads | English St | Drainage repairs to headwall - made safe on 13/01/11. | $4,000 |
| Roads | Campbells Pocket Rd | Slip/drainage repairs - works started on 14/01/11. | $15,750 |
| Roads | Neurum rd - Stabilisation sites 1 | Repair failed pavement - near new bridge near Woodford Showground. Quotes called. | $80,000 |
| Roads | Greens Rd | Repair damaged headwall. Made safe on 14/01/11. | $3,761 |
| Roads | Central Ave | Repair damaged pavement. Made safe on 14/01/11. | $6,000 |
| Roads | McClintock Rd | Backfill to washed headwall. Made safe on 14/01/11. | $2,250 |
| Roads | Alexandra Pde | Backfill to headwall, stabilise fence footings. Made safe on 13/01/11. | $3,600 |
| Roads | Batchelor Rd | Gravel - Reinstate washed out pavement. Reinstatement works commenced on 19/01/11. | $6,000 |
| Roads | Ipswich City Streets | Ipswich City Council flood relief assistance | $9,000 |
| Roads | Youngs Crossing Rd | Flood damage to road culverts / footpaths - Young's Crossing Road & gates. Required works by contractors - guardrail Only. Design, supply & fit new guardrail to meet current standards to protect pedestrians on bridge footpath from oncoming traffic. Petrie | $120,000 |
| Roads | Mayfield Rd | Reinstate pavement & drainage- complete. Landslip subject to geotechnical advice. Estimate dependent on result. | $180,000 |
| Roads | Gleeson Rd / Adsett Rd | Reconstruction of pavement and repair damage to culverts. | $307,934 |
| Roads | Neurum Rd | Gravel repair to washed out shoulders. Make safe works completed on 17/01/11. | $5,000 |
| Roads | O'Shea Rd | Repair damaged headwalls and rock stabilisation. Made safe on 19/01/11. | $3,000 |
| Roads | Powell Rd | Gravel - replacement to washed out causeway. | $7,769 |
| Roads | Homestead Court | Reinstatement of pavement and bitumen seal. | $5,000 |
| Roads | Edmond Ct | Reinstatement of pavement and bitumen seal. | $5,000 |
| Roads | Mt Brisbane Rd - (near Frederick Ct) | Reinstatement of material behind culvert headwalls and minor pavement repair. | $8,000 |
| Roads | Mt Brisbane Rd - #454 (near Graham Ct) | Reinstatement of material behind culvert headwalls and minor pavement repair. (Mt Brisbane Rd) | $8,000 |
| Roads | Mt Brisbane Rd - (near House 179) | Reinstatement of material behind culvert headwalls and minor pavement repair. | $5,000 |
| Roads | Mt Brisbane Rd - (near House 112) | Reinstatement of material behind culvert headwalls and minor pavement repair. | $5,000 |
| Roads | Mt Pleasant Rd - (near Henzell Rd) | Reinstatement of material behind culvert headwalls and minor pavement repair. (Mt Pleasant Rd) | $7,081 |
| Roads | Mt Pleasant Rd - (near House 526) | Reinstatement of material behind culvert headwalls and minor pavement repair. | $8,000 |
| Roads | Mt Pleasant Rd - (near Clifford Rd) | Reinstatement of material behind culvert headwalls and minor pavement repair. | $5,000 |
| Roads | Jackson Rd | Gravel - Repair eroded road pavement batter and culvert headwall. | $12,827 |
| Roads | Gympie Rd | Dept of Transport & Main Roads- A J Wyllie Bridge - Supply traffic control & Variable Message Signs to assist Transport and Main Roads. Ongoing. Invoices sent to TMR for reimbursement | $21,669 |
| Roads | Bellbird Court / Masseys Court | Reinstatement of drains, pavement and bitumen seal. | $30,000 |
| Roads | Flooded Roads in Central Area | Replacement of missing signs. | $6,000 |

**Flood Event January 2011**
**Moreton Bay Regional Council - damage cost estimates**

| Service Type | Road, Park or Building Location | Details of Defect / Work Required | Estimated Cost |
|---|---|---|---|
| Roads | Flooded Roads in Southern Area | Replacement of missing signs - south area. | $6,000 |
| Roads | Forbes Rd | Bitumen and pavement washed away - to be replaced. +PF - 199m2 | $21,597 |
| Roads | McLoughlin Rd | Bitumen and pavement washed away - to be replaced. New work should strengthen structure +PF 202m2 | $36,000 |
| Roads | Juffs Rd West - Stabilisation sites 1 | Repair water damage to pavement. Reinstate Armco railing | $40,000 |
| Roads | Graham Court | Repair water damage to pavement. Reinstate guardrail. | $1,304 |
| Roads | Boyd St | Remove debris from beach/foreshore & transfer to Caboolture landfill. | $10,000 |
| Roads | Dayboro - Floodmarkers, signs and guideposts in the Dayboro area | Flood markers, signs and guideposts washed away adjacent to creek crossings - to be replaced. | $10,000 |
| Roads | Leis Park | Reinstate road, turnaround and signage in park. | $30,000 |
| Roads | Tosca St - #55 | Reinstate drain, culvert end walls and cutoff walls. | $26,000 |
| Roads | Todds Rd | Pavement repairs required due to inundation of pavement. | $45,000 |
| Roads | Mt Samson Rd - #1335 | Landslip - investigate and repair (CR 977626). **Required works by contract.** Repairs to slips on LHS & RHS of pavement at 1335 Mt Samson Road, Mt Samson. Approximately 280m2 to be concrete sprayed using F72 mesh reinforcing. | $150,000 |
| Roads | Kremzow Park, South Pine Rd | Reinstate culverts, place rock protection. | $35,000 |
| Roads | Laceys Creek Rd | Work arising from geotechnical advice to stabilise slips. 2 slips | $200,000 |
| Roads | Mt Brisbane Rd | Clear slips. | $20,000 |
| Roads | Hawkins Rd | Repair eroded section of road over pipe crossing. | $40,000 |
| Roads | Fingerboard Rd | Repair eroded section of road over pipe crossing. | $30,000 |
| Roads | Normanby Way - footpath near Dixon St | Footpath under-cut by North Pine River. Realign footpath and move seat. **Required works by contract.** Riverbank scour - supply rock protection work to scoured river bank: approx 25m3 of rock & geofabric to be placed. | $70,000 |
| Roads | Farrow Rd - Site 1 | Road slipped away around pipe crossings. Reinstatement of road batter and roadway. | $60,000 |
| Roads | Raaen Rd | Road slipped away around pipe crossings. Reinstatement of road batter and roadway. | $30,000 |
| Roads | Farrow Rd - Site 2 | Road slipped away around pipe crossings. Reinstatement of road batter and roadway. | $60,000 |
| Roads | Maryvale St | Reinstate asphalt causeway with concrete due to failures caused by flood inundation of pavement. + PF RC | $60,000 |
| Roads | Grant St - Drain | Remove flood debris blocking drain. | $10,000 |
| Roads | Homestead Court | Repairs to road and stormwater infrastructure. | $22,000 |
| Roads | Hawkins Rd - #88 | Repair river crossing damaged during flood. | $4,000 |
| Roads | Church Rd | Repair flood damaged culvert pipe and head wall. | $10,000 |
| Roads | Jullyan St | Repairs to storm water drain system. | $10,000 |
| Roads | Norfolk Lake spillway. | Flood mitigation structure - Dam spillway damaged. To be repaired. | $50,000 |
| Roads | Mt Nebo Rd - Slip below Waste Transfer Station Stage 1 | Slope failure. Make safe work included installation of water filled barriers and warning signs. Do not touch slope debris. Slope stabilisation works required. | $10,000 |
| Roads | Laceys Creek Rd - before 576 | Reinstatement of culvert apron . | $12,000 |
| Roads | Dayboro Streets | Repairs to bitumen road surface (pot holes).Dayboro, Laceys Creek, Kobble Creek | $10,000 |

**Flood Event January 2011**
**Moreton Bay Regional Council - damage cost estimates**

| Service Type | Road, Park or Building Location | Details of Defect / Work Required | Estimated Cost |
|---|---|---|---|
| Roads | Stony Creek Rd | Gravel - Grade and gravel track from Stony Creek Rd through forestry to allow access. Works commenced on 14/01/11. | $200,000 |
| Roads | Mt Brisbane Rd - Doc's driveway | Repair 100 metre long slip on edge of road. | $30,000 |
| Roads | Baker Road Crossing | Repair washed away rock protection area around culvert. | $10,000 |
| Roads | Brays and Cairns Rd cnr | Pavement repairs / reinstatement. | $22,000 |
| Roads | Caboolture River Rd and Virginia Rd | Pavement repairs / reinstatement. | $9,000 |
| Roads | Harold McDonald Place | Mud slide. Consultancy costs only. No operational work by Council. | $5,636 |
| Roads | Footpaths various | Clean footpaths of debris and mud left over from flooding. | $10,000 |
| Roads | Mungara Reserve | Repair footpaths, railings and board walks damaged from flooding. | $20,000 |
| Roads | Morrison Rd | Undermining of concrete protection on bridge; remove / replace rock gabions; reinstate drain; and pavement repairs. | $43,500 |
| Roads | Ocean View Rd | Remove slips. | $7,000 |
| Roads | Rocksberg area | Flood markers, lateral shift markers, warning signs and guide posts washed away from creek crossings and adjacent to creek crossings - to be replaced. | $10,000 |
| Roads | Farrow Rd - Site 3 | Road slipped away around pipe crossings. Reinstatement of road batter and roadway. | $60,000 |
| Roads | Farrow Rd - Site 4 | Road slipped away around pipe crossings. Reinstatement of road batter and roadway. | $60,000 |
| Roads | Assessment of Six bridge for abutment damage per list | Scoured abutments require armour protection. Technical advice required from bridge specialists: Tasman & Assoc. | $12,000 |
| Roads | Bridge - 8 Cedar Creek Bridge Structural Damage | Repair scour damage to abutments; damaged approache; and pipe outlets. | $30,500 |
| Roads | Bridge - 10 Gordons Road | Repair scour damage to abutments; damaged approaches; damaged signage. | $4,000 |
| Roads | Bridge - (11) Bunya Road | Removal of fallen trees from bridge abutments. | $3,000 |
| Roads | Bridge - (16) Mt Samson Rd | Scour damage to bridge abutments - replace rock protection. | $10,000 |
| Roads | Bridge - (18) Mt Brisbane Rd | Concrete supporting walls to the bridge abutment have subsided leaving a gap. Professional engineering advice sought. Proposed concrete pressure pumping to repair voids. | $6,000 |
| Roads | Bridge -161 Nelson Rd Res | Approach on the west side requires reconstructing: 40 LM x 8LM x 1.2M deep - rock / road base / CTB & geofabric membrane. Bridge rails require replacement. | $15,000 |
| Roads | Wirth Rd - 4th Crossing | Concrete crossing completely washed away. Has been made safe and trafficable. To be reinstated. | $25,000 |
| Roads | Stony Creek Reserve - Creekside Drive | Stony Creek Reserve of Creekside Dr & Riveroak Way: bridge and storm water pipe footings require repair. Bridge approaches require repair. Reinstate garden edging and mulch and reinstate rock and geofabric protection. Reconstruction of concrete spillway to prevent further scour. | $9,000 |
| Roads | Bridge - 2 Mt Samson Road - North Pine River | Repair scour to bridge abutments. Requires installation of rock > 400mm nominal size. | $10,000 |
| Roads | Bridge - 3 Mt Samson Rd - Over Cedar Creek | Repair scour to bridge abutments. Requires installation of rock > 400mm nominal size. | $10,000 |
| Roads | Bridge - (4) Delaney Creek Road Over Bungo Creek | Severe damage to the bridge abutment. Specialiest technical advice required to determine reinstatement requirements. Access track required to facilitate reinstatement works. | $200,000 |
| Roads | Bridge - (18) Commissioners Flat Road over Stanley River | Scour to bridge abutments. Requires installation of rock > 400mm nominal size. / Pavement repair. | $70,000 |
| Roads | Bridge - (28) O'Brien Road over Burpengary Creek | Require a revetment mattress or construction of shotcrete wall and foundation. Specialist design required. Reconstruction of 240m length of pavement and 40mm AC pavement overlay. Reinstall guardrail. | $35,000 |
| Roads | Costello Rd | Approach to crossing washed away. Has been made safe and trafficable. Reinstatement to include scour protection. | $15,000 |
| Roads | Mt Brisbane Rd - Stubbings Crossing | Concrete apron to crossing washed away. Apron to be reinstated. | $10,000 |
| Roads | Stony Creek Rd - culvert Bri 20 Mountford Creek | Wing wall southern side scoured. Required spray concrete repairs. | $3,000 |
| Roads | Eaton Lane - culvert Bri 23 Mary Smokes Creek | Wing wall southern side scoured. Required spray concrete adjustment. Seal each end of bridge. | $23,000 |
| Roads | Basin Rd | Repair slips 150m and 200m from end of asphalt. | $150,000 |
| Roads | Mt Samson Rd - opposite intersection with Kobble Creek Rd | Repair slip and reinstate road batter. | $20,000 |

**Flood Event January 2011**
**Moreton Bay Regional Council - damage cost estimates**

| Service Type | Road, Park or Building Location | Details of Defect / Work Required | Estimated Cost |
|---|---|---|---|
| Roads | Bridge - (22) Campbells Pocket Rd Waraba Creek | Scour to abutment southwest side & under headstock, debris under bridge and water main. Under bridge unit required for detailed investigation. Traffic control required during this inspeciton. Repairs required to minor subsidence under relieving slab. | $7,000 |
| Roads | Bridge - (29) Campbells Pocket Road Caboolture River | Spraycrete has been undermined. Construct concrete footing toe wall and pump concrete into scoured foundation. Works will require traffic control. | $5,000 |
| Roads | Nonmus Rd - Br1 34Running Creek NO1 DS | Gravel - Debris against guardrail. Removal by machine under traffic control. | $2,000 |
| Roads | Bellmere Rd | Debris on roadway and bridge to be removed. Traffic control during water blasting. RC | $4,000 |
| Roads | Curtis Rd - Stabilisation sites 1 | Stabilisation programme - pavement from Cedar Creek Road to the end (750m2). (To be carried out with Cedar Creek Road Project.) | $54,000 |
| Roads | Kirk Rd | Restoration of end wall and surrounds and pavement. | $2,000 |
| Roads | Bridge - (15) Mt O'Reilly Road Morrisons Crossing over South Pine River | Repair guardrails. Possible scour to abutments to be checked. | $2,000 |
| Roads | Bridge - 6 Cedar Creek Road Andy Williams Park | Repair various types of damage to road, bridge and guardrail. | $150,000 |
| Roads | Rusty Lane Bri 36 Gregors Creek | Storm debris to be cleared to bridge control point. Road has scoured at the approaches - 5m2. | $3,000 |
| Roads | Gordons Crossing Rd - Job 1 - Chandler Reserve CSR 993674 | Bridge and drainage outlet scour protecton. Installation of rock scour protection to bridge abutment and reconstruct central pier rock armour. Installation of scour protection around outlet to 1050 dia pipe culvert. | $15,000 |
| Roads | Gordons Crossing Rd - Job 2 - Chandler Reserve CSR 993674 | At One Mile Creek - approximately 3m high embankment scour. Unstable embankment requires stablisation. Construction of a 1.5m gabion wall approximately 30m in length. Batter embankment 1 in 4 batter. $35,000 DERM approvals required. Geotechnical advice required. | $35,000 |
| Roads | Delaney Creek Rd | Scour to road surface and pavement. Reconstruct 80m2 pavement and a 40mm AC pavement overlay. | $5,000 |
| Roads | Wightman Reserve bikeway exit to Alan Court Yingally Drive (behind 5 Allan Crt) | Flood damaged timber walkway - unsafe for pedestrians and cyclists near bikeway exit to Alan Court. 30LM is severely buckled. Board walk closed & detour signs erected. Broken pipe in Cabbage Tree Creek also needs to be replaced. | $9,000 |
| Roads | Campbell Parade | Severe damage to pavement - requires rehabilitation. WOR | $130,000 |
| Roads | Kropp Rd | Removal of debris and replace reflectors. | $1,000 |
| Roads | Wights Mt Rd | Gravel footpath to be restored. | $30,000 |
| Roads | Bridge - Neurum Rd Bri 21 | Bridge deck heavily silted. To be removed with bobcat and broom attachment; traffic control required. | $3,000 |
| Roads | Litherland Rd Culvert | Minor scour to the road surface. Reconstruction with cement modified roadbase and compact. | $3,000 |
| Roads | Boongala Court | Repair 100 metres of road shoulder washed away 100 from the end of the bitumen. | $12,000 |
| Roads | Boongala Court | Two road batter slips 150 metres and 200 metres from the end of the bitumen. | $60,000 |
| Roads | Various Roads throughout Council | Emergency repairs to bitumen roads - potholes etc. | $142,000 |
| Roads | Raynbird Creek Rd | Drainage & road scour. Three (3) pipe crossings need repair. | $62,500 |
| Roads | Gordons Rd - Stabilisation sites 1 | Several trees down, approximately 1hr work for tree crew. Stabilise pavement from Cedar Creek Road to 50m past bridge (750m2 ). Redefine table drain full length. (To be carried out with Cedar Creek Road project.) | $76,000 |
| Roads | Huntley St | Repair seawall to stabilise wall & pathway. | $3,864 |
| Roads | Various areas in Shire | Sandbagging various areas within the Region. | $12,000 |
| Roads | Dales Rd Shepherds Crossing | Gravel road needs grading. | $80,000 |
| Roads | Armstrong Creek Road - Stabilisation sites 1 | Repairs to pavement failure. | $60,000 |
| Roads | Basin Rd - Stabilisation sites 4 | Repairs to pavement failure. | $80,000 |
| Roads | Old Toorbul Point Rd | Pavement ~ 1300m x 6.0m in width = 7800m2 damaged from major increase in traffic due to Bribie Island Road closure thus only access in & out of Bribie Is, Ningi, Sandstone Point & parts of Beachmere. | $390,000 |

**Flood Event January 2011**
**Moreton Bay Regional Council - damage cost estimates**

| Service Type | Road, Park or Building Location | Details of Defect / Work Required | Estimated Cost |
|---|---|---|---|
| Roads | Maba Court culvert over Kedron Brook, Intersection Maba Court & Cribb Ave Oxford Park | Downstream rock pitched protection severely undermined leading to collapse. To be reinstated. | $65,000 |
| Roads | Arnan Court - #11 | Repair sinkhole & damage to stormwater drainage & infrastructure | $22,300 |
| Roads | Forestry Rd | Replace 2x end pipe & repair headwall (pipe diameters ~375 & 450). | $10,000 |
| Roads | Camp Mountain Rd | Slip made safe; slip material in table drain approx 100m3 to be removed from batter. | $16,000 |
| Roads | Mondial Dve | Scour - requiring rock armour & redefine drain. | $25,000 |
| Roads | River Crossing for YMCA to access Old Petrie Town from Camp Warrawee | Damage to concrete crossing - scour. To be reinstated. | $58,000 |
| Roads | Kobble Lane Kobble Creek | Scour to road surface | $20,000 |
| Roads | Bridge - Antibidawa Creek Bridge - Campbells Pocket Road | Reinstatement of pavement, culvert - scour damage from overtopped culvert drain | $114,000 |
| Roads | Mt Pleasant Rd | Replace land slip against edge of roadway 100m up hill from main bridge | $30,000 |
| Roads | Darcey Kelley Rd | Reinstate damaged pipehead | $7,000 |
| Roads | Morrison Rd - Park | Damaged fencing surrounding Morrison Rd Park | $4,420 |
| Roads | Farrow Rd - Site 6 | Road slipped away around pipe crossings. Reinstatement of road batter and roadway. | $30,000 |
| Roads | Gympie Rd - (between Leis Pde & AJ Wyllie Bridge) | Replace embankment to footpath, remove & replace fence & vegetation. | $23,000 |
| Roads | Mahr Bridge Rowley Rd | Scour to bridge abutments & spraycreting scoured. | $50,000 |
| Roads | Endwood Crt | Drainage & pathway erosion repairs | $5,900 |
| Roads | Dawson Creek Rd | Repairs to erosion to road reserve | $7,500 |
| Roads | Farrow Rd - Site 5 | Road slipped away around pipe crossings. Reinstate road batter and roadway. | $60,000 |
| Roads | Stony Creek Rd - Stabilisation sites 2 | Missing & failed section of various locations from causeway to gravel road. | $500,000 |
| Roads | Cederton Rd | Failed section of roadway. | $11,000 |
| Roads | Board walk behind 39 Olympus Ct - approx 100m NW of Cashs Crossing Bridge Southpine Rd | Replace 50m of boardwalk & remove large tree stumps | $20,000 |
| Roads | Leis Park | Relocate cul de sac & install bollards | $45,000 |
| Roads | Gibbons Rd | Pavement Fails | $20,000 |
| Roads | Lees Crossing Rd | Pavement Fails | $20,000 |
| Roads | McKenzie St | Pavement Fails | $20,000 |
| Roads | George St - Stabilisation sites 1 | Pavement Fails - 600m2 | $300,000 |
| Roads | Golf Course Rd - Stabilisation sites 1 | Pavement Fails - 500m2 | $42,500 |
| Roads | Walkers Lane - Stabilisation sites 3 | Pavement Fails - 800m2 | $300,000 |
| Roads | Pates Rd - 4 sites | Pavement Fails -Total 1151m2 - 259m2 + 72m2 + 473m2 + 347m2 | $51,795 |
| Roads | Donnybrook Rd - Stabilisation sites 1 | Pavement Fails - 500m2 RC | $160,000 |
| Roads | Goodwin Dr | Pavement Fails - 400m2 | $34,000 |
| Roads | Eucalypt St | Pavement Fails - 120m2 | $19,000 |
| Roads | Verdoni St | Pavement Fails - 100m2 | $13,900 |
| Roads | Patane St - 5 sites | Pavement Fails -Total 1006m2 - 599m2 + 99m2 + 90m2 + 20m2 + 198m2 | $45,270 |
| Roads | Williams Rd - 5 sites | Pavement Fails - Total - Total 1529m2 - 440m2 + 110m2 + 110m2 + 352m2 + 517m2 | $67,005 |
| Roads | Fahey Rd - Stabilisation sites 1 | Pavement Fails | $150,000 |
| Roads | Kremzow Rd - Stabilisation sites 1 | Stabilisation Programme - 350lm | $100,000 |
| Roads | F Lindsay Rd - Stabilisation sites 2 | Pavement fails & potholes - 500m in 2 locations - Customer complaint 1024609 Road has fallen below an acceptable standard of service with numerous failures and potholes over its entire length - needs staged construction - tyne, reshape, compact, 150mm gravel seal, etc | $40,000 |

**Flood Event January 2011**
**Moreton Bay Regional Council - damage cost estimates**

| Service Type | Road, Park or Building Location | Details of Defect / Work Required | Estimated Cost |
|---|---|---|---|
| Roads | Moorina Rd - Stabilisation sites 1 | Insitu stabilisation - Severe scour of road along embankment of creek. Crossing needs to be investigated. Causeway needs to be restored. Verbal customer request for reestablishment of the road over the last 2.9km of the road, (from Haywood Road). Potentially needs road to be relocated away from the creek over a distance of about 700m or have the road embankment reconstructed with suitably sized rock. The rest of the road needs reconstruction. - Complimentary Works also proposed. | $310,000 |
| Roads | Old North Rd - Stabilisation sites 2 | Part of stabilisation programme. | $100,000 |
| Roads | Sunrise Drive | Pavement Fails - plus landslip to Geotech & legal for advice. Costs to be advised. | $20,000 |
| Roads | Neurum Rd near Somerset Council boundary - Stabilisation site 1 | Approaches to bridge - pavement lifted from saturation - about to breakup & disintegrate | $45,000 |
| Roads | Old Gympie Rd - Stabilisation sites 1 | Gravel - Stabilisation programe | $450,000 |
| Roads | Nonmus Rd - Stabilisation sites 2 | Road replacement - Gravel - Stabilisation programe | $460,000 |
| Roads | Kropp Rd - Stabilisation sites 1 | Stabilisation programme | $50,000 |
| Roads | Youngs Crossing Rd - Stabilisation sites 2 | Stabilisation programme | $80,000 |
| Roads | Bullock Creek Rd - Stabilisation sites 1 | Stabilisation programme | $260,000 |
| Roads | Duke St - Stabilisation sites 1 | Stabilisation programme | $104,000 |
| Roads | Meldale Rd - Stabilisation sites 1 | Stabilisation programme RC | $80,000 |
| Roads | Winn Rd & Tom Schmidt Court - 3 sites | Pavement Fails - Total 98m2 - 16m2 + 56m2 + 26m2 | $4,410 |
| Roads | Bells Pocket Rd & Lawnton Pocket Rds | Pavement Fails - Total 294m2 -140m2 + 154m2 | $13,230 |
| Roads | Warner Rd - outside 87 - 2 sites | Pavement Fails - Total 960m2 - 360m2 + 600m2 | $43,200 |
| Roads | Leitchs Rd (2 sites) - 50m nth & sth of Davis Lane (1 site) | Part of stabilisation programme - Pavement Fails - Total 1251 - Total for Leitchs 1107m2 (933m2 + 174m2) + Davis Lane 144m2 | $56,295 |
| Roads | Browns Rd - 3 sites + intersections-Moore + with McCormack Rd | Pavement Fails - Total 1722m2 - 252m2 + 330m2 + 840m2 + 300ms | $120,870 |
| Roads | Kurrajong Rd | Pavement Fails - 20m2 | $2,060 |
| Roads | Mountain View Rd -Stabilisation sites 1 | Stabilisation programme - 8400m2 | $420,000 |
| Roads | Haywood Rd - Stabilisation sites 1 | Stabilisation programme - 11200m2 | $560,000 |
| Roads | Mt Nebo Rd - 84 sites | Pavement Fails - 2,847m2 | $256,230 |
| Roads | Benson Rd - outside #19 | Pavement Fails - 15m2 | $3,190 |
| Roads | Upper Wights Mtn Rd - outside 35 & 126 | Pavement Fails - 25m2, 10m2 | $4,378 |
| Roads | Upper Camp Mtn Rd - outside299 | Pavement Fails - 50m2 | $5,445 |
| Roads | Clarks Rd - 1 site | 2000m2 + stabilisation | $100,000 |
| **Total Count** | | | |
| ~~Roads~~ | ~~Baxters Creek Rd~~ | ~~Not to be added~~ | |
| **Total Dollars** | | | **$29,683,181** |

Flood Data Under Review
Subject to Change

# Areas of Potential Inundation During a '1 in 100 Year' Flood

**Map 9 of 18**

**Approximate Flood Depth**

- 0 - 0.5m
- 0.5m - 1.5m
- 1.5m Plus

**Key to Map Features**

- Property Boundaries
- Waterways
- Major Streams
- Motorway
- Major Roads
- Significant Roads
- Roads
- Railway

**Important Advisory Notes and Disclaimers:**

1.The information provided on these plans illustrates the potential extent of inundation of the ground surface during a '1 in 100 year' flood. A '1 in 100 year' flood is a flood event that has a 1 in 100 chance of occurring in any 1 year. It is a large flood that is currently used as the standard measure for setting flood controls on properties in the Moreton Bay Region. Many other councils throughout Australia have also adopted the '1 in 100 year' flood as their standard measure for the same purpose. Over a 100 year period, it is likely that such an event will be observed at the location shown at least once. It is also possible, though less likely, that a '1 in 100 year' flood or even greater flood could occur more than once over a 100 year period. For example, the inundation caused by the January 2011 flood event was greater than a '1 in 100' flood for some parts of the Moreton Bay Region.

2.Moreton Bay Regional Council makes no representation and gives no warranty about the accuracy, reliability, completeness or suitability for any particular purpose of the data shown on these plans. To the full extent that it is able to do so in law, the Council disclaims all liability, (including liability in negligence), for losses and damages, (including indirect and consequential loss and damage), caused by or arising from anyone using or relying on the data for any purpose whatsoever.

3.The information provided on these plans is extracted from the Council's flood study for the area. Changes in catchment and floodplain conditions since the study was prepared could alter the extent of inundation experienced. Future studies may also change or qualify the information provided on these plans.

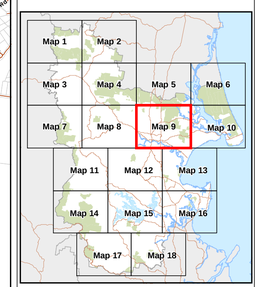
4.The extent of inundation shown on these plans was calculated using the Council's ground surface elevation data, which has known accuracy limitations. The extent of inundation shown on these plans should therefore be considered approximate only, particularly if the property is flat near the limit of the inundation shown. If the property was created as part of a subdivision but is identified as being inundated this may be because the land surface was modified.

5.The Council does not yet have flood information for all floodplains in the region. It is currently completing a 'Regional Floodplain Database' project, the aim of which is to provide more up-to-date mapping and include additional mapping for those parts of the region where information is not currently available. It is anticipated that the project should be completed by approximately mid 2012. If parts of your property are low-lying but no inundation is shown on these plans, it is possible that the property may still experience some flooding. If you are concerned about flood risk in any way, you should engage the services of a suitably qualified engineer to provide you with further advice.

6.The information provided does not relate to or take into account localised areas of inundation resulting from overland runoff from adjacent properties or when the capacity of street or local drainage systems is exceeded. In such circumstances, runoff will pond or flow to the lowest point and flow overland via the lowest available route.

7.Copyright in the spatial data shown on these plans is owned by Moreton Bay Regional Council and the Department of Environment and Resource Management.

8.You may obtain a more comprehensive flood search by contacting the Council on (07) 3205 0555 to request a flood search request form or by referring to the following Council website link www.moretonbay.qld.gov.au/floodplains.

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Date: 9 Feb 2011 | Scale: 1:20,000 (at A1)