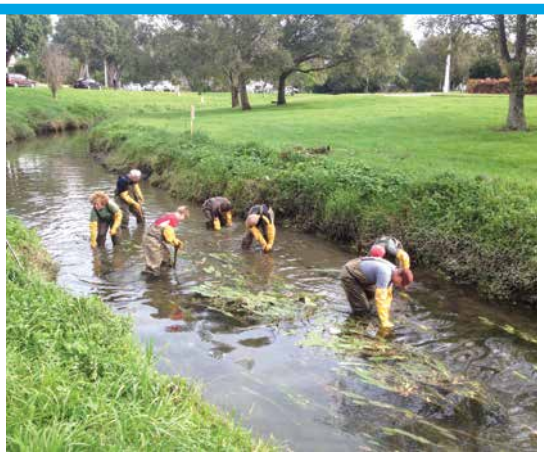
Guidelines for Floodplain Management Planning

greater WELLINGTON
REGIONAL COUNCIL
Te Pane Matua Taiao





Cover photos (clockwise from top left): Waingawa River 1940s; Waiwhetu Stream weed clearing, 2004; Waiwhetu Stream flooding 2004; Wainuiomata River 1998; Petone 1976 floods; Floodway near Waihenga Bridge, SH53, 2006; Otaki River Rail Bridge 2010; Pinehaven 1976 flood (middle photo)

Contents

Executive Summary

This document provides guidance on the floodplain management planning process, and on the preparation and production of Floodplain Management Plans. The purposes of the guidelines are to apply consistent principles and approaches in preparing Floodplain Management Plans throughout the region, based on good practice lessons in floodplain management planning, and to help Greater Wellington Regional Council (GWRC) meet its legislative responsibilities.

These guidelines contain general guidance on steps and actions for preparing a Floodplain Management Plan, but do not contain the Flood Protection Department's operational and business objectives, or specific engineering details or requirements.

The primary audience of this document is GWRC staff. It may also be of interest to a wider audience, such as members of the public who are directly affected by the risks and consequences of flooding, as well as central and local government and other organisations with a role or interest in floodplain management planning and practice.

The first part of the guidelines sets out the statutory and policy context for floodplain management planning. The process of and approach to floodplain management planning is influenced by legislation and direction from central and regional levels of government.

Following the statutory and policy context, the guidance is split into four sections based on the floodplain management planning process. There is a general guidance section which provides details on floodplain management planning objectives, the development process, the decision-making framework, reporting and implementation, engagement, and scoping.

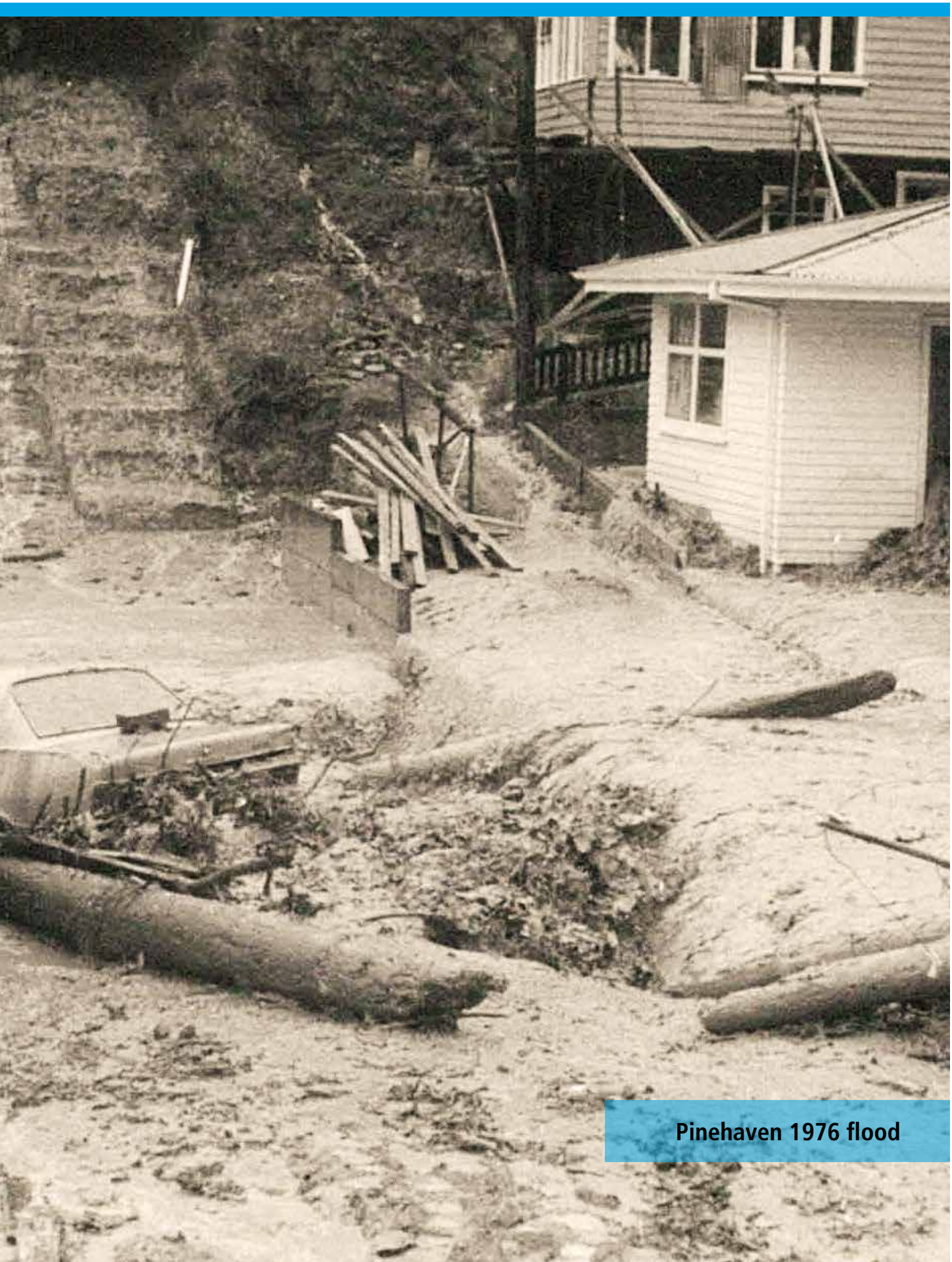
Section 3 of the guidelines focuses on Phase 1 of the floodplain management planning process: Establish the Context. In this section, guidance is provided on the information to be collected on the values of the floodplain, defining the flood issues and identifying and describing the flood risk. There is also guidance on the contents of the report to be prepared as an output from the Phase 1 process.

Section 4 relates to Phase 2 of the floodplain management planning process: Identify and Assess Management Options. In this section, guidance is provided on identifying potential options to address the flood issues and flood risk identified in Phase 1, and on the approach and methods for evaluating the options through a process of scoping, evaluating, selecting and refining. At the end of this section is guidance on the output from Phase 2.

Section 5 contains guidance on Phase 3 of the floodplain management planning process: Preparation and Implementation of Floodplain Management Plan. Guidance focuses on the issues and actions required to produce the Plan itself, and on processes and operations for implementing the Plan. This section also includes guidance on reviewing a Floodplain Management Plan.

These guidelines will be updated and revised in response to legislative or policy changes, changes in the Flood Protection Department's business plan, and future lessons learnt in the application of floodplain management planning in the region.

1. Background and Purpose



Pinehaven 1976 flood

1.1 Floodplain Management Planning – An Overview

Floodplain management planning is an internationally recognised process that provides a comprehensive long-term strategy for managing areas at risk from flooding. However, effective management of risk requires political leadership and widespread community understanding and acceptance of the range of flood risk measures available, and this can present particular challenges in selecting and implementing an appropriate response (for example, avoiding development in flood-prone areas versus structural protection measures).

Floodplain management planning generally involves the following steps:

- Investigating and understanding the probability and likely extent of flooding, and the economic, social, cultural and environmental values within a defined catchment;
- Identifying, evaluating and selecting a range of appropriate management options to reduce the probability and impact of flood risk; and
- Implementing a preferred option(s) for managing the flood risk in a way that ensures a co-ordinated response by relevant agencies and/or individuals.

This process results in a Floodplain Management Plan (FMP). Floodplain management planning is a high-level strategic planning tool that Greater Wellington Regional Council (GWRC) seeks to use with other key decision-makers and the community of a river catchment to identify and agree policies and options for sustainable flood risk management.

These Guidelines have been prepared by the GWRC to assist staff with the floodplain management planning process, and provide guidance on the preparation and production of FMPs. The Guidelines are structured into two main sections, as follows:

- Section 1 provides policy guidance on the objectives, outcomes and stages relating to the production of a FMP; and
- Sections 2 – 5 set out general and specific procedures and guidance for each step of the process and contains practical guidance on appropriate methodologies for the various aspects of the development of a FMP.

While GWRC staff are the intended audience of this document, it may be of interest to a wider audience, including people directly affected by the risks and consequences of flooding. In addition, the document may be useful to the wider community, central and local government organisations, and other public agencies and interest groups to increase their understanding of floodplain management planning and practice.

1.2 Flood Risk Management – National Policy Direction

Decisions about floodplain management need to be considered within the context of national, regional and local legislation, regulations and policy, and also need to align with best practice in floodplain management.

1.2.1 Legislation[1]

There are currently seven statutes of specific relevance to floodplain management which cover a broad range of private property and public good issues relating to land development and management, land use controls, flood risk management and its funding, flood emergency response and recovery, and flood protection insurance. These are:

- Resource Management Act 1991;
- Building Act 2004 (and Building Code 1992);
- Local Government Act 2002;
- Land Drainage Act 1908;
- Soil Conservation and Rivers Control Act 1941;
- Rivers Board Act 1908; and
- Civil Defence Emergency Management Act 2002.

Each of these statutes performs a distinct and important role in managing flood risk and provides a range of legislative mechanisms to enable effective flood management across local and central government.

To a lesser degree, a number of other statutes also influence flood risk management. These include:

- Public Works Act 1981;
- Local Government Official Information and Meetings Act 1987;
- Earthquake Commission Act 1993;
- Environment Act 1986; and
- Local Government (Rating) Act 2002.

This suite of statutes allows for a wide range of approaches to be applied to managing flood risk as follows:

1 McSweeney, John. November 2006. 'Overview of Flood Management Legislation in New Zealand'. Johnson McSweeney Ltd for Ministry for the Environment, Wellington.

1. *Hazard Control* measures such as the provision of stopbanks, channel maintenance and clearance, dams, etc. The Local Government Act 2002, the Soil Conservation and Rivers Control Act 1941, and the Rivers Board Act 1908 are the primary statutes which allow for these works to be undertaken. The Land Drainage Act 1908 and a number of localised drainage acts allow water-logged land to be drained for food production and urban purposes. Drainage schemes also contribute to modifying flood events. As the Land Drainage Act applies to natural watercourses, it can also be used as a mechanism to require landowners to maintain watercourses that traverse private land.
2. *Flooding information and education* is provided by a number of agencies. This includes scientific and practical information about flooding and ways to minimise the impacts of flood events. Specific mechanisms such as land information memoranda (LIMs) under the Local Government Official Information and Meetings Act 1987, provide the means by which members of the public can access site-specific flooding information from territorial authorities (where this is available).
3. *Flood hazard preparedness, response and recovery* measures are authorised principally under the Civil Defence Emergency Management Act 2002. This statute provides the legislative framework for national, regional and local communities to prepare for, and respond to, flooding.
4. *Flood loss insurance and financial assistance* is principally provided by the Earthquake Commission under the Earthquake Commission Act 1993. Central government can also provide disaster relief funding to assist local communities after large-scale flood (and natural disaster) events.

The Soil Conservation and Rivers Control Act 1941 mandates GWRC to protect communities within the region from flooding using the most appropriate methods.[2] The statute also authorises it to undertake physical works (including structural measures) to mitigate erosion damage and protect property from flooding. In effect, this means that it is up to the Regional Council and the local community to determine those rivers requiring most attention and the nature of the works required. In the Wellington region, only rivers and larger streams of "regional significance" are managed by the Regional Council. City and district councils handle smaller urban streams and stormwater channels.

1.2.2 Policy/Guidelines

Currently there is a lack of specific floodplain management policy or related guidance at the national level (eg, National Policy Statement). In the absence of such policy direction, decisions about flood risk management are primarily made at the regional level.

1.3 Flood Risk Management – Regional Policy Direction

1.3.1 Long-Term Plan

Under the Local Government Act 2002, at a strategic level, the GWRC is required to prepare a Long-Term Plan (LTP) that outlines key outcomes anticipated and services to be provided over the next 10 years. The current outcomes for the region are "strong economy, connected community, resilient community, healthy environment and quality of life". Flood protection is a key activity in achieving these community outcomes.

The LTP identifies that flood protection activities contribute towards achieving a resilient community by:

- *Reducing the risk of flooding in the region now and in the future by encouraging new development away from our most flood-prone areas; and*
- *Building planned flood protection works and informing communities about the risk and consequences of flood events in their area.*

The flood protection activities also contribute towards achieving the outcomes of:

- *A strong economy by minimising the impact of flooding on activities that contribute to the regional economy;*
- *Quality of life by enabling people to enjoy recreational use of river corridors; and*
- *A healthy environment by enhancing the environment along river corridors.*

The strategy for flood protection works outlined in the LTP reflects the vision and goals in Appendix 1. At the time of writing, the current relevant priorities outlined in the 2012 - 2015 LTP are:

- *Maintain existing flood protection assets;*
- *Complete planned flood protection structures;*
- *Raise public awareness through floodplain management planning and education;*

2 This Act's mandate enabling Regional Councils to carry out wider floodplain management planning has been largely superseded by the provisions of the Resource Management Act 1991. The Soil Conservation and Rivers Control Act 1941 provides the mandate to undertake works for the purposes of flood protection and erosion control but does not require GWRC to act. The Council's ability to do this as of right or to prevent others is implemented through the RMA consent process.

- *Investigate and model the potential impacts of climate change;*
- *Continue to build collaborative partnerships with territorial authorities and other government agencies, particularly in relation to managing flood risk through District Plans; and*
- *Utilise best-practice flood protection methods to enhance river and stream ecology and provide for recreational opportunities.*

In undertaking these activities, the LTP recognises FMPs and the Regional Policy Statement (RPS) as the two primary policy frameworks for flood protection in the region.

1.3.2 Asset Management Plans

The goal of asset management within GWRC's Flood Protection Department is "to meet a required level of service, in the most cost-effective manner, through the management of assets for present and future customers"[3].

Key elements of Flood Protection's asset management system are to:

- Provide a defined level of service and monitoring performance;
- Manage the impact of growth through demand management and infrastructure investment;
- Take a lifecycle approach to developing cost-effective management strategies for the long term that meet that defined level of service;
- Identify, assess and appropriately control risks; and
- Have a long-term financial plan which identifies required expenditure and how it will be funded.

There are existing Asset Management Plans for all flood protection schemes which have physical/structural assets. The existing Asset Management Plans would inform Phase 1 of the FMP process, relating to the condition of existing assets and their effectiveness in managing flood risks. Asset Management Plans would be reviewed following adoption of a FMP to ensure they reflected the FMP objectives and selected options. When new physical/structural assets are implemented (built), the Asset Management Plans should also be updated.

3 NAMS 2011. Definition of asset management taken from International Infrastructure Management Manual.

1.3.3 Regional Policy Statement

As part of its responsibilities under the Resource Management Act 1991 (RMA), GWRC is required to prepare a RPS which identifies the significant resource management issues for the region, and outlines objectives, policies and methods to manage the region's natural and physical resources.

The Greater Wellington RPS contains a specific topic on natural hazards, with river flooding identified as one of the three most significant natural hazards in the region. It also contains the following natural hazard-related objectives:

- *Objective 18: The risks and consequences to people, communities, their businesses, property and infrastructure from natural hazards and climate change effects are reduced.*
- *Objective 19: Hazard mitigation measures, structural works and other activities do not increase the risk and consequences of natural hazard events.*
- *Objective 20 Communities are more resilient to natural hazards, including the impacts of climate change, and people are better prepared for the consequences of natural hazard events.*

To achieve these objectives, three principal policies are relied upon:

- *Policy 28: Avoiding subdivision and inappropriate development in areas at high risk from natural hazards – district and regional plans.*
- *Policy 50: Minimising the risks and consequences of natural hazards – consideration.*
- *Policy 51: Minimising adverse effects of hazard mitigation measures – consideration.*

In terms of responsibility for implementing these policies, the RPS states (Policy 62) that these responsibilities are shared between the Regional Council and City/District Councils, and identifies a range of methods, including:

- *Method 1: District plan implementation (city and district councils).*
- *Method 4: Resource consents, notices of requirement and when changing, varying or reviewing plans (Wellington Regional Council and city and district councils).*
- *Method 14: Information about natural hazard and climate change effects (Wellington Regional Council, city and district councils and Civil Defence Emergency Management Group).*
- *Method 22: Information about areas at high risk from natural hazards (Wellington Regional Council and city and district councils).*

- *Method 23: Information about natural features to protect property from natural hazards (Wellington Regional Council and city and district councils).*

A FMP provides the framework for determining the nature and extent to which each of the above methods is necessary to respond to identified flood risks.

Any Regional Plan or District Plan prepared under the RMA is required to put a RPS into practice. These plans help the respective regional and city/district councils to carry out their resource management functions, including managing natural hazards and their associated effects, and to develop ways to deal with the full range of floodplain management planning issues.

The Regional Freshwater Plan supports the Regional Council's development of FMPs and provides guidance for managing development in flood-prone areas, as well as the policies and rules to manage structural measures (eg, river control works).

1.4 Floodplain Management Planning – Anticipated Outcomes

The Flood Protection Department Vision and Goals are set out in Appendix 1. In realising these, the outcomes sought by FMPs are as follows:

- Reduce the risk of flooding, and the impact of flood events on people and the natural, historic and built environment;
- Maximise opportunities to work with natural processes and to deliver multiple benefits from flood risk management, including positive environmental, cultural, recreational and economic outcomes;
- Identify, evaluate and apply a broad range of measures to address the flood risk in a manner that:
  - reduces potential flood damage to acceptable levels for existing development in flood-risk areas, through river management and structural measures that do not impose unacceptable limitations or costs on future generations; and
  - promotes sustainable flood risk management by generally discouraging new development in flood risk areas, through, for example, appropriately targeted regulation in regional and district policies and plans;
- A highly engaged and informed community that:
  - is involved in decision making throughout the FMP development process;
  - understands the flood hazard risks and the multiple values of the floodplain; and
  - is actively involved in the identification and evaluation of acceptable flood management options;
- Support the implementation of relevant legislative requirements and associated national, regional and local policy directives.

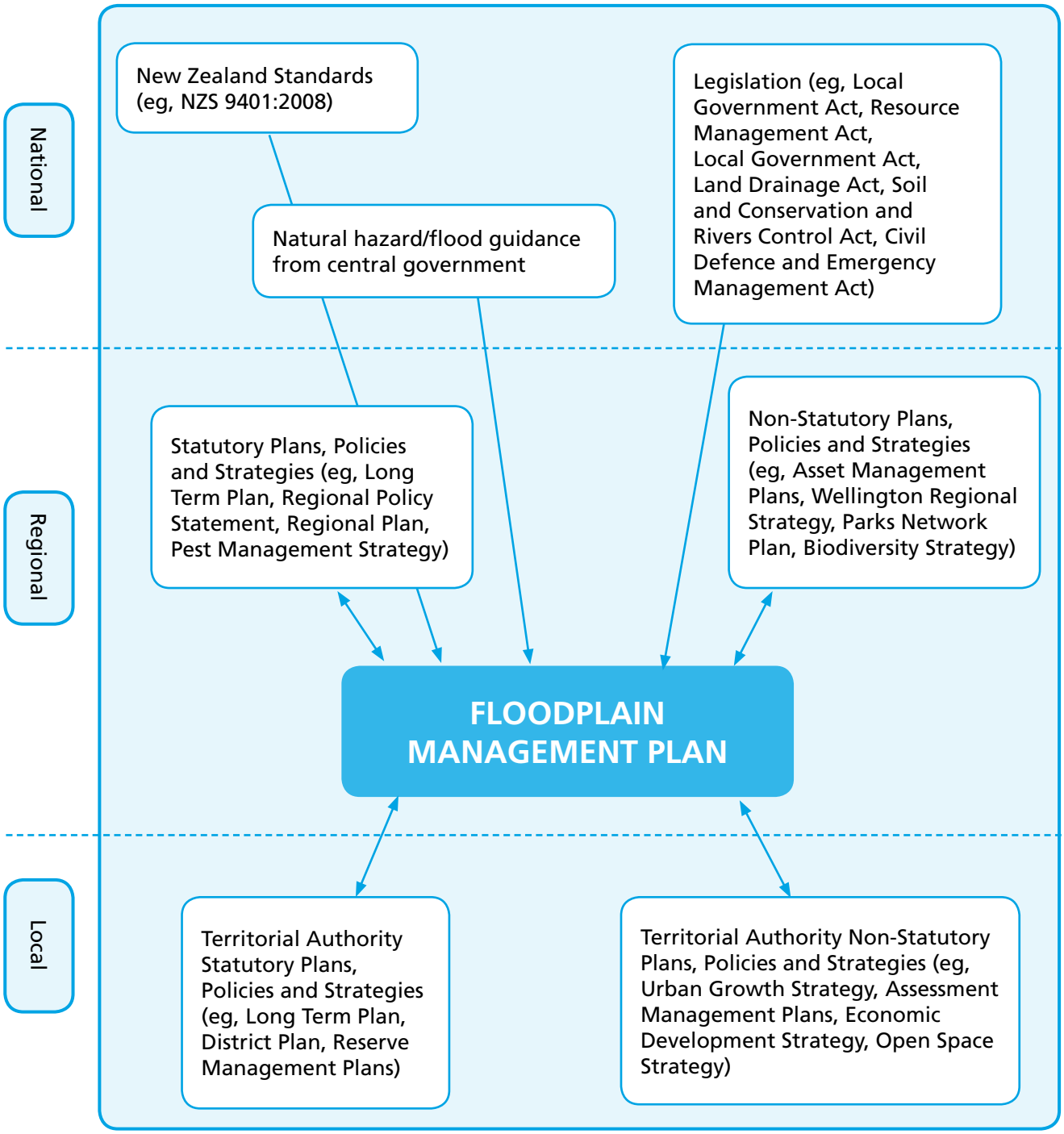
These outcomes are the broad, long-term targets anticipated for flood risk management at the regional scale.

However, FMPs are non-statutory plans and, as such, their policies and flood mitigation methods have no legal standing as regulations. Regardless, FMPs carry considerable weight in any decision making for the following reasons:

- The public process undertaken to prepare the plans; and
- The Council's statutory responsibility for flood protection in the region.

Figure 1 below illustrates where FMPs fit into the overall relationship of flood protection policies and plans.

Figure 1: Relationship of FMP to Other Statutory and Non-Statutory Documents



2. Floodplain Management Planning Process – General Guidance

Spring Fair, Belmont Domain, 2009

2.1 Process Objectives

In preparing a FMP, there are a number of objectives that GWRC is seeking to achieve. These include:

- Engage with communities and stakeholders to identify and understand flood issues and risks, formulate and evaluate flood risk management options, and implement the FMP, so that decisions are a shared responsibility of all relevant interests. Decisions will be based on how communities seek to manage risk in terms of their interests and affordability;
- Undertake an assessment of current and projected flood risk from all sources within the catchment by understanding the parts that make up risk (both probability and consequence) and the effect of current measures to reduce flood risk;
- Identify opportunities and constraints within the catchment to reduce flood risk through strategic changes or responses such as changes in land use, land management practices and/or the flood protection infrastructure;
- Develop complementary policies to manage long-term flood risk that take into account the likely impacts of climate change and the effects of land use and land management within the floodplain and wider catchment, and that offer a range of benefits, including contributing towards sustainable development;
- Identify, when managing flood risk, opportunities to maintain, restore or improve the natural, recreational and cultural values of the river and catchment; and
- Identify and assess the relative priorities for actions or projects to manage flood risk within the catchment, and assign responsibility for their implementation.

Any weighting that might be applied between structural and non-structural measures will be influenced by practical considerations, such as:

- The nature and extent of development on the floodplain;
- Whether the river's natural pathway is already confined by development; and
- The costs of constructing and maintaining structural measures and the imposition on landowners of land use controls.

2.2 Development Process

To achieve these objectives, the FMP process employed by GWRC comprises the following key elements:

a. Collective decision making and accountability (refer Sections 2.2.1 and 2.2.2);

b. Active community engagement (refer Section 2.2.3);

c. Structured risk assessment process (refer Section 2.2.4); and

d. Project scoping and start-up (refer Sections 2.2.5 and 2.2.6).

Each of these elements is outlined in further detail below.

2.2.1 Decision Making

Floodplain management planning requires input from a variety of sources. Individuals and organisations that contribute input need to have a clear idea of their roles and what is expected. To inform decision making, the following questions may be helpful:

- Who makes the decisions in the planning process?
- How do they get access to the information and knowledge necessary to make those decisions?

Establishing a framework, similar to that illustrated in Figure 2 below, helps identify who makes the decisions, while thinking about reporting and implementation accesses the knowledge needed to help people make decisions. The specific decision-making framework for each FMP would be determined as part of the initial Scoping Report discussed in Section 2.2.6 below.

2.2.2 Reporting and Implementation

Reporting is required throughout the FMP process, both during and at the end of each phase. The reporting needs to document information collected, community issues and views/preferences, and reasons for decisions. The prepared reports need to be tailored for the audience. For example, reports for community engagement need to be written in plain English and be understandable to lay people. The guidance below in Sections 3 – 5 identifies the nature and content of reporting for each phase.

Generally, the following matters should be reported on:

- Objectives for managing the particular area of floodplain under review;
- Various issues, problems, special features and values of the area;
- How the FMP is to be carried out, including information describing how particular areas of land are to be used and managed to achieve the specified objectives; and
- Means and timing of implementation, including processes for ongoing management, monitoring and review.

The final FMP would report the outcomes of the floodplain management planning process, with Section 5.1 containing an outline on the contents for a FMP. The final contents of the plan would depend on the nature and scale of the flood issues and hazard, the management options assessed and selected, and the implementation plan.

Once the outcomes of the floodplain management planning process have been adopted, the final step is implementation. Not all provisions of the floodplain management planning process can be implemented immediately. Generally, planning and emergency management measures, such as land use and building controls, flood education and public awareness programmes, can be implemented relatively quickly. Funding availability determines when certain options can begin. A strategy needs to be developed to implement the various elements of the planning process over time, and this strategy should include the staging of measures that depend on availability of funds, the adoption of interim measures, and prioritising the timing of individual measures. GWRC's Long-Term Plan process will be crucial to effective ongoing implementation.

2.2.3 Engagement

Engagement with affected individuals, organisations, iwi and the public is essential in formulating, accepting and implementing outcomes. Reference should be made to GWRC's Community Engagement Toolbox (WGN_DOCS_#947850) when planning engagement for the FMP process.

When input from a variety of sources is needed, it has to be co-ordinated. The best way to do this is to ensure an engagement/communication and decision-making framework is put in place as part of the Project Plan. The engagement/communication component of the Project Plan should support the adoption of clear and consistent messages, be pro-active and encourage a high level of public involvement. Planning for engagement should not be viewed as a one-off exercise; instead it is about creating an ongoing process of engagement that can be applied at all stages of the floodplain management plan process.

The engagement/communication strategy should help ensure that affected individuals, organisations, iwi and the public:

- Are provided with accessible and comprehensible information on flood risk and management options;
- Are aware of actions being taken by GWRC and other authorities responsible for managing flood risk;
- Have appropriate expectations for the level of flood protection that can be provided;
- Have access to information on the consequences of key flood risk management options and decisions;
- Have clear opportunities to communicate their views and priorities for flood risk management;
- Have confidence that their views and priorities are fully considered in decision-making processes; and
- Understand the basis on which decisions have been made.

Public engagement and participation in floodplain management planning will help reassure the public that sustainable actions are being selected. In undertaking public engagement, the focus should be on:

- Building understanding and trust locally, particularly through inclusive decision making;
- Involving local residents, landowners and key community representatives in the planning process;
- Clarifying the responsibilities of both public bodies and home and business owners and the important supportive role that voluntary organisations assume;
- Agreeing priorities and setting realistic expectations, to best achieve the needs of those with different interests; and
- Raising long-term awareness of flood risk and how this risk can be sustainably managed.

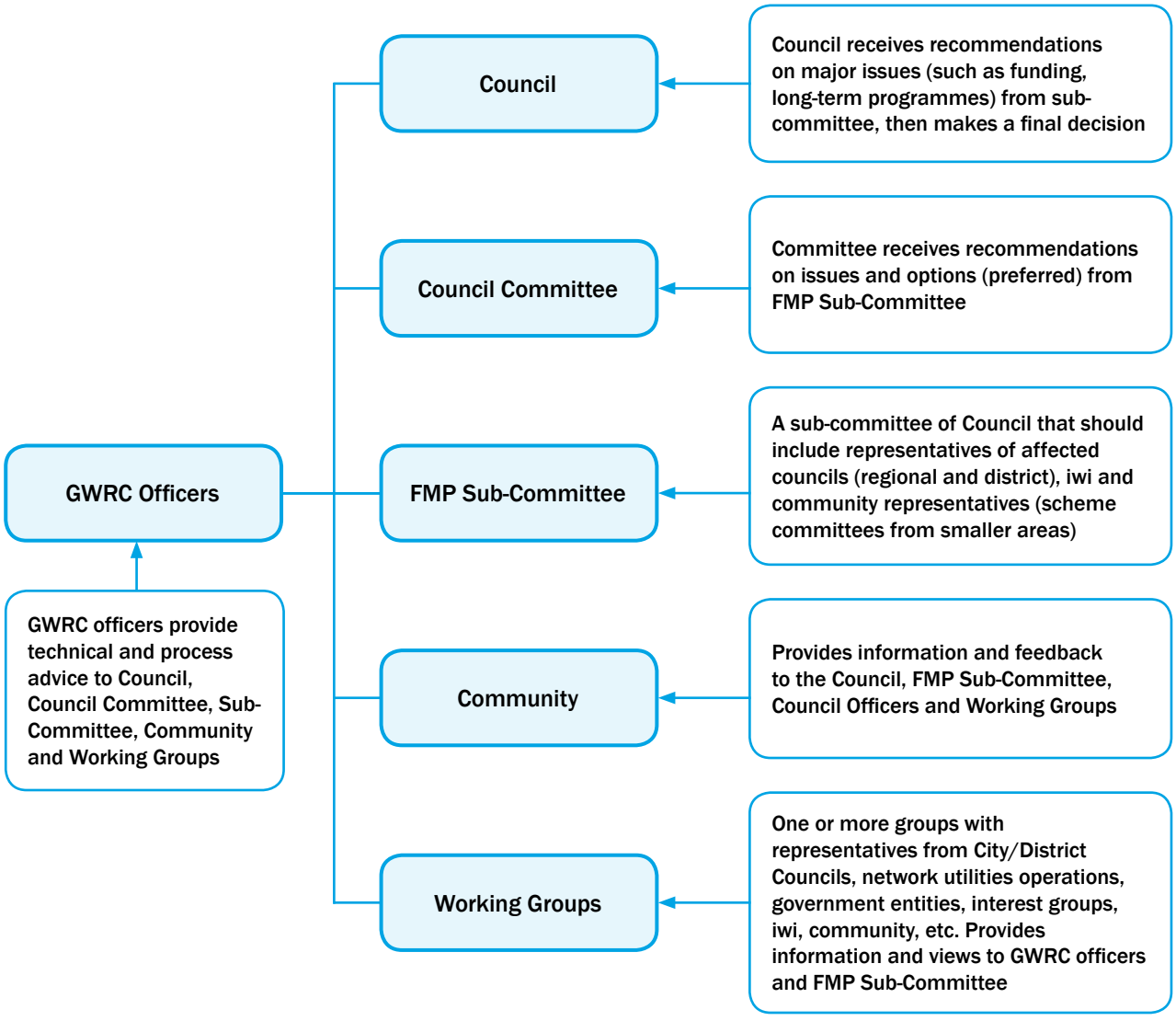
As highlighted above, engagement should occur at all phases of the floodplain management process. In particular, it should occur when:

- Defining the flood issues and values of the floodplain;

- Developing options (the combination of measures for flood risk management);
- Assessing options (using social, environmental, economic, technical and political acceptability criteria); and
- Preparing a plan for implementing the selected options.

The framework can also define who is responsible for preparing, evaluating and deciding on floodplain management planning options. Figure 2 below illustrates an engagement/communication and decision-making framework that is anticipated to be used for most FMPs.

Figure 2: Engagement and Decision-Making Framework



The multi-phase approach to floodplain management planning in the Wellington region allows for several stages of engagement, including newsletter drops, newspaper inserts, press releases, and draft documents, as well as public meetings. Further information on various methods and approaches to engagement is available in the GWRC publication "Community Engagement Toolbox".[4]

In developing the Hutt, Otaki, Waikanae and Waitohu FMPs, input was sought from the community, iwi, business and agencies over several years. In particular, this engagement focused on:

- Sharing new flood hazard information and examining issues concerning the community;
- Likely social and economic impacts of flooding;
- Developing and confirming design standard, river management, structural, planning and emergency management options;
- Forming environmental strategies to enhance river environments; and
- Preparing a floodplain management plan.

This approach is deliberately comprehensive to ensure that responses to key issues can be more effectively considered, acted upon and agreed with the community over a longer period. When developing the above-mentioned plans, GWRC endeavoured to go into each engagement phase with reasonably comprehensive information for the community to understand and respond to. This approach helps to reduce the chances of the engagement time dragging on.

The benefits of the multi-phase approach are as follows:

- It results in widespread community understanding of the nature and extent of the flood problem;
- It identifies issues at an early stage; and
- It leads to a more enduring FMP.

However, this approach is not devoid of disadvantages – the obvious ones being that segments of the community can feel over-consulted and in larger communities it can be harder to engage in a meaningful and/or effective manner. This approach also requires significant resourcing and staff time.

4 GWRC (2010), Community Engagement Toolbox (WGN_DOCS_#947850)

2.2.4 Structured Process

Assessments about the level and focus of floodplain management planning are made within a structured process, the benefits of which are:

- Combinations of measures to address the flood hazard are able to be devised with appropriate engagement and in an atmosphere free of the stresses which actual events create;
- Flooding consequences are mitigated through identifying areas susceptible to flooding, who is potentially affected and problems that may be encountered; and
- Planning ahead reduces the impact on a community by creating a justified priority order of measures and actions that will improve the community's ability to manage the flood risk. This approach enables a set of measures to be devised that would otherwise be managed in an ad hoc fashion.

The focus of this approach is therefore on ensuring a good "process" is followed, and that this, in turn, will lead to the achievement of good floodplain management outcomes.

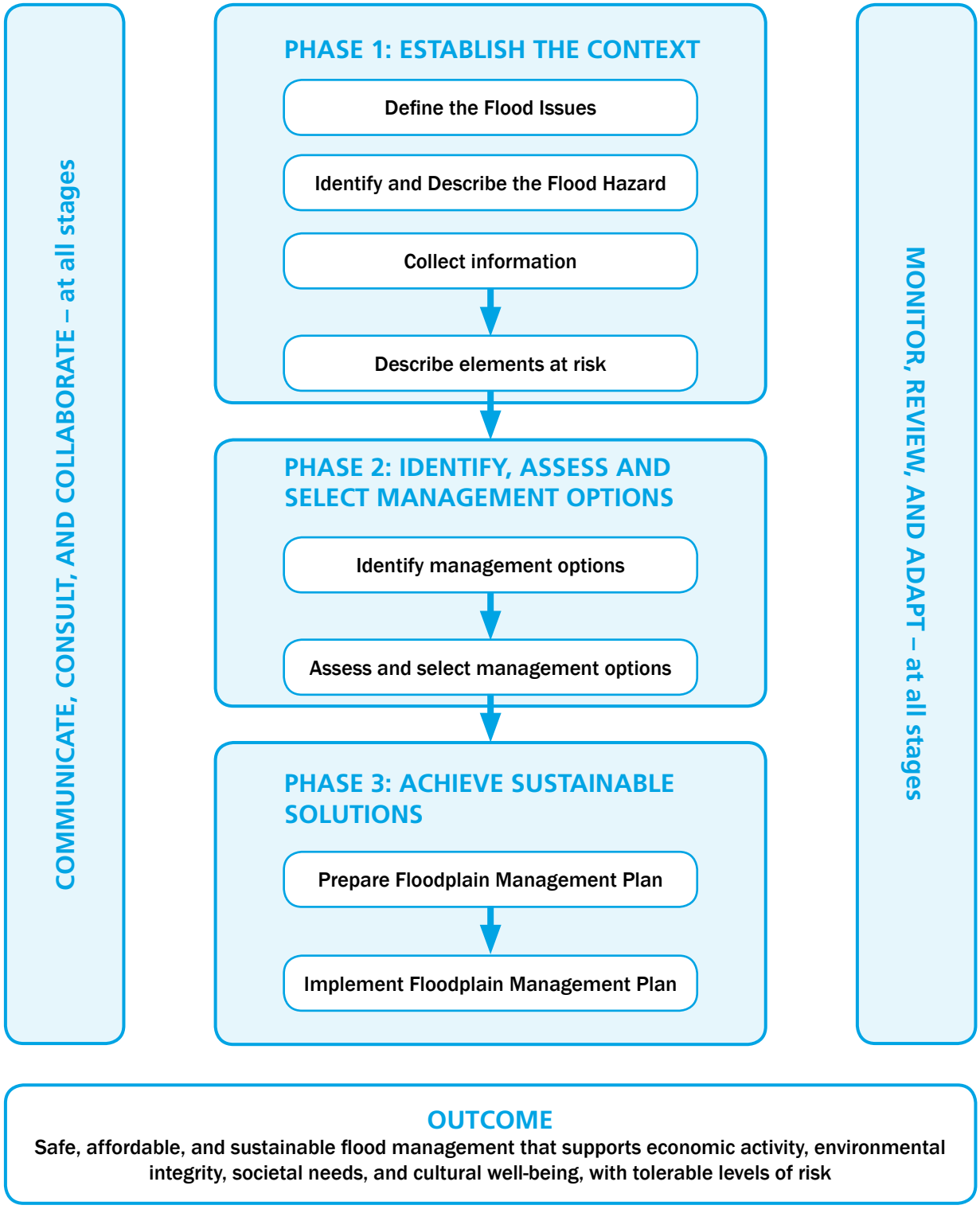
A structured process is adopted for floodplain management planning using a risk management framework as shown in Figure 3 below. This methodology is useful regardless of the size or scale of the potential flood problem, as the extent of information collected and size of the study can be adapted to suit local needs.

The process for developing a FMP involves the following phases:

- Phase 1: Establish the context;
- Phase 2: Identify and assess the management options; and
- Phase 3: Achieve sustainable solutions.

Phase 2 is the most complex of these phases, and is therefore the most challenging and time-consuming facet of the FMP development process.

Figure 3: The Floodplain Management Planning Process (based on NZS 9401:2008)



2.2.5 Project Start-Up

The initial step in preparing a FMP is project start-up and scoping. The main purpose of this step is to define the nature and scope of the FMP and to establish the structure for preparing the FMP.

The first task involved in this step is to define the proposed boundaries to be covered by the FMP. Typically this boundary will follow catchment boundaries, but in some circumstances may only apply to the main river/floodplain and/or include some or all of its tributaries. A FMP could also cover more than one main river. The anticipated output of this task is a map illustrating the location of the boundaries for the FMP.

The decision making and reporting and implementation requirements associated with preparing a FMP are outlined in Sections 2.2.1 and 2.2.2, with delivery occurring through the formation of plan-specific Sub-Committees and Project Teams.

The main objective of the Sub-Committee is to assist the Council in the development and potential implementation of the FMP. The Sub-Committee is the focus of, and a forum for, the discussion of issues and options from a range of viewpoints (eg, technical, social, economic and ecological) and the distillation of possible solutions or preferred approaches. The Sub-Committee would be the primary forum where community views are expressed and discussed. It is important to recognise that the Sub-Committee role is advisory in nature, as responsibility for the final FMP lies with the Council.

The Sub-Committee would be made up of GWRC Councillors and key stakeholder representatives (eg, Councillors and/or staff of City/District Councils), landowners, iwi, interest groups (eg, Fish and Game) and government departments (eg, Department of Conservation). GWRC would appoint an independent chair for the Sub-Committee, preferably someone with local knowledge and an understanding of the issues.

By contrast, the Project Team would be responsible for preparing and delivering the FMP. The team would primarily consist of GWRC staff from the Flood Protection Department, but staff from other departments could also be drawn upon, along with additional external support for technical aspects of the FMP on an as-needed basis. A Project Leader would be appointed to lead the team.

2.2.6 Scoping

Scoping is one of the most important tasks in the FMP process, as it clarifies what the FMP process is intending to achieve, how it will be implemented, who is to be involved and what the timing of it will be.

A variety of data is needed to assess flood risks and the effectiveness, costs and benefits of management measures. Key tasks during this scoping step are to define the data and information that is needed for the FMP, collate what is currently available, and identify information gaps. Where gaps exist, the nature and scope of the information required should be clearly documented. Below is a list of the data and information that should be researched and collated as part of the scoping exercise:

1. General Information Requirements and Availability
    - Land and property information;
    - Aerial photography;
    - LiDAR Survey and DTM;
    - Cross-section survey.
2. Phase 1: Technical Information
    - Climatology and hydrology assessment;
    - Floodplain hydraulics;
    - River channel characteristics and geomorphology;
    - Assessment of current flood protection assets;
    - Damage and loss assessment;
    - Ecology;
    - Cultural values;
    - Recreation, landscape and historic values;
    - Planning and land use.
3. Phase 2: Management Options and Assessment
    - Options development;
    - Options assessment.

From the available data and information, an initial understanding of the floodplain issues should be developed. This initial understanding of the issues would inform priorities for data/information/research and the overall engagement approach. As part of the scoping stage, a general engagement and communication plan[5] would be prepared, which would outline the key stakeholders and target audience for the FMP, and how and when these parties would be consulted.

The information gathered during this stage would

5 GWRC has templates that should be used to develop a communications plan, but these should be discussed with the Communications Team.

be collated and presented in a Scoping Report. This report establishes the specific process and requirements for preparing the FMP, and is intended to be an internal GWRC document (ie, generally not for public distribution or engagement). A document and data archive would also be compiled that contains all information sourced and referenced in researching and preparing the Scoping Report (as an information repository in the development and implementation of the FMP).

3. Floodplain Management Planning Process – Phase 1

Public meeting, Te Kauru, FMP, 2014

3.1 Establish the Context

Phase 1 of the FMP process involves establishing the context by capturing information on the current state of the river environment, including the hazards it presents to the surrounding community. This phase will typically involve hydrological/hydraulic analysis, hazard assessment, geomorphic assessment, terrestrial and aquatic ecology studies, bird nesting/habitat assessments, assessment of recreational and amenity values and understanding cultural and historical values. This phase also involves establishing contact with stakeholders and providing an outline of the timeframes and deliverables.

Phase 1 builds on the knowledge gathered during the scoping stage and addresses the information gaps identified. The sub-sections below outline the key activities to be undertaken as part of Phase 1.

3.1.1 Phase 1 Engagement

The purpose of engaging with the community during Phase 1 is to identify and confirm the flood issues, the values of the floodplain and elements at risk from flooding, and to confirm the FMP objectives. In collecting information through this phase, it is likely that contact will be made with a variety of parties/stakeholders who hold or manage relevant data/records.

The nature and extent of engagement in this phase should reflect the area and community of interest relating to the FMP, as well as the size of these. However, to ensure that the process is effective, a variety of methods should be employed, such as summary information (newsletters, summary documents), open/field days, community meetings and one-on-one meetings (refer to Section 2.2.3 – Engagement).

3.1.2 Collect Information

A variety of information is required to assess flood behaviour and the effectiveness, costs and benefits of various management measures. Social, economic, and ecological information should be considered alongside flood data and information on the benefits of the various management measures.

Table 1 below identifies the core information that would be collated in Phase 1. The information listed should be appropriate for the majority of rivers in the Region. However, it may be necessary to source further information, where specific issues associated with a particular river have been identified.

Table 1: Phase 1 Information to be Collected

Topic	Type of Information	Reason for Collecting Information	Potential Information Source
Flood Records	Past flood data, flood behaviour (including extent and depth, major flow paths and ponding areas), peak flood levels, flow velocities, rate of rise and fall, duration, travel time, flood damage – extent and cost, etc.	To provide baseline data against which hydraulic modelling can be compared and calibrated. To assist in the development of hazard maps and design channel alignments during later stages of the FMP process.	GWRC flood records, newspaper reports which may show flood extent and damage, photographs, information from the community, especially photographs
Climatology and Hydrology Assessment	Rainfall records and projections of future rainfall characteristics. River flow monitoring records.	To provide information used to develop hydraulic model. To determine stormwater patterns and frequency/size of design events.	GWRC and NIWA climate data records. GWRC river flood records.
Floodplain Hydraulics	Identify areas of flooding and erosion hazards.	To define the existing flood risk and identify areas of flooding and erosion hazard. Review the appropriateness of any existing hydraulic modelling to address FMP objectives.	GWRC hydraulic models.
River Channel Characteristics and Geomorphology	Geomorphology of the area, including soil and rock types and rates or evidence of erosion, deposition and seismic risk.	To provide information used to develop hydraulic model and hazard maps. Also, to assist with the design channel alignments during later stages of the FMP process.	Cross Section Surveys, LiDAR and historical GWRC records.
Assessment of Current Flood Protection Measures	Current floodplain management measures (structural assets, river management, planning and emergency management), their effectiveness and deficiencies, including costs and benefits.	To assess the current state of flood protection measures and define current quality and levels of protection.	GWRC Asset Management Plans, SAP and construction records, District Plans and Emergency Management/Civil Defence Plans

Ecology	Current ecological state of the river and floodplain – both aquatic and terrestrial habitats.	To report on the current ecological state of the floodplain and river, including water quality, fish counts and habitat qualities.	State of the Environment Monitoring Data (water quality), fish counts, benthic surveys, river health and terrestrial surveys (eg, Significant Natural Areas).
Cultural Values	Areas/places/sites of significance to tangata whenua, such as waahi tapu, mahinga kai and other taonga.	To understand the location, extent, nature and importance of cultural values, sites and areas of interest.	Iwi Management Plans, Regional Policy Statement, District Plans, Cultural Impact Assessments
Recreation, Landscape and Historic Values	Areas/places/sites of recreation, landscape and/or historic significance. Describes the amenity values of the river environment.	To understand the location, extent, nature and importance of recreation, landscape and historic sites and areas of interest. Identifies recreation, heritage and other interest groups who may wish to be involved in the floodplain management plan process.	Recreational groups, Angling Survey, Swimming Spots, Historical Societies, Regional Policy Statement, District Plan, NZ Historic Places Trust Register, NZ Archaeological Association Database
Planning and Land Use	Past, current and proposed land use within the catchment. Should be based on cadastral parcels.	To ensure flood management issues and options are developed in unison with local plans, local visioning and urban growth works, and policies for new development and planned changes. Identifying land parcels and property ownership assists in identifying who may be affected by the floodplain management plan.	District Plans, hazard maps, urban growth plans, and structure plans.
Consultation Database	Database of people and organisations potentially affected or interested in the development of the FMP (eg, iwi, residents, government departments, business/industry, interest groups, recreational organisations, schools and individuals).	To identify people and organisations potentially affected by the development of a floodplain management plan. Also, aids the development of an engagement strategy. Provides ready access to contact details.	Rating database, consultation database for other FMPs.
Archival Information	Historical data relating to a flood protection scheme compiled into a single document.	To create a consolidated record of all previous works to understand changes over time.	Existing flood protection scheme documentation.

The extent of information collected should be viewed in light of the following:

- Size and scale of the flooding issues;
- Community and political expectations and ability to pay; and
- Assets and the extent of the community potentially at risk.

Weighing up these factors will help to ensure that the right balance is achieved for different flood events across the district/region.

3.1.3 Define the Flood Issues

Defining flood issues sounds obvious, but it is an important first step to establish the extent of the floodplain management study. In many instances, these issues may already be identified in existing policy, planning or strategy documents (eg, RPS, District Plans, and previous FMPs or scheme documents). Further investigations can also be undertaken later in the process if warranted.

Identification of relevant flood issues could involve reviewing the above documents, holding GWRC cross-departmental workshops and engaging with the local community and stakeholders.

Once issues have been identified, they should be grouped under the following areas of functional responsibility for consistency and clarity:[6]

- Policy Issues – these include matters relating to GWRC's statutory management role;
- Technical and Operational Issues – these include issues relating to the management and improvement of flood defences and improvement of the physical and ecological environment within a river corridor; and
- Territorial Authority Issues – these include issues relating to reduction of flood risk in populated areas.

3.1.4 Identify and Describe the Flood Hazard[7]

This involves defining the nature of the flood hazard by providing information on the extent, level and velocity of floodwater and the distribution of flood flows across various sections of the floodplain, for the full range of flood events up to and including the Probable Maximum Flood (PMF) (see Figure 4 below). This flood hazard study constitutes the major technical foundation from which the FMP is formulated. The flood hazard would be defined for the area determined in the Scoping Report.

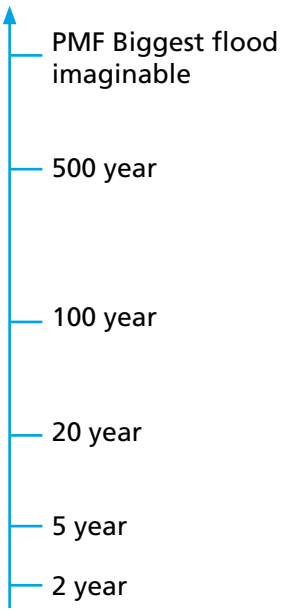
The principal components of the flood hazard study are:

- Flood discharges for floods of various sizes (hydrologic aspect);
- Flood levels and velocities for the various flood events (hydraulic aspects);
- Extent and security of existing structural measures (which may be beyond a technical collection exercise); and
- Spatial extent of the flood hazard.

6 An illustration of the application of this approach and an associated summary of key issues is contained in 'Living with the River' – Hutt River Floodplain Management Plan: Phase 1 Summary Report (GWRC, 1996)

7 The term 'flood hazard' also includes any associated erosion hazard

Figure 3: Continuum of Flood Events to be Modelled



Existing data, information and knowledge from previous studies may be used, and extensive additional studies may not be required. However, existing information or practices should be challenged to ensure a robust understanding of the flood risks. The extent and nature of information, analysis and modelled flood hazard should be appropriate to the objectives of the FMP, the assets at risk, community aspirations and cost. The models should be set up for use in Phases 2 and 3 of the FMP process to develop and assess management options. The level of detail and approach to hydrological and hydraulic modelling will vary for different floodplains; the aim is to apply the "best and most appropriate" model available at the time.

More detailed guidance on identifying and describing the flood hazard (eg, hydrologic analysis, hydraulic analysis, flood mapping) and a description of flood hazard effects is included in Appendix 2: Flood Study and Flood Hazard Effects. Any modelling undertaken should also comply with GWRC's current climate change policy and quality assurance/peer review process.

An output of this activity is information that illustrates the variation of hazard and flood behaviour across flood-prone areas. This information should be prepared in consultation with affected property owners and should be presented in a form that is easily understood by residents, landowners and the community (eg, maps showing the extent of the flood hazard).

3.1.5 Describe Elements at Risk

The final activity in Phase 1 is describing the elements at risk in a flood event. These elements include anything the community values that is exposed to the flood hazard. Much of the information needed to describe the elements at risk would be covered by the topics listed in Table 1 above.

The elements of the floodplain exposed to flood hazard include:

- People and communities on the floodplain, including people who use the floodplain (eg, numbers of people affected by flooding and the threat to life and health);
- The economy (eg, loss or damage to public and privately owned buildings), infrastructure (eg, water supply, sewerage systems, roads, energy, telecommunications etc), and activities (including agricultural) that have economic value;
- Social impact (eg, community disruption, loss of services, and intangible damages such as trauma and stress); and
- Environment and ecological impact (eg, poorer water quality and loss or damage to indigenous habitats).

These impacts from flooding should be considered for frequent minor flood events as well as catastrophic events.

Where major economic and social costs are anticipated, a specific flood damage and loss assessment should be undertaken. Such an assessment should include scenarios on potential changes on the floodplain, looking 50 years ahead (refer to Appendix 4: Economic Analysis). Scenarios should comprise combinations of:

- Urban development, both on the floodplain and in the wider catchment; and
- Change in land use and land management practices, both on the floodplain and in the wider catchment.

Information to determine future urban development trends and patterns and land use change could be drawn from the planning and land use assessment in Section 3.1.2 above. These future scenarios would be used in evaluating the options in Phase 2. However, it is helpful to develop them as part of Phase 1 so that they can be consulted on with key stakeholders.

3.1.6 Develop Draft FMP Objectives and Confirm Phase 2 and 3 Requirements

The options development and assessment in Phase 2 of the FMP process need to be guided by a set of specific objectives that apply to the floodplain. These draft objectives help inform the development and evaluation of the options, and provide a focus for discussing and weighing up the importance of various (sometimes conflicting) issues that are raised by the stakeholders during plan formulation.

The draft objectives need to relate to flood risk management within the floodplain, and should either be drawn from, or an expansion of, the following list of generic objectives:

- Minimise the risk to life, health and safety from a flood;
- Reduce the degree of damage resulting from a flood event;
- Ensure a high level of public awareness of the flood hazard;
- Ensure the community is aware of their own responsibilities, as well as the responsibilities of various organisations regarding flood preparedness and recovery;
- Ensure the traditional, spiritual and cultural values of the tangata whenua are adequately recognised in accordance with the principles of the Treaty of Waitangi;
- Maintain and enhance the environmental quality of rivers and their corridors;
- Recognise and provide for the recreational use of rivers and their corridors; and
- Develop and implement a FMP that is acceptable to the community (including its affordability), and that achieves community buy-in about future management of the floodplain and the level of flood protection to be provided.

These objectives provide a starting point for each individual FMP, and can either be tailored to the specific issues and circumstances of the FMP or adopted without change.

In determining and confirming the subsequent requirements for Phases 2 and 3 of the FMP, consideration should be given to the following:

- The nature of the flood issues;
- The extent of the flood hazard;
- Elements at risk (eg, existing and future development);

- Ability to fund management options relative to GWRC's funding policy; and
- The objectives of the FMP.

However, the level of detail required to inform Phases 1 to 3 needs to be carefully considered and should be determined on a "fit for purpose" basis.

3.1.7 Phase 1 Report

The output/deliverable from the above activities is a Phase 1 Report that contains:

- A summary of the information derived from each of the preceding activities; and
- Reference to associated technical investigations or their inclusion as an appendix.

At a minimum, the Phase 1 Report should contain:

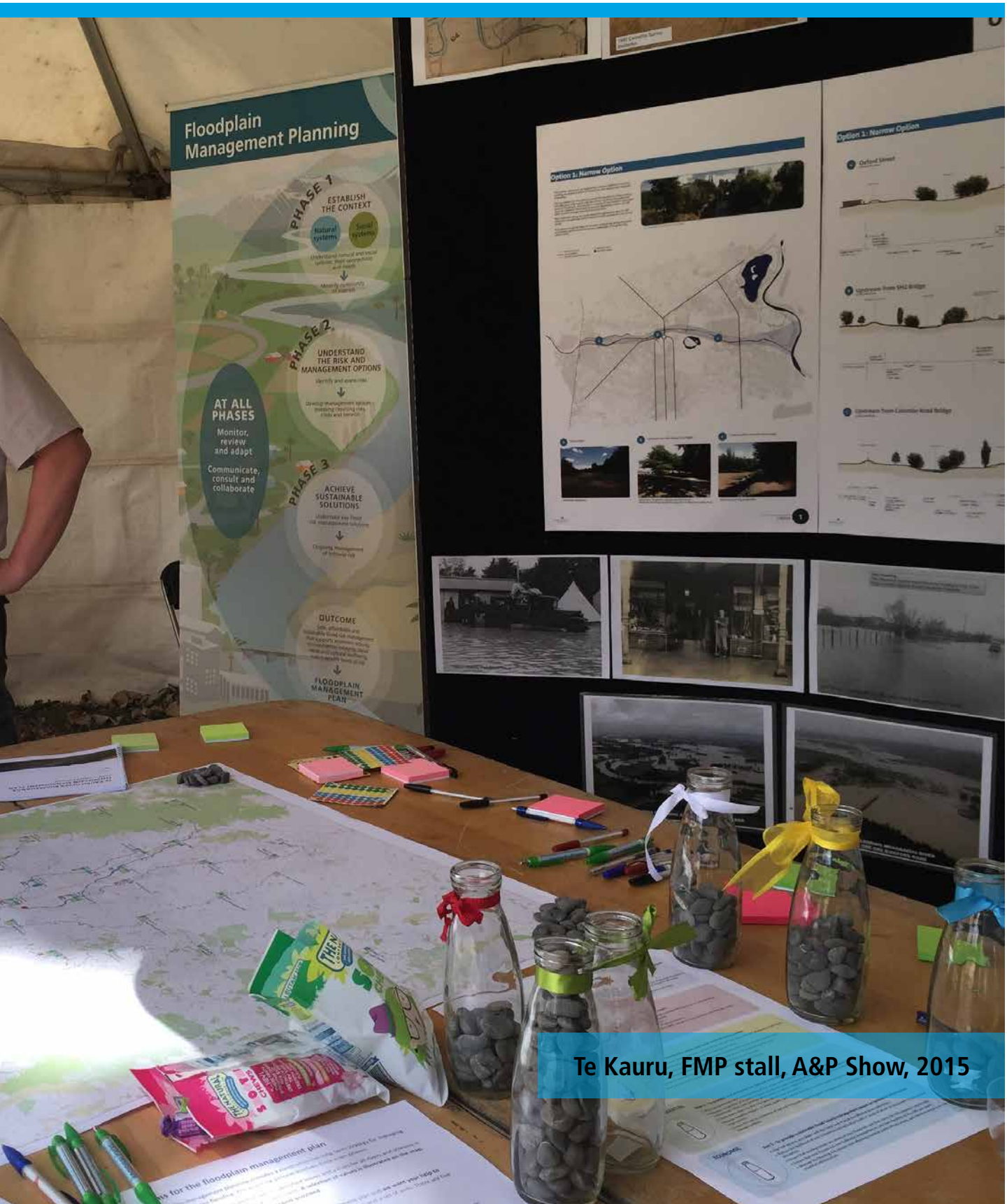
- River and Catchment Description
  - Climate;
  - Weather Pattern Response;
  - Structural Geology;
  - Catchment Geology;
  - Geomorphology;
  - Vegetation;
  - Soils and Erosion.
- Flood Issues
  - Policy Issues;
  - Technical and Operational Issues; and
  - Territorial Authority Issues.
- Flood Hazard
  - Hydrology; and
  - Hydraulics.
- Values of the Floodplain
  - Environmental;
  - Social;
  - Cultural;
  - Recreational;
  - Historic;
  - Landscape; and
  - Ecological.
- Elements at Risk
  - People and communities;
  - The economy, infrastructure and activities that have economic value; and
  - Social impacts.
- Draft FMP Objectives;
- Outline of Tasks and Programme for Phase 2; and
- Record of Community Engagement, including a summary of the process and key outcomes.

Following consideration and approval by the FMP Sub-Committee, the draft Phase 1 Report would be released for public comment. At this point the public would be invited to:

- Examine the issues raised in the report and highlight any significant flood issues or economic, environmental, cultural and social issues that may have been overlooked, or whether identified issues are more or less significant;
- Identify any major opportunities or constraints that should be taken into account during the assessment of management options; and
- Provide feedback on the draft objectives.

Based on the comments received, the report would be amended, if required, and referred to the FMP Sub-Committee for their consideration, response and approval, before being referred to the Environmental Sub-Committee for endorsement.

4. Floodplain Management Planning Process – Phase 2



Te Kauru, FMP stall, A&P Show, 2015

4.1 Identify and Assess Management Options

Once the context has been established for defining the flood issues and identifying the flood hazards and elements at risk, the next phase is to identify and assess the available management options, including opportunities for environmental enhancement.

This phase brings together the results of the flood study and data collection from Phase 1, and indicates the information and tools required to assess:

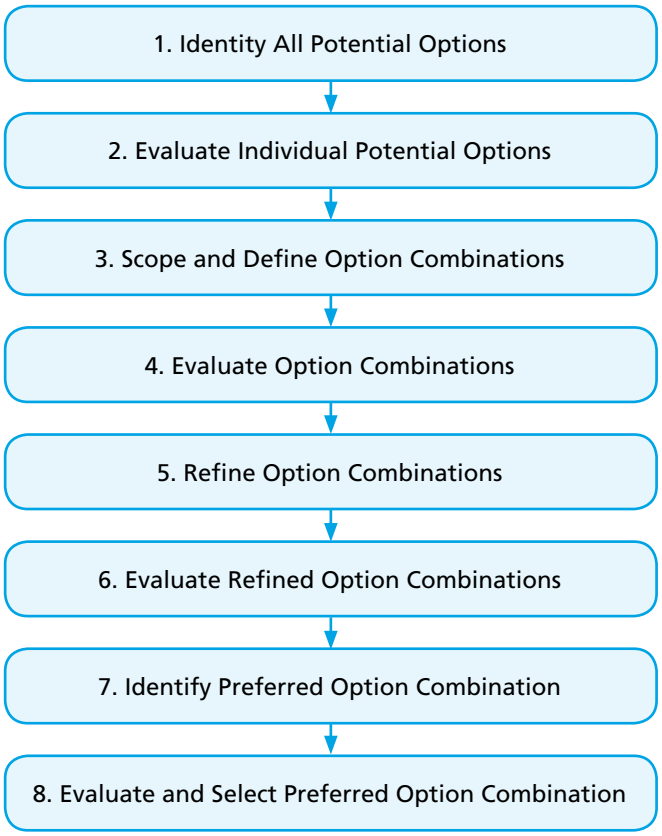
- The impact of existing, future and continuing flood risk management options on flood behaviour (ie, location and depth) and hazards; and
- The social, economic, environmental and cultural impacts and benefits of the options.

Phase 2 of the FMP process is focused on ensuring that decision making is transparent, robust, informed by various stakeholder/community views and technical advice, and well documented. It is also directed towards achieving (or balancing) multiple objectives.

Ultimately, the combination of preferred options identified at the end of this phase will inform the preparation of the FMP in Phase 3.

Outlined below is a step-by-step process for undertaking Phase 2. Although the process applies to all FMPs, the level of detail and information will vary, depending on the particular scale and complexity of the plan, and such factors as the level of flood risk, cost and community expectations. Community engagement occurs throughout this phase, but particularly in steps 1, 4, 6 and 8.

Figure 5: Process for Undertaking Phase 2



4.1.1 Phase 2 Engagement

The purpose of engagement during Phase 2 is to identify and assess the management options against the FMP objectives. Engagement with the community, and particularly key stakeholders, on identifying and evaluating the management options should occur throughout this phase and be as inclusive as possible (refer back to Section 2.2.3 for general guidance on engagement).

As GWRC staff are the technical experts on floodplain management, their role during this phase involves:

- Advising the community on the technical aspects and impacts of the identified management options and option combinations;
- Analysing community responses to the option combinations identified; and
- Identifying and evaluating the option combinations and advising on a preferred set of management measures.

The stakeholders engaged in Phase 2 are likely to comprise the Working Group(s) formed in Phase 1, along with any individuals and/or groups consulted during Phase 1 who expressed a willingness to play an active, ongoing role in developing the FMP.

However, as it is unlikely that stakeholders will remain constant throughout this phase (eg, change in property owners, representatives of different organisations), it is important that appropriate accommodation is made for people to enter and exit the process as required.

Ideally, those engaged during Phase 2 should represent a cross-section of the community and reflect a diverse range of perspectives, including local residents, landowners, businesses, and recreational, environmental and cultural interests. Key steps that stakeholders would be involved in include weighing up assessment criteria and evaluating the impacts of different options.

To ensure effective engagement, those participating need to be sufficiently well informed about the options and their implications to enable them to fully participate in developing and combining options. Care therefore needs to be taken that different options are presented in an impartial and balanced way, with sufficient technical and interpretive support provided by GWRC.

Wider public engagement in Phase 2 seeks to confirm whether, from the community's perspective, the management option combinations presented represent an appropriate response to the economic, environmental, cultural and social issues identified. It also provides the public with an opportunity to question the preferred options and to indicate whether they agree/disagree with the associated benefits, costs and risks. This feedback is used to help formulate the draft FMP, including re-calibrating the FMP objectives and preferred options.

Again, any such engagement needs to ensure that the community has enough information to make well-informed comment. Particular care also needs to be taken to ensure the engagement material is easily understood and tailored to the audience.

The nature and extent of engagement should reflect the area, size and community of interest relating to the FMP. Different engagement methods should also be considered (refer to Section 2.2.3 above), such as summary information (newsletters, summary documents), open/field days, community meetings and one-on-one meetings.

4.1.2 Step 1- Identify All Potential Options

This first step involves the development of a preliminary list of options to manage the flood risks identified (ie, a "blue sky" approach).

Two basic approaches are generally adopted to manage flood risk. These are:

1. Structural measures to modify the flood event (eg, stopbanks and floodwalls, detention dams, channel diversions); and
2. Non-structural measures to modify the level of damage susceptibility and flood loss burden (eg, land-use planning and building consent restrictions, managed retreat, flood-proofing, flood warning, community preparedness, response and recovery planning, insurance, and disaster relief).

A typical range of flood management options along with an associated description are included in Appendix 5: Flood Management Options.

4.1.3 Step 2 – Evaluate Potential Individual Options

The second step involves an initial evaluation of the list of options identified in Step 1, including an assessment of these options against either the "do nothing" or "do minimum" option (eg, maintain existing management regime as a baseline). The purpose of this step is to "filter" or reduce the list to a workable set of options for more detailed investigation and evaluation.

In undertaking this initial evaluation, the following factors should be considered:

- Practicality;
- Feasibility (technical and financial);
- Potential benefits and impacts (the environment, social, and cultural aspects);
- Likely ability to manage identified flood issues; and
- Community input.

It is also a good stage at which to engage with the community and to gauge their views on the options identified.

Although there should be enough information available from Phase 1 for this evaluation (including community engagement identifying the key flood issues and the effectiveness of existing flood management measures), it is recognised that the full range of relevant information and/or detail may be unavailable.

Ultimately this assessment will rely on the professional judgement exercised by GWRC staff as well as the knowledge and experience of the FMP Committee itself. Depending on the level of detail available, this assessment could be based on a simple pass/fail scoring system.

The output of this step is a summary report outlining the management options identified, along with the reasons why they should be accepted or discounted.

4.1.4 Step 3 - Scope and Define Option Combinations

This third step involves scoping and defining different combinations of individual management options. Each combination is likely to include a mix of measures representing each type of management option. In selecting the individual options for each combination, it is important that none of the individual options are incompatible or conflict with each other.

An example of the combinations developed for the Waiwhetu FMP is illustrated in Figure 6.

As part of the process of scoping and defining management options, a "design standard" for the river needs to be determined and agreed with the community. The term "design standard" refers to the flood size that structural measures are built to contain and non-structural measures to avoid or mitigate. The design standard also has a bearing on what measures are used and how.

In setting the design standard and associated management options, it is important to recognise that each FMP may reflect the flood risk differently based on the floodplain values identified and the community views expressed. The influence of factors such as climate change on flood return periods also needs to be recognised.

Figure 7 below shows how different management options can be applied to different flood levels in a FMP. The key outcome is to ensure that a co-ordinated mix of measures is used that addresses the existing, future and residual flood risk.

Figure 6: Example of Option Combinations from Waiwhetu FMP

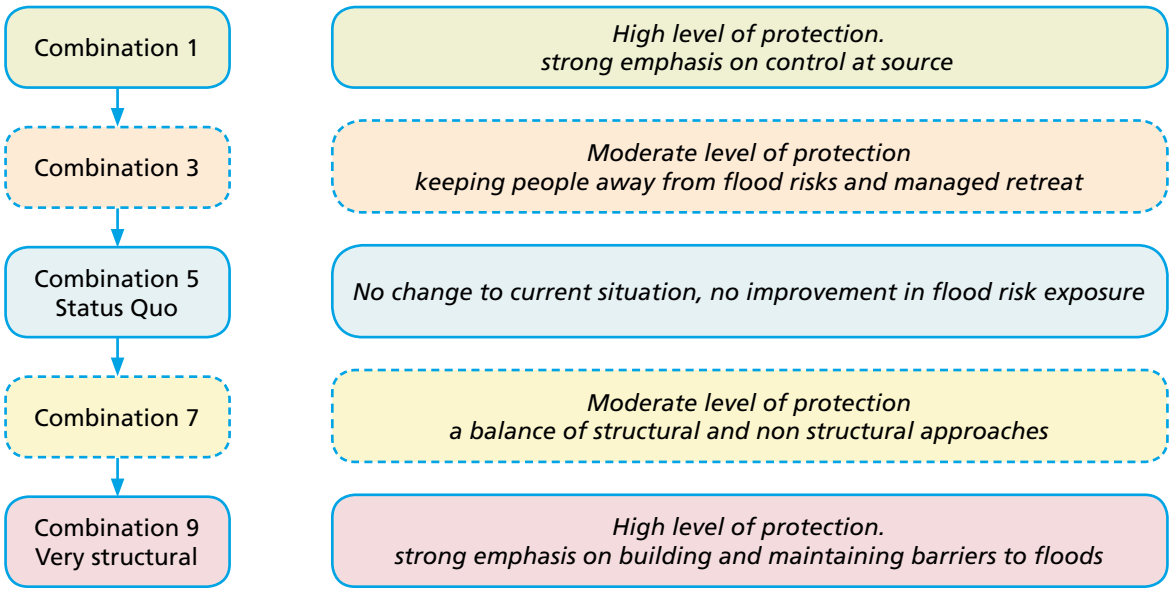
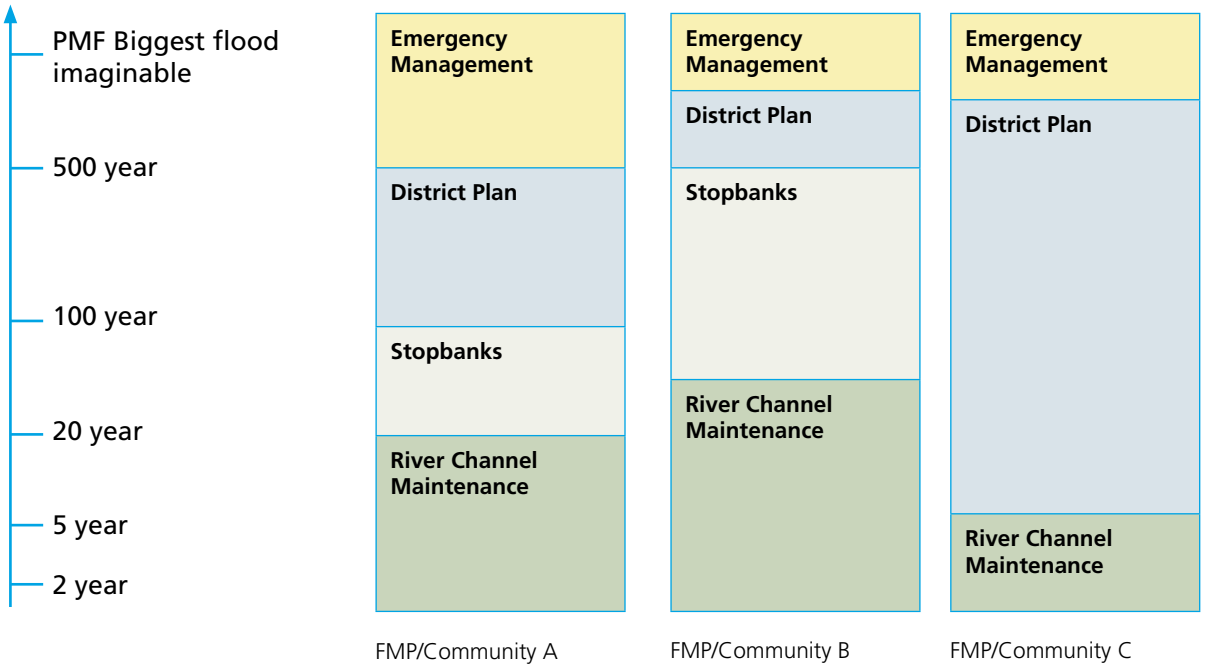


Figure 7: Flood Level Continuum and Different FMP Responses



Appendix 5: Flood Management Options contains further guidance on selecting the design standard, with the Hutt River FMP considered a good example of the process and considerations that could be used to guide the preparation of other FMPs.

The degree of detail required to define the option combinations should be proportionate to the complexity of the flooding issues, the size of the flood risk and corresponding consequences, and the anticipated cost of preparing and implementing the FMP.

Where no scheme exists, defining the "do nothing" option as the evaluative baseline is an obvious choice, due to the absence of structural intervention in natural processes. By contrast, where there is an existing scheme, the "do minimum" option involves maintaining structural and non-structural measures at existing service levels as the baseline.

For river management options, the full range of techniques and the scale of works would need to be identified and considered (eg, do nothing, continue with past and present practices, alter past and present practices, and/or undertake new types of river management activities). General information about the costs, benefits and impacts of the different management options should be sufficient for the initial evaluation, and could be derived from available information about the operation of the existing Scheme or other Schemes in the region.

For more detailed evaluations, it would be necessary to calculate and quantify the anticipated costs and benefits, as well as the respective environmental, cultural and social impacts. To ensure a fair comparison of options, river management costs should be compared against structural options based on net present value, including projected maintenance costs.

For structural options, the location, sizing and design would need to be determined, as well as the construction and maintenance costs. Various structural options built to design standards would be developed and used in different option combinations. The flood risk and elements at risk would influence the level of detail required for scoping and describing the structural options. For the initial evaluation, generic information from other recent structural options could be used as a guide. However, for the detailed evaluation, specific information for each structural option would be required (eg, cost/risk/benefit/environmental impact).

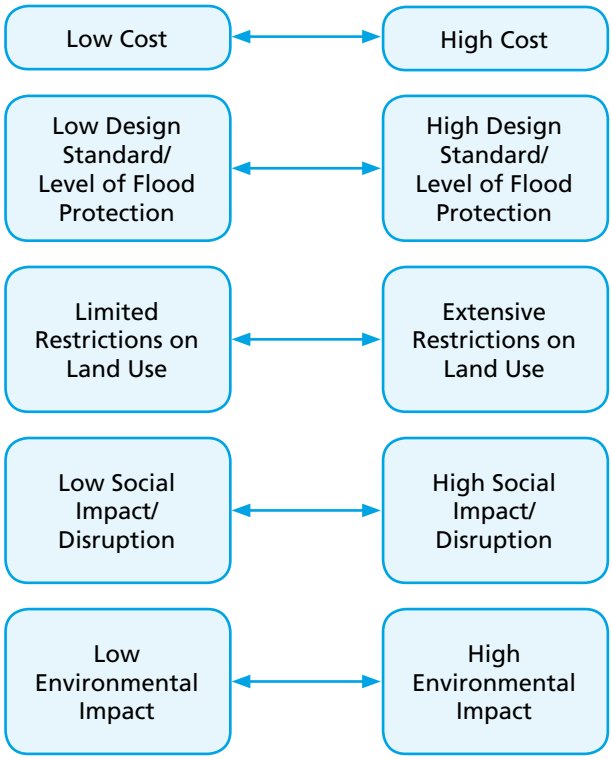
For planning and land use control options, the starting point is the current policies and controls in the Regional Policy Statement, Regional Plan and District Plan (eg, avoid new development and subdivision in existing "greenfields" situations, introduce minimum floor levels in developed areas). These measures may include flood hazard maps and associated rules (including when resource consent is required), urban growth strategies and

plans, individual resource consent applications and decisions, and built developments/subdivisions. The effectiveness of these existing controls should be reviewed in light of the flood issues identified in Phase 1 (eg, are the flood issues more or less significant than in the current planning documents? Have the planning controls reduced the flooding issues and risks?). The detail required for planning and land use control options should identify the flood extent of a 100-year flood event and what associated policies are required.

For emergency management options, the existing emergency management strategies and plans should be used as a guide on current measures in place. These existing measures may include flood warning systems, evacuation plans, emergency shelter, post-event contingency arrangements for network utility operators, and recovery plans. The effectiveness of these existing measures should be reviewed in light of the flood issues identified in Phase 1, as well as any other measures used in other areas.

To help the community to weigh up the options, proposed option combinations should be developed based on a range of continuums that cover relevant factors for consideration. Possible continuums that could be considered are illustrated in Figure 8.

Figure 8: Possible Factor Continuums for Considering Option Combinations



4.1.5 Step 4 – Evaluate Option Combinations

The fourth step involves making a thorough and robust evaluation of the management options defined in Step 3, many of which are likely to have been generated by the community. Evaluation should not begin until the options have been fully described, so that all participants in this step of the process (eg, FMP Sub-Committee Members, stakeholders and GWRC staff) are fully informed of the options.

This step draws on the information obtained during Phase 1 and involves each option being individually evaluated, recognising that some options will have different benefits, costs and associated risks. For example, an option that might be beneficial from a social/community impact perspective might also present an increased risk of flooding. Alternatively, an option that might be environmentally beneficial and pose a lesser flood risk could be undesirable from a community perspective.

Although it is important that the evaluation process is as objective as possible, it needs to be informed by technical advice and community views. To aid evaluation, the complex set of matters to be considered also needs to be translated into a form that is simple and transparent for decision making. An effective tool for this is multi-criteria analysis.

Multi-Criteria Analysis

Multi-Criteria Analysis (MCA) is a tool designed specifically to:

- Inform option selection in situations where multiple options are feasible;
- Help organise and present the benefits, costs and risk of the different options; and
- Identify issues and weigh up conflicts and trade-offs.

Its purpose, therefore, is to aid decision making, not to make the decision itself; equally, its application may not be appropriate to all FMPs. The key to effective use of the tool is that the process is rigorously followed, and basic assumptions fully documented so that the reasoning behind subsequent decisions is demonstrable and accessible.

MCA involves selecting a range of criteria that are relevant to the circumstances and assigning each of these with an appropriate weighting. Based on this, the alternative options are assessed and scored (typically by a representative panel of stakeholders and/or technical experts) against the criteria, with the assigned scores multiplied by the weightings, yielding a ranking of alternative options.

MCA can also be applied without explicitly weighting the criteria. However, an un-weighted approach can reduce the transparency and validity of the ranking process. For floodplain management planning purposes, any such evaluation should include weightings to recognise community views about what they value most and what is important in the content of a FMP.

Further background information and guidance on MCA is contained in Appendix 6.

Below, as an example, is a table the outlines the criteria/issues that are likely to be considered in most FMP processes. These criteria/issues and their weightings will vary between FMPs (reflecting the objectives of the FMP and community views) and therefore need to be confirmed at the outset of Phase 2.

Table 2: Example of Table for Weighting Criteria

Criteria/Issue	Weighting	Options (Base Scores)			Options (Weighted Scores)		
Flooding Behaviour/ Impact							
Implementation/							
Feasibility							
Economic							
Social							
Cultural							
Environmental							
Cost ($) (capital and maintenance)							

Once the criteria and weightings have been confirmed (typically by the FMP Sub-Committee), a rating or score is applied to individual criteria across each of the options. This technique is commonly used in MCA to assist decision making and to compare different factors. The assigned rating or score is simply a method to assess the relative importance, significance or extent of an issue, and does not attempt to capture the complexity or variability of an issue.

For the purposes of FMP, a scoring system of 0 – 5 is used, with a score of 0 – 2.5 having negative impacts (0 being significant negative impacts), 2.5 a "do minimum" or neutral score, and 2.5 – 5.0 having positive impacts.

The table is then populated with scores for each option and associated criteria. Appendix 6 contains further guidance on key information required to inform the scoring of different criteria.

Additional Information Requirements

Where information from Phase 1 is unavailable or insufficient to provide input into the MCA, additional information may be necessary. The additional information requirements will depend on the nature and degree of the flood issues and existing or proposed management measures. There are four potential areas where additional information may be required:

1. Feasibility, Flood Impact and Response

   The feasibility of each option will need to be assessed to determine any physical or technical constraints to implementing the option. An assessment of the flood impact of each option will therefore be required to determine the extent of change (positive or negative) in hydraulic behaviour of the flood, as well as the consequences of this behaviour.

2. Economic Analysis

   Economic analysis provides a common framework for assessing the effects of mitigation options from a positive/negative, social, environmental or financial perspective. Proposed options need to be analysed to ensure that costs are justified by associated benefits. The economic analysis usually follows conventional cost-benefit procedures. For further information about economic analysis, refer to Appendix 3.

3. Social/Community Analysis

   A social/community analysis would need to consider the level and nature of disruption to people (residents and wider community) arising from each option. For example, how many properties would be directly affected by each option, and what is the nature of the impact (eg, continue to occupy with restriction on use of land, or land is required for structural measure so residents would need to be relocated).

4. Environmental/Cultural Impact Assessments

   Environmental/cultural impact assessments consider the positive and negative effects of each option. The level and detail of these assessments would depend on the nature of the option and the sensitivity of the receiving environment. Mitigation measures that would typically be anticipated should also be considered. More detailed assessments may also be required as

part of any resource consent and/or designation process under the RMA where options proceed to implementation.

It is anticipated that most of the above-mentioned studies and assessments would be desktop exercises, but a site visit to verify field conditions would also be advisable.

4.1.6 Step 5 – Refine Option Combinations

Step 5 is effectively a repeat of Step 3 and refines the short-listed option combinations from Step 4. Further detail on some options may be required to better understand, quantify or evaluate the impacts of the management measure(s). This further detail may include taking a concept design for a structural option to a preliminary detailed design to determine land requirements and construction and management costs.

In addition, some assumptions may have been made in the initial scoping of the options in Step 3. It may be necessary to investigate or test these assumptions to determine whether or not the option is feasible.

To refine and detail the short-listed option combinations, further technical investigations may be required to, firstly, better define the options and, secondly, evaluate the impacts of the options. The first set of investigations would be carried out as part of Step 5, with the second carried out as part of Step 6.

4.1.7 Step 6 – Evaluate Option Combinations

Similar to Step 5 above, Step 6 is effectively a repeat of Step 4 and evaluates in more detail the short-listed option combinations from Step 5. The more defined scope and detail of the option combinations from Step 5 would be used to evaluate the impacts of the management measure(s).

This sixth step may repeat the MCA outlined in Step 4, but instead for the options short-listed using the additional knowledge and information gained in Step 5. The reasons for the scope of the evaluation should be recorded in the Phase 2 report. Ultimately, the option combinations still need to be evaluated against FMP objectives.

4.1.8 Step 7 – Identify Preferred Option Combination

The seventh step involves examining the results from the MCA of option combinations to select a preferred option combination. The preferred combination is likely to include a mix of flood risk management options (eg, river management, structural, land use planning controls and emergency management).

A consideration in selecting preferred options is the risk that different options pose when examined from a range of perspectives and when used in combination. In particular, it is important to ensure that entries on the final short-list are highly likely to successfully deliver a preferred option combination that is affordable, timely, realistic and sensitive to the assessment values, and that meets the relevant legislative requirements (eg, LGA, RMA).

4.1.9 Step 8 – Confirm Preferred Option Combination

In this final step, the preferred combination of options is evaluated and selected.

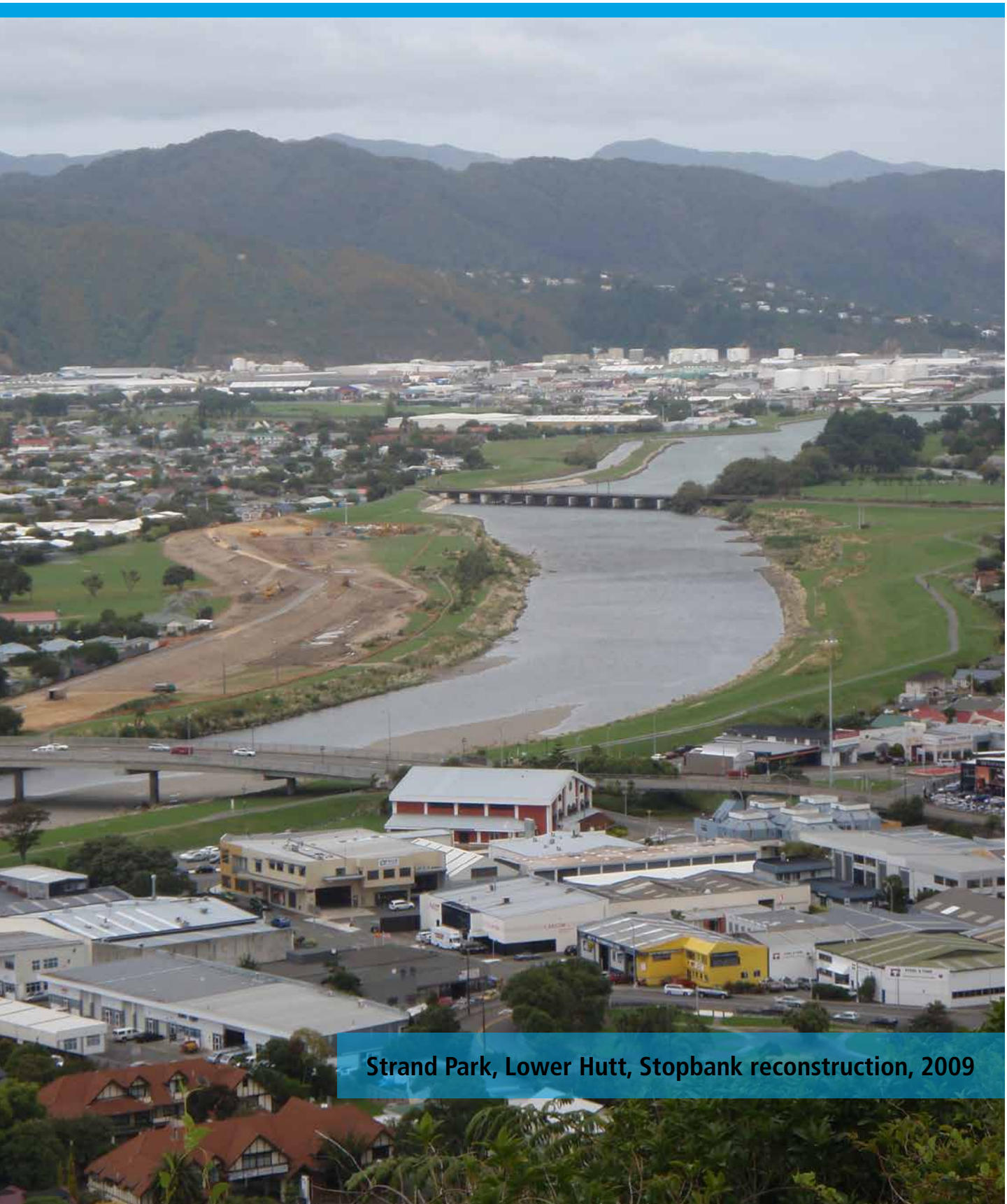
To assist decision making, a further MCA (refer section 4.1.5 above) should be undertaken on the preferred option combination. However, the weightings may need to be adjusted to take into account the results of any further investigations and/or the outcomes of any further engagement.

4.1.10 Phase 2 Report

The output/deliverable from all of the above steps is a Phase 2 Report. This report contains a summary of the information obtained from each step, along with any associated technical investigations which are appended or referenced. At a minimum, the Phase 2 Report should contain the following:

- Summary of the engagement undertaken and the issues raised on the Phase 1 Report;
- Summary of the current flood risk, and floodplain management measures and their effectiveness;
- Summary of the objectives of the FMP;
- Summary of all of the suggested flood risk management options, including reasons why some options are not to be considered further;
- Description of management options;
- Evaluation of management options, including assessment methodology and results;
- Summary of flood risk management option combinations, including reasons why some combinations are not to be investigated further;
- Evaluation of flood risk management option combinations, including assessment methodology and results;
- Recommended preferred option combination; and
- Outline of tasks and programme for Phase 3.

5. Floodplain Management Planning Process – Phase 3



Strand Park, Lower Hutt, Stopbank reconstruction, 2009

5.1 Preparation of the Floodplain Management Plan

The Floodplain Management Plan (FMP) document is the culmination of the work undertaken in Phases 1 and 2, and presents the long-term approach to floodplain management for the river/catchment. It is the formal document that records the outcomes and considerations from investigations, evaluations and decisions made in Phases 1 and 2. Key components are recording the flood issues, identifying the flood extent, describing the values of the floodplain and elements at risk, the coordinated mix of management measures that address the flood risks, and an action plan for implementing them.

As a FMP is a non-statutory document, it is important that it is written and produced in a way that informs the content of strategic and statutory documents (eg, Long Term Plans, District Plans, Asset Management Plans). Specifically, FMPs provide information that is necessary to ensure that flood-prone land is appropriately managed within relevant catchments, reflecting legislative requirements and giving effect to policy direction (such as that in the Regional Policy Statement, which is avoiding development in areas at high risk from flooding and reducing reliance on structural measures).

Depending on the catchment(s) and floodplain(s) the FMP relates to, it can focus on a specific area or river, or cover multiple areas. If specific locations or aspects are included or excluded from the FMP, these should be highlighted and explained. In addition, depending on the flood issues and the extent, number and nature of management measures proposed, the detail and length of the FMP should reflect all relevant circumstances.

The matters a FMP should contain are as follows:

- Floodplain management philosophy;
- Statutory and policy context;
- Objectives of the FMP;
- Description of the flood issues;
- Definition of the flood extent (including flood hazard maps);
- Values of the floodplain (economic, social, cultural and environmental);
- Evaluation of option combinations;
- Description of the selected option combination, including associated policies and methods;
- Action plan for implementing management measures;
- Review/monitoring requirements;
- Summary of plan preparation and community engagement; and
- Bibliography and associated definitions.

The FMP can also contain appendices with further detail on the above matters. Alternatively, it can contain a reference list referring to documents (eg, assessments, natural resource studies, hydraulic analysis) prepared in Phases 1 and 2.

The target audience for the FMP is both internal GWRC staff and external parties (eg, territorial authorities, affected landowners), and as such, it needs to be written in language and style that is technically correct but understandable to a lay person. The information should be presented in both written and diagrammatic form.

The FMP essentially draws on the content of the Phase 1 and 2 reports. However, a specific task in this phase is to develop an action plan to implement the selected combination of management measures from Phase 2, including priorities, staging/timing, funding, responsibilities, constraints and monitoring.

As FMPs are implemented over a number of years, the action plan should be structured on the basis of short-term (1 – 5 years), medium-term (5 – 20 years) and long-term (20 – 50 years) projects. Action plan timeframes also need to align with GWRC corporate planning cycles (eg, Long-Term Plan).

The level of detail required for each action will depend on the relevant timeframe, with clear and specific actions defined in the FMP for short-term actions, and more generic information for identified medium and long-term actions. The levels of services need to be detailed for all actions. Some actions may apply beyond the boundaries of the individual FMP (eg, region-wide emergency management measures), but should still be recorded in the respective FMPs.

Land use planning controls (ie, new or amended District Plans) should generally be a high-priority action, given their effectiveness in managing development in flood-prone areas. For other actions, funding is likely to determine when certain management measures (eg, structural measures) are undertaken. Funding availability should therefore be reviewed on a regular basis (eg, 1 – 3 years) to gauge if implementation targets are likely to be met and whether the projected timeframes need revising (refer to Section 5.3 for guidance on reviews). Furthermore, the implementation of some actions would be the responsibility of other organisations, not only GWRC. Before including such actions in the FMP, a commitment to implementing them should be received from the other organisations.

An example of a generic FMP action plan is illustrated in Table 3.

Table 3: Action Plan Example

Management Measure Category	Management Measure Description	Primary Responsibility for Implementation	Partner for Implementation	Timing of Implementation	Funding Source and Budget Considerations	Monitoring and Performance Measure
River Management	Increase gravel extraction to Xm3 per annum	GWRC Flood Protection	Aggregate Companies	2014	n/a	Target quantity of gravel extracted
Structural	Upgrade Y stopbank to Z design standard	GWRC Flood Protection		2015	$3 million (loan funded and targeted rate)	Stopbank upgrade completed
Land Use Planning	District Plan Change incorporating new Flood Hazard Maps that restrict new development and subdivision in identified flood-prone areas	ABC City Council	GWRC Flood Protection	2013	$25,000 (District Plan Budget)	District Plan Change made "operative"
Emergency Management	Flood warning system installed in abc stream	Wellington Regional Emergency Management Office	GWRC Environmental Monitoring, NZ Police, NZ Fire Service, Ministry of Emergency Management	2013	$50,000 (Environ-mental Monitoring Budget)	New monitoring and warning site installed

Responsibility for preparing the action plan and determining the rate of implementation rests with GWRC, with the FMP Committee setting initial priorities. If external organisations (in either a primary or partner capacity) are responsible for any identified actions, these organisations should be actively engaged during preparation of the plan.

Once a "draft" FMP has been prepared, including the action plan, a more formal submission and hearing process (similar to the RMA submission/hearing process) would be undertaken. The purpose of engaging at this stage of the process is to obtain widespread views and to explore whether a consensus can be reached on the objectives and actions contained in the draft plan.

It is likely that the "draft" FMP would produce a range of views and opinions on the objectives, actions and other contents of the FMP. A hearing would be held by the FMP Committee to listen to and consider all submission points, with decisions made on each submission point and reasons given for the decision, and after this changes may be made to the FMP. Where possible, attention should be directed towards resolving conflicting viewpoints as part of selecting the preferred option combination. A record of the decisions made, the reasons for it, and amendments to the FMP should be prepared.

The final step is the formal adoption of the FMP by GWRC full Council and the seeking of endorsement by the relevant territorial authority(s). This step involves the following:

- The FMP Committee making recommendations on the contents of the FMP to the full Council; and
- The full Council considering whether to adopt the FMP and in what form.

Following formal adoption, the FMP should be distributed to internal and external stakeholders, including the general public. All technical reports, engagement records and background information should be kept and stored in a single location for future reference, such as during implementation and review. In addition, at this point, the full GWRC Council would decide on the appropriate governance and decision-making structure to implement and monitor the FMP.

5.2 Implementation of the Floodplain Management Plan

Once the FMP has been formally adopted, the next phase is implementating the plan. The FMP sets out how it is to be implemented, including governance, administration, monitoring, review and reporting, with the associated action plan driving the implementation programme.

5.2.1 Responsibilities

The following parties have direct or indirect roles in implementing the FMP:

Floodplain Management Advisory Group

A Floodplain Management Advisory Group (eg, Friends of the Waikanae River or Hutt River FMP Advisory Group) would be established in an advisory role to monitor the implementation of the FMP. The role of the Advisory Group is primarily to ensure the action plan in the FMP is further developed and implemented, including monitoring progress against actions. The Advisory Group would be established and serviced by GWRC with a Terms of Reference. The Advisory Group would also continue to act as a point of contact for members of the public, landowners and other stakeholders, for any issues they might have about the plan's implementation. The Advisory Group could make recommendations on implementing the FMP to GWRC and other organisations with responsibilities in this area.

GWRC (Councillors and officers)

The Council is responsible for the overall coordination and monitoring of the FMP, as well as relevant physical flood protection structures and works such as river management and stopbanks. In addition, it advises territorial authorities (based on the FMP) on flood hazard areas in order to inform the development of appropriate land use planning controls.

The respective roles of elected representatives and staff are as follows:

- GWRC elected representatives – to assume a governance role in the FMP implementation process and be responsible for decision making about the timing, funding of the action plan; and
- GWRC staff – to assume the overall role of managing implementation of the action plan, as well as implementing major capital works and other river management aspects identified in the plan, within the timing and funding constraints set by Council.

Territorial Authorities (City/District Councils)

Many of the land use planning control measures would be implemented by territorial authorities through their District Plans. Structural works such as road raising or bridge improvements and environmental enhancements (eg, riparian planting, walkways/cycleways on riverside reserves) would also be implemented by territorial authorities. These authorities would have established decision-making structures for the timing and funding of these actions.

Landowners

Landowners in the floodplain are important parties for both implementing identified actions and being beneficiaries of successful implementation. Landowners may be required to set up particular projects or works, as well as play an ongoing role in maintaining projects or works (eg, maintaining or protecting riparian vegetation buffers).

Community Groups and Other Parties

Interest or community groups can be a valuable resource and may help to implement various actions. Typically, community or interest groups would not assume primary responsibility for implementing actions, but instead would assist/contribute to the work of other parties (eg, Friends of the Otaki River planting and maintaining riparian vegetation buffers).

Regional Emergency Management Office

The FMP would incorporate the roles and responsibilities of the Wellington Region Emergency Management Office (WREMO). WREMO would be responsible for coordinating and implementing emergency-management-related actions outlined in the FMP. The Office would liaise with other associated organisations (eg, NZ Police, NZ Fire Service) on relevant region-wide and/or FMP-specific actions.

5.2.2 Annual Action Plan and Monitoring Report

An annual action plan and monitoring report should be prepared at the start/end of each year (aligned with GWRC's financial year), covering projects undertaken in the previous year and projects that will be implemented in the coming year as outlined in the FMP action plan. In preparing an annual action plan, the following details should be provided for each action:

Table 4: Example of an Annual Action Plan

Management Measure Category	Management Measure Description	Primary Responsibility for Action	Secondary Responsibility: Partner Organisation for Action	Timing	Cost and Funding	Monitoring and Performance Measure
River Management	Increase gravel extraction to Xm3 per annum	GWRC Flood Protection	Aggregate Companies	2014	n/a	Target quantity of gravel extracted

The monitoring section of this report should measure performance against the previous year's plan (ie, were all actions completed?). This report would be prepared by GWRC Flood Protection staff and reported to the FMP Advisory Group.

5.2.3 Funding and Costs

Implementation costs and associated funding should be outlined in the FMP at a high level. The FMP provides useful input into the budget and financial planning cycles of the respective implementation parties (eg, amendments to GWRC and territorial authority Long-Term Plans may be required to fund actions identified in the FMP).

5.2.4 Asset Management

Physical flood protection works are valuable assets that require ongoing management, so it is important that these assets are well managed and maintained to ensure they provide the level of protection they were designed for.

GWRC has a dedicated asset management programme which ensures all flood protection assets are effectively and efficiently managed (refer to SAP Plant Maintenance document - WGN_DOCS-#1091145-v2). Following the adoption of the FMP, a review of any existing Asset Management Plan for the catchments should be completed to align the Asset Management Plan with the FMP. In addition, the Asset Management Plan should be updated when construction of new assets is completed as part of implementing the FMP. In the absence of a current Asset Management Plan, a new plan should be prepared.

5.2.5 Detailed Design and Approvals

Detailed design relating to the selected management measures should be based on the concept design and outline of works described in the FMP. However, any assumptions and conditions that may have informed these measures (such as confirming the extent of the land required, maintenance requirements, environmental effects, etc) should be reviewed before any detailed design work is begun.

Implementation of some management measures will be subject to statutory requirements and processes (eg, incorporation of new Flood Hazard Maps into a District Plan requires a formal Plan Change to be initiated under the RMA). Some river management works and structural measures may also require resource consents and/or designations.

The FMP and the process involved in preparing it can inform these statutory processes by providing technical information and a record of community engagement. They can also demonstrate the assessment of alternatives for a Notice of Requirement (designation) and District Plan Change (Section 32 analysis). However, more detailed assessment or analysis (eg, environmental impact assessments, cost/benefit analysis) may be required once the detail of the management measure has been determined, to address considerations that might not be covered in the FMP.

5.2.6 Review Issues Register

Any specific investigations, commitments or other issues that need to be addressed during the next major FMP review should be recorded in an issues register. This allows the review scope to be clearly seen from the start of the review and ensures that nothing is missed by the reviewer.

5.3 Review

The FMP is a "living" document and should be used and actively maintained to ensure it is kept current and reflects the specified level of services and/or a revised level of service to manage assessed risk. All FMPs should be regularly reviewed, with a formal review being undertaken once every ten years and a major review after 20 years or in response to specific events (eg, a major flood). FMPs should also contain a review section outlining the specific review periods and corresponding scope. Table 5 sets out what these should be:

Table 5: Review Periods and Scope

Review Period	Review Scope

Every Year (as part of Flood Protection Department's Annual Monitoring Report)	• Monitoring implementation of actions
	• Operational programme summary
	• Annual action plan
	• Record in a single report:
	  • What we said we would do
	  • What we actually did
	  • Why the difference
	  • What's proposed for next year
	  • Summary of implementation status

Every Three Years (as part of Long-Term Plan)	• Priority and cost of works/ projects/actions where a specific need has been identified • Outline reporting on effectiveness of management measures and anticipated outcomes
Every 10 Years	• Processes for implementing the Plan • Effectiveness of the measures implemented • Progress on implementing all management measures • Catchment hydrology • Flood extent and river hydraulics • Flood events and damages • Capital and operational expenditure budgets • Full report on effectiveness of management measures and anticipated outcomes • Priority and cost of all outstanding works
In response to specific events, such as following a major flood, completion of a major structural work, or where major changes are proposed in future land-use trends outside those considered in the FMP	• Extent of flood hazard, including maps • Performance of flood protection works • Flood damages and disruption • Effectiveness of land-use control methods • Advice to landowners, territorial authorities and other interested parties

FMP reviews should be based on information collected through the ongoing asset management planning work. Generally this work should provide all the information necessary to complete the annual and three-yearly reviews. Targeted monitoring and investigations may also be required for the 10-yearly reviews, as well as in response to specific events. The 10-yearly review of technical and financial components should consider any new information obtained since the FMP was prepared, and these components in the FMP should be updated if necessary, based on this new information. The primary objective of the review is to assess the progress and effectiveness of the measures in the FMP, not to extensively revise the document itself.

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Glossary

100-year flood	A 100-year flood event has a 1% (one in 100) chance of being equalled or exceeded in any one year. On average, this is expected to occur once in 100 years, based on past flood records, though in reality it could happen at any time.
Adverse effect	A negative impact on the environment caused by a particular activity or set of activities. Adverse effects can: • be temporary or permanent • have a low or high impact • have a low or high chance of occurring • be cumulative: arising over time in combination with other effects • vary in their scale, duration, intensity or frequency. *Minimising adverse effects* means taking all practical and reasonable steps to limit adverse effects. This implies allowing minor effects, but does not mean that all adverse effects must be eliminated. A legal definition of the term "effect" can be found in Section 3 of the Resource Management Act 1991.
Amenity values	Those natural or physical qualities and characteristics of an area that contribute to people's appreciation of its pleasantness and aesthetic coherence, and its cultural and recreational attributes. Adverse amenity effects occur when these values are impacted on in a negative way.
Annual exceedance probability (AEP)	Expressed as a percentage, it gives the chances of a flood of that size or larger occurring in any given year. It is equal to the inverse of the "return period" that is also used to describe flood probability. For instance: • A "1% AEP flood" means a flood with a 1% or 1 in 100 chance of occurring in any given year. This is equal to a "100-year return period flood event". On average, this is expected to occur once in 100 years, based on past flood records, though in reality it could happen at any time. • A "5% AEP flood" means a flood with a 5% or 1 in 20 chance of occurring in any given year. This is equal to a "20-year return period flood event".
Annualised flood damages	The cost of flood damages averaged on a yearly basis. For instance, a 100-year flood occurs infrequently, but the total costs of the resulting damages can be represented as an average cost every year.
Asset management plans (AMP)	Plans that assist with the physical and financial management of a Council's assets.
Breaching	Breaching occurs when flood waters attack and erode stopbanks and floodwalls, eventually breaking through to flow through previously protected floodplain areas.
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.
Community preparedness	An appreciation of the likely effects of flooding and knowledge of the relevant emergency management readiness, flood response and recovery programmes and procedures. It ensures that the community has the ability to cope with a flood. People who are prepared will respond more appropriately to flood warnings (see non-structural measures).
Design standard	The standard of the flood management methods designed to contain a flood of a certain size (eg, the height of river stopbanks).
Development	Erecting a building, carrying out excavations, using land for a building, or subdividing land. *Infill development* refers to developing vacant blocks of land that are generally surrounded by developed properties. *Greenfield development* refers to developing properties in previously undeveloped areas, eg, the urban subdivision of an area previously used for rural purposes (see *non-structural measures*).
Effects	See *adverse effect* or *flood hazard effects*.

Emergency management measures	See *non-structural measures*.
Flood	A relatively high river flow that overtops (rises over the top of) the natural or artificial banks in any part of a watercourse
Flood defences	Physical structures that keep floodwater in the river corridor. They include stopbanks and flood walls (see *structural measures*).
Flood hazard	The potential for damage to property or people due to flooding and associated erosion.
Flood hazard effects	The negative impacts of flooding caused by fast-flowing or deep ponded flood waters. Fast-flowing or ponded flood waters are dangerous for people, becoming more severe where floods affect urban areas. These effects also include damage to the flood protection system, and other structures and buildings by water and debris, or by erosion.
Floodplain	The low-lying portion of a river valley, adjacent to the *river corridor*, which is covered with water when the river overflows during floods.
Flood risk	The combination of the probability of a flood occurring multiplied by the consequence of the effects of that flood
Flood warning	The process used to warn a community of an impending flood. Warnings to the general public may be provided by methods such as local radio stations and street alarm systems (see *emergency management measures*).
Freeboard	An allowance used when setting floor levels, stopbank crest levels, etc, that takes account of: • Uncertainties in the precision of the hydraulic modelling • Physical processes that may not have been allowed for in the design water level, eg debris build-up, wave action, changes in bed level • Uncertainties in the prediction of physical processes (eg rainfall patterns) that affect the design water level The inclusion of a freeboard allowance provides an upper confidence level that water levels will have a high degree of certainty of not being exceeded.
Geomorphology	The landform and landscape of a particular place, shaped by physical processes.
Habitat	The place or type of site where an organism or population normally occurs.
Hazard	A hazard refers to the potential for flooding and erosion to affect floodplain. See *flood hazard effects*.
House raising	The action of raising the floor level on existing houses to reduce potential flood damage.
Infill development	See *development*.
Infrastructure	Networks, links and parts of facility systems, eg, transport infrastructure (roads, rail, parking) or water system infrastructure (pipes, pumps and treatment works).
Land information memorandum (LIM)/ **project information memorandum (PIM)**	These contain a wide range of information about a chosen parcel of land, such as the presence of natural hazards, access easements, services such as stormwater drains, or resource consents issued on the property. Including all publicly available hazard information in a LIM or a PIM is a statutory requirement under section 31 of the Building Act, and section 44 of the Local Government and Official Information and Meetings Acts. Guidance may be given for the way this information is interpreted and presented.
Lifelines	Utilities and/or organisations that provide services essential for the ongoing functioning of a community during and following an emergency event. They include utility service providers (telecommunications, gas, electricity and water); and transportation network providers (for road, rail, port and airport services). Other essential services include hospitals and medical centres, and emergency services (such as the police, ambulance and fire services).
Land	This includes land covered by water.
Land-use measures	See *non-structural measures*.

Mitigation	For this guideline, the act of moderating or reducing the effects of the flood hazard or flood protection works (see *flood hazard effects* and *adverse effects*).
Non-structural measures	Non-structural measures mainly deal with the residual risk of flooding. These measures keep people away from flood waters and help the community cope when flooding occurs. *Land-use measures* influence the way land is used and buildings are constructed. They include *regulatory methods* (policies and rules in district plans) and *voluntary actions* (information and advice to help people to make their own decisions). *Emergency management measures* seek to improve the community's preparedness and response to flooding. Non-structural measures are the most cost-effective flood mitigation approach.
Overflow path	Overflow paths (also known as a flow paths) include areas in the *river corridor* and on the adjacent *floodplain* where a large volume of water could flow during a major event. They are often areas of land which lead fast-flowing water away from the river corridor and over the *floodplain*. The depth and speed of flood waters are such that development could sustain major damage, and there may be danger to life. The rise of flood water may be rapid. Evacuation of people and their possessions would be dangerous and difficult, and social disruption and financial loss could be high. A blocked overflow path could potentially cause a significant redistribution of flood flows to other areas of the floodplain. Due to water depths and velocities, overflow paths are generally unsuitable for development, unless adequate flood avoidance and/or mitigation provisions are made.
Ponding area	Ponding areas are those areas where flood waters would pond either during or after a major flood event. Water speed is slow in ponds, but water levels could rise rapidly. Evacuation of people and their possessions may be difficult, especially on foot, and may need to be by boat. There could be danger to life. Social disruption may be high. Generally, ponding areas are unsuitable for development, unless adequate avoidance and mitigation provisions are made (see *flood hazard effects*).
Probable maximum flood (PMF)	The largest flood that could occur.
Residual risk	The risk of flooding that exists despite the protection provided by flood protection structures. In other words, it is the additional or "leftover" risk due to possible breaching and overtopping of structures such as stopbanks.
Riparian management	This is the management of the riparian zone, which consists of the *berms* and the *floodway*. The riparian zone is an important ecological link between the river and land-based ecosystems. Good riparian management is essential for minimising bank erosion, maintaining healthy ecosystems and ensuring good water quality.
Riverbed	Riverbed is defined in the Resource Management Act 1991 as: "In relation to any river, the space of land which the waters of the river cover at its fullest flow without overtopping the banks."
River corridor	Includes land immediately next to the river. It is the minimum area able to contain a major flood and allow the water to pass safely to the sea. Because of its location, the river corridor represents a significant flooding and erosion hazard to people and structures, including flood defences, sited in the corridor. The depth and speed of flood waters are such that existing development in the corridor could sustain major damage, and there is a potential danger to life. Water may rapidly rise, evacuation of people and their possessions would be extremely difficult, and social disruption and financial loss could be very high.
Risk	Chance of something happening that will have an impact. It is measured in terms of consequences and likelihood. In these Guidelines, it is the likelihood of consequences arising from the interaction of floods, communities and the environment.
Service	As in *utility* service, it is a system and its network infrastructure that supply a community need.
Stopbanks	Banks aligned beside the river to prevent floodwater flowing into floodplain areas. They are also known as flood defences.

Structural measures	Structural measures are structures or other physical works designed to keep flood waters away from existing development. Stopbanks and floodwalls are obvious examples of structural works. Channel works include bank edge works and channel management. Rock linings, vegetation buffers and groynes are bank edge works, which protect flood defences like stopbanks and maintain the channel's position. Other active channel management methods include bed and beach re-contouring and gravel extraction. They are used occasionally to reduce the opportunity for the river to erode its banks and damage structural works.
Sustainable management	As defined by section 5 of the Resource Management Act: *Managing the use, development, and protection of natural and physical resources in a way, or at a rate, which enables people and communities to provide for their social, economic, and cultural well-being and for their health and safety while:* *a) sustaining the potential of natural and physical resources (excluding minerals) to meet the reasonably foreseeable needs of future generations; and* *b) safeguarding the life-supporting capacity of air, water, soil, and ecosystems; and avoiding, remedying, or mitigating any adverse effects of activities on the environment.*
Upper catchment	The generally hilly and mountainous areas in the headwaters of a catchment.
Voluntary actions	See *non-structural measures.*
Zone/zoning	Areas of land classified for a certain range of land-uses; eg, residential zoning specifically provides for residential homes as well as associated structures such as garages and storage sheds.

Appendix 1: Flood Protection Department Vision and Goals

The foundation of all work undertaken by GWRC is its overall vision, which is:

Greater Wellington Regional Council - Vision

"Greater Wellington Regional Council promotes Quality for Life by ensuring our environment is protected while meeting the economic, cultural and social needs of the community."

In terms of the Flood Protection Department, a further vision and set of specific goals and objectives have been developed to guide the way in which this work is undertaken. These are as follows:

Flood Protection Department – Vision

"A prosperous community safe from the consequences of flooding, with rivers and streams in a natural state providing ecological diversity and recreational opportunities."

Flood Protection – Goals (what do we want to do?)

- ***Avoid the loss of life as a consequence of flooding;***
- ***Ensure use and development of land is compatible with the flood risk;***
- ***Inform and empower communities to take appropriate action about avoiding flood risk;***
- ***Contribute to the economic well-being of the region through flood risk management;***
- ***Recognise the relationship of tangata whenua with bodies of water, as well as the cultural values they attribute to rivers and streams;***
- ***Enhance the environmental quality of rivers and streams;***
- ***Recognise and provide for the recreational use of rivers and streams; and***
- ***Encourage best practice in flood risk management.***

Flood Protection Objectives (what can we achieve)

- ***Avoid the loss of life as a consequence of flooding***
  - Design and maintain flood protection assets so they perform to or above expectation
  - Advise people of the flood risk
- ***Ensure use and development of land is compatible with the flood risk***
  - Communicate with and provide advice on flood risk to decision makers and the community, so that appropriate decisions are made about land use to begin with
- ***Inform and empower communities to take appropriate action about flood risk***
  - Help the community avoid and manage flood risks through the provision of information and advice
- ***Contribute to the economic well-being of the region through flood risk management***
  - Agree levels of service with the community
  - Maintain schemes to the agreed standard
  - Inform landowners about flood risk management through implementation of sustainable land management practices, and provide advice on appropriate flood risk responses
- ***Recognise the relationship of tangata whenua with bodies of water, as well as the cultural values they attribute to rivers and streams***
  - Engage with tangata whenua to understand the values associated with different rivers and floodplains when investigating and evaluating floodplain management options
  - Consider the role of tangata whenua in the decision-making process
- ***Enhance the environmental quality of rivers and streams***
  - Enhance the environment in undertaking flood protection capital, and operational and maintenance works
  - Raise public awareness of the important ecological and recreational function that rivers assume
  - Foster a sense of community responsibility for flood protection and for the river environment, through leading by example, providing education and encouraging active community participation
- ***Recognise and provide for the recreational use of rivers and streams***
  - Provide for passive recreation in the river environment.
  - Provide access to rivers in a managed way to support recreational use while protecting the environment and managing flood risks.
  - Work with recreational and community groups to create opportunities for enhanced recreation use and community enjoyment of the river consistent with the identified flood risk and quality of the natural environment.
- ***Encourage best practice in flood risk management***
  - Provide national and regional leadership through sound floodplain management planning practice
  - Develop "best practice" skills, knowledge and culture within the department
  - Ensure departmental work is consistent with the floodplain management guidelines

These high-level visions, goals and objectives set the overall direction for floodplain management planning by Greater Wellington Regional Council.

Appendix 2: Flood Study and Flood Hazard Effects

Flood Study

This part of the appendix provides more detail on technical guidance for the flood study, including hydrologic analysis, hydraulic analysis and flood mapping.

Opus reviewed previous hydraulic modelling undertaken by or for GWRC as part of a Climate Change Impacts Scoping Study[8]. In this study, the methodology for climate change impact assessment on flood risk is documented. This methodology includes recommended requirements for:

- Hydrologic Analysis
- Hydraulic Analysis
- Flood Mapping

This methodology should be used as a guide for undertaking the flood study, along with any updates to modelling software and technology, to ensure the best practice approach is used.

Hydrologic Analysis

The accuracy and reliability of any hydraulic model relies on the quality of the data it uses. The design flows used are derived from measurements of the river's water level which are then converted to flow information using a rating curve (a calibration which relates the water level to the volume of flow), so producing flood model results that are accurate depends on:

- How accurately water levels are recorded;
- How accurate the rating is that is used to convert the water level information to flows; and
- The length of the flow record (and therefore the quality of any analysis of the frequency and magnitude of flood events).

Accuracy of Water Level Records

With most flow records, the water level is measured at regular time intervals (usually every 15 minutes), and these measurements are then converted to flow rates using a rating curve. The method used to record the water level must be taken into account when building a flood model, as each method has differing levels of accuracy. For example, manual staff gauge readings are probably accurate to ±10mm, while modern shaft encoders in stilling wells are accurate to ±1mm.

Accuracy of Rating Curves

A rating curve is developed by taking a series of measurements of the actual flow of the river (ie water level measurements) and recording the particular water level at the time. A relationship is derived (the rating curve) which allows all the water level measurements to be converted into estimates of flow. Variables such as the stability of the channel and the range of flows gauged can affect the accuracy of the rating curve, and it should be noted that accuracy decreases during floods due to the rapidly changing water level and difficulties in measuring depth and speed.

Length of Flow Record

The longer the flow record, the better; a long record contains more actual flood event data that can be used to infer the behaviour of possible future floods. If the flow record is extremely short (ie less than 20 years) and contains no large flood events, there are alternative methods to statistical analysis (such as the regional method, translation and scaling of flows from adjacent and similar catchments, or rainfall-runoff methods), but these all contain assumptions that increase the uncertainty of the results.

Other Factors

Other factors that should be considered when building a flood model include:

- Whether the impact of climate change has been included, and how potential changes in the magnitude of design flood events have been assessed.
- Whether there are any periods of greater or lesser flood activity other than an annual pattern of greater flows over winter (this could indicate climatic oscillations), and how this has been accommodated within the model.

Hydraulic Analysis

Survey Data

The quality of the flood model depends on the quality and age of survey data. Rivers in New Zealand tend to be highly mobile and can change their cross-section and/or alignment relatively often. Because of this, the older the date of the survey, the greater the likelihood that changes have affected the accuracy of the model's predictions. Survey data for a river that is deeply carved into the rural landscape will probably still be valid 10 years (or more) later, whereas a river with an active bed or near urban areas with development occurring could experience significant changes that influence the flow of flood waters within a five-year period. Flood defences or

8 Edwards, S., McConchie, J., Maas, K., Smith, H. 2012. Greater Wellington Region Climate Change Impacts Scoping Study. Opus International Consultants, Wellington.

river training works such as rock groynes may restrict the migration of a river channel, but there may still be changes in the channel shape.

Model Schematisation

A model of a river and its floodplain is only good if it represents the physical world and the interaction of flows in the watercourses and floodplains. This is constrained by the limits of the modelling software used.

Loss Coefficients of Hydraulic Structures

Hydraulic structures in the models represent structures such as weirs, bridges and exchanges of flows between the waterways and the floodplains. Losses due to contractions, changes in cross-section, and so on, affect the water levels and flows near these structures. This effect is represented in the models through loss coefficients.

Roughness

The flow in a watercourse and over a floodplain is affected by a number of factors, with the key ones being vegetation, surface material, obstructions, and channel shape. Generally this is summarised in a roughness parameter.

Flood Level Approach

The flows and ponding on floodplains can be modelled in two different ways. One way is to turn the LiDAR data of the floodplain into a digital terrain model (DTM), and then use a two-dimensional (2D) modelling package such as MIKE 21 to model the flow of water across it and to determine the water levels. This is much more likely to produce accurate results, as the hydraulic model determines where the water will go, and overland flow paths do not have to be determined before building the model. Another way is to represent the flows and ponding on the floodplain in a one-dimensional (1D) modelling package such as MIKE 11 and then use GIS tools or other post-processing tools such as WaterRIDE Flood Manager to determine and fine-tune the flood extents and depths. This approach requires careful definition of the likely flow paths at model build time. (1D modelling of the floodplain tends to only be seen in older flood models, or ones with known, well-defined overflow paths).

Model Calibration

A model's performance is usually compared with recorded flood events to make sure it represents the physical world. If there is a discrepancy, some of the model parameters (eg channel roughness) are adjusted, within reason, so that the model as near as possible reflects what actually happened; this process is known as calibration. For greater confidence in the model's results, as many events as possible across a broad spectrum of frequency should be used to calibrate the results.

Flood Mapping

A collection of flood maps should be produced which show both current and future flood risk across the full continuum of flood events affecting the managed floodplain. Commonly used flood mapping intervals include 2, 5, 10, 20, 50, 100, 500, and PMF year return period flood events, however these intervals may not be appropriate for every catchment.

With current and developing technology, there is an opportunity to make the presentation of this information much more relevant to individual land owners, rather than producing the generic, single-event maps developed in the past, and these capabilities should be developed and used where practical.

Flood Hazard Effects

This part of the appendix provides more detail on physical impacts and emergency management effects of the flood hazard.

Physical Impacts

Flood Severity

The severity or size of a flood affects the flood hazard (eg, depths, velocities, rates of rise) and it also determines the number of people at risk. Predicting a flood is impossible until the event is developing but then becomes possible through the use of rainfall forecasting and flood prediction modelling. Even if a severe flood has recently occurred, it does not mean that a flood as severe or more severe will not happen in the near future.

Floodwater Depth and Velocity

The velocity of flow and depth of floodwater are the main cause of threat to life and structural damage to property. Depth and velocity depend on the size of the flood and the hydraulic characteristics of the river and its floodplain. Combining depth and velocity can affect people and structures in the following ways:

- Wading by able-bodied adults becomes difficult and dangerous as the depth of still water increases.
- In assessing for wading, factors other than depth and velocity need to be taken into account; for example, evenness of the ground surface or presence of depressions, potholes, fences or major stormwater drains.

- Small, light and low motor vehicles crossing rapidly flowing roads can become unstable as water depths increase. Travel by larger, higher vehicles is generally only possible and safe when water depths are low.
- As the depth of floodwater increases, vehicles and buildings may begin to float. In these circumstances the buildings can be severely damaged when they settle unevenly in receding floodwater. If the flood velocity is significant, buildings can be destroyed and cars and other vehicles can be swept away. In certain areas, the build-up of debris and the impact of floating debris can cause significant structural damage to buildings and bridges.
- As velocities increase, the stability of foundations can be affected by scour. As grass and earth surfaces begin to erode, scour holes can develop.
- As depths increase, lightly framed buildings can be damaged by water pressure, flotation and debris impact, even at low velocities.
- Depth of flooding and overall flood damage can be increased by obstructions to floodwater movement (eg, buildings, embankments and bridges, areas built up by landfill, and the blocking effect of trees, shrubs, fences and debris). The increase in flood levels depends on the floodwater's velocity and degree of obstruction.

Rate of Floodwater Rise

Rapidly rising floodwater presents a situation that is potentially far more dangerous than where flood levels increase slowly. Floodwater generally rises faster in small, steep catchments than in larger, flatter catchments.

Flooding Duration

Flooding duration generally correlates with the rate of rise of floodwater, typically being longer for slow rates of rise (larger, flatter catchments) and shorter for rapid rates of rise (smaller, steeper catchments). Extended periods of flooding can saturate stopbanks, potentially affecting their integrity and leading to premature failures.

Flood Awareness

People who are flood-aware can be effective in mitigating the flood hazard for themselves, and so can reduce the hazard experienced during a flood event. Past experience with flooding generally affects how people respond to flooding and can reduce the time taken to respond to flood warnings. The response to flood warnings is usually more prompt, efficient and effective in communities with a high degree of flood awareness, as these communities more often know what to do when a flood warning is received.

Emergency Management

Public education campaigns promoting flood readiness and response are an essential component of flood emergency planning.

If warning time is sufficient, the flood hazard can be reduced by appropriate mitigation, including staying put, getting up high or, in some circumstances, evacuating. However, the flood may still cause significant damage to buildings and infrastructure and substantially disrupt the community, even once people and possessions have been evacuated.

Flood Warning

Catchment characteristics primarily dictate the available warning time. Large catchments and slowly rising floodwater mean a longer available warning time than small steep catchments, which may flood very quickly. Flood warnings can be based on peak rainfall and flow levels and rates of rise at upstream gauges in large catchments. In smaller catchments, flood warnings may need to be based on rainfall measurements. This is generally carried out by automatic monitoring equipment.

In some of the smallest catchments, warnings may need to be made using predictions of likely rainfall before the rainfall occurs. This may be carried out by using radar to detect the location and extent of likely heavy rainfall and provide the basis for short-term forecasts of rainfall combined with meteorological forecasting models.

The flood duration, or length of time a community is cut off by floodwater, can significantly affect the costs and disruption caused by flooding. Extended periods of isolation in stressful situations can increase post-event anxiety and trauma-related disorders. Shortages of water and food may occur, placing high demands on limited emergency services, and treatment may be delayed or prevented for medical emergencies.

Mitigation Problems

Levels of damage and disruption caused by a flood are influenced by difficulties in mitigating the flood hazard effects on people and property. Complicating factors include:

- The number of people requiring assistance and whether it is day or night;
- Depth and velocity of floodwater;
- Wading problems that may be worsened by

uneven ground, fences, debris, localised high velocities;

- Distance to flood-free ground and whether this may be across a river;
- Loss of access along main routes because of rising floodwater;
- Bottlenecks on main routes (ie, roads cannot cope with the increased volume of traffic, the large number of people and goods that may have to be moved);
- Inability to contact emergency services;
- Unavailability of suitable emergency equipment such as boats, heavy trucks and helicopters.
- Extent and duration of flooding (ie, numbers of individuals or communities affected).

Effective Flood-Free Access

The flood hazard is directly affected by the availability of effective access routes from floodable areas. Effective access is defined as a route that remains open to traffic for enough time to help the at-risk population (ie, evacuation can be undertaken solely by motor vehicle).

Access to at-risk populations can be lost relatively early in the flood when:

- Evacuation routes lead across the floodplain (due to rising floodwater).
- Residential developments built on high land with no through access may only have access onto and across the floodplain. Vehicle access is likely to be lost early in the flood, although it may be possible to evacuate residents by walking to high land. There may be a consequent loss of vehicles and possessions.
- Roads act as flow paths in severe stormwater flooding. This severely reduces access.

Regional and local road networks for flood-prone areas should be designed taking possible evacuation needs into account.

Access is generally divided into two categories: pedestrian and vehicular. The provision of vehicle access for all floods obviously helps to reduce the flood hazard and enhance the effectiveness of emergency services. Providing pedestrian access for all floods is complicated by issues with moving elderly people, children and the disabled.

Access route suitability should be investigated for a range of flood events. Evacuation routes may become unsafe or inoperable for more severe floods As a minimum, pedestrian access routes should be provided for use in potentially hazardous situations in extreme flood events, as the danger to the stranded and their rescuers may be unacceptable without such access.

Islands formed by rising floodwater isolating an area of land present a potentially hazardous situation. The degree of hazard depends on the depth, velocity and rate of rise of floodwater between the island and possible places of refuge, which determines if people at risk may be able to safely evacuate. In this situation, vehicle access may be cut off rapidly and pedestrian access is extremely hazardous. Rescue by boat, helicopter or large vehicle may be necessary, putting the rescuers' lives at risk. A check should be made to see whether any flood events might cause islands to develop, and whether these islands might eventually become submerged, although such a situation may not develop except in extreme events.

Appendix 3: Flood Risk Management

Introduction

Flood risk management is about managing the risk from flooding to existing and proposed development. The most effective mechanism for identifying and managing flood risk is the floodplain management planning process, which provides a risk management framework to:

- Identify and evaluate the various social, economic, financial, ecological and other factors in the risk management process;
- Develop an appropriate organisational structure for integrated risk management across the various organisations involved with floodplain management.

The floodplain management planning process may be presented in a slightly different format, although with basically the same components, using an adapted risk management process from AS/NZS 4360:2004. This risk management framework is shown in Figure 1.

Risk

Risk is a product of probability (likelihood) and consequence. When assessing flood risk, both of these aspects need to be considered: how likely is it that a flood event will occur (likelihood), and how severe might the flood event be (consequence)?

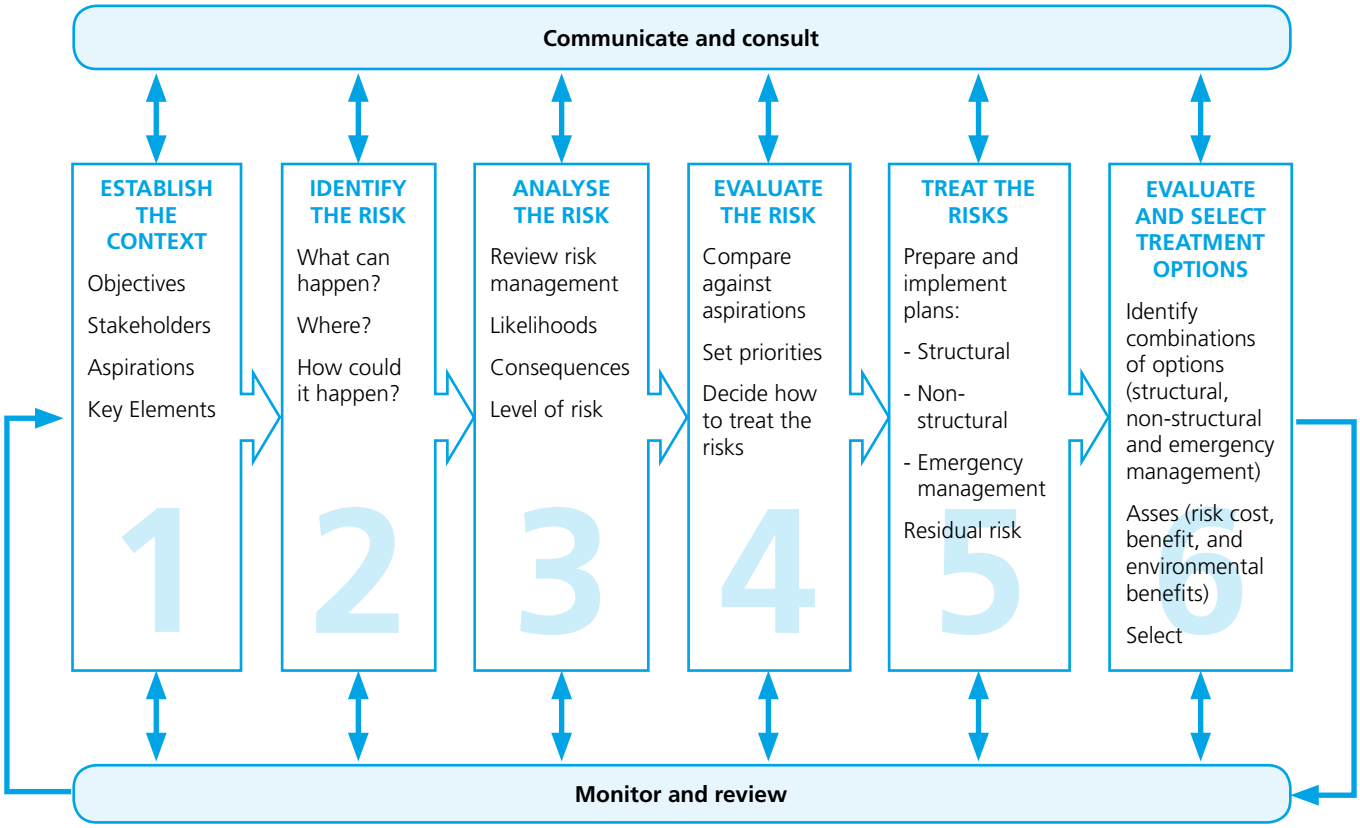
For further guidance in working through flood risk management issues, the New Zealand standard NZS 9401:2008 Managing Flood Risk – A Process Standard sets out a decision-making framework based on accepted best practice.

Likelihood

Likelihood can be expressed either as a percentage chance of an event occurring, or it can be described qualitatively as falling somewhere between "frequent" (or "almost certain") and "improbable" (or "rare"). For instance, "frequent" could mean a flood event that has happened before and is expected to happen again in the next 12 months. "Improbable" could mean a flood event that has not happened within recent experience but is in the realms of possibility.

When considering assets or infrastructure that are at risk from flooding, the design life should be taken into account. For example, some buildings might be designed for a 50-year lifespan but more realistically have a 100-year lifespan; therefore, the probability that a damaging flood will occur within that 100-year time horizon should be considered. The risk to a subdivision should be analysed over a longer period of time, because once land has been developed

Figure 1: The Floodplain Management Planning Process in a Risk Management Framework.



for residential use it usually remains occupied for very long periods of time, if not permanently. For temporary assets (eg, a culvert) or temporary land uses (eg, a camping ground), a shorter time horizon may be appropriate.

Consequences

When rating the consequences of a flood, it is important to consider a range of different social, cultural, economic and environmental consequences, as well as the level of severity. For example:

- social consequences include impacts on public safety (injuries or fatalities) and community disruption and dispersion (eg, where a community is forced to relocate during repair or reinstatement work, which breaks community bonds and creates longer-term impacts such as vacant damaged properties and a general decline in social values);
- cultural consequences include damage to sites of importance to Maori;
- economic consequences include the impacts of flooding on the local economy and its growth, as well as on services such as telecommunications, power and roads (causing disruption to business or industry resulting in financial loss);
- environmental consequences include the damage to the natural environment and surroundings, either through direct impact (eg, erosion of significant habitat during a flood) or through indirect impact (eg, the deposition of contaminated floodwaters/sewage in a sensitive receiving environment such as an inanga spawning habitat).

The level of rating applied to particular consequences should reflect the risks for a specific type of catchment or location. For example, large-scale flooding of rural land may affect relatively few people but can have significant economic consequences at a regional level. Flooding of urban areas is likely to affect more people and could result in serious public health and safety consequences, large business disruptions and significant social upheaval.

Figure 2 shows how likelihood and consequences are considered together to assess the risk of flood. As an example, a PMF (probable maximum flood) may get a 5 severity rating due to its catastrophic consequences, but may have a likelihood rating of 1, since it's very unlikely to happen. The overall risk rating is therefore 5, giving it a low risk action plan. By contrast, a 100-year event would have less severe consequences but is more likely to occur; it might be given a severity rating of 4 and a likelihood rating of 3, making the overall risk rating 12, a much higher risk than the PMF despite the lesser consequences.

Flood Risk Management

Risk management options include:

- Avoiding risk (eg, the adoption of land use planning controls to prohibit high-risk activities from hazardous areas of the floodplain);
- Reducing the frequency of occurrence (eg, by providing stopbanks or other structural protection measures);
- Reducing the consequences (eg, use of planning and building controls to flood-proof buildings, allowing for relocatable buildings, removing electric motors from the floodable area, recognising and addressing residual risk via flood emergency measures etc);

Figure 2: Risk Matrix

Risk Rating = Likelihood x Severity

Severity			Likelihood: 1 Improbable	2 Remote	3 Occasional	4 Probable	5 Frequent
	Catastrophic	5	5	10	15	20	25
	Significant	4	4	8	12	16	20
	Moderate	3	3	6	9	12	15
	Low	2	2	4	6	8	10
	Negligible	1	1	2	3	4	5

Catastrophic	STOP
Unacceptable	URGENT
Undesirable	ACTION
Acceptable	MONITOR
Desirable	NO ACTION

- Transferring and financing risk (eg, through insurance, EQC and disaster relief funds);
- Accepting risk (eg, recognising and addressing residual risk via flood emergency measures).

Options should be evaluated using the degree of risk reduction together with the costs and benefits of risk reduction measures. Selecting the most appropriate options means balancing the costs of implementation against the benefits derived from them. Where large reductions in flood risk may be achieved for a relatively low expenditure (eg, the use of land use planning measures to control future risk), such options should be implemented as a matter of course. The adopted flood risk management plan will define an integrated range of management measures to address direct and residual flood risks and flood hazards.

Monitor and Review Risks

Circumstances and conditions affecting floodplain management planning change with time, and it is important that floodplain management plans are reviewed every five to 10 years. As part of this process, flood risks and flood hazards should also be reviewed to determine if significant changes (for instance, reducing adverse flood hazard effects, managing the residual flood hazard risk, involving the community and iwi, enhancing environmental values) have occurred and if it is necessary to revise the selected measures.

Communicating Risk

Community engagement is essential during the risk management process. In gaining community acceptance of flood risk, communication between the general public and local councils (risk management agencies) is very important. Generally, community involvement in the decision-making process improves tolerability of the risk. People's tolerance of risk is higher when they know that such risks are being reduced (ie, when they see the risk as being only short-term) or managed, or when they benefit from the activity causing the risk.

One of the biggest issues facing floodplain management planners is the widely held misconception by the public and others about the probability of flooding; for instance that a "100-year flood" will only occur once every 100 years. Of course, this is not so, since a 100-year flood is a flood that has a 1% (one in 100) chance of being equalled or exceeded in any one year and can happen any time, but risk perception and risk acceptance are often based around such misconceptions.

Additionally, where structural measures are used, the risk of failure remains. Overtopping of structural measures can occur, due to factors such as channel degradation or aggradation (capacity changes), and with a more comprehensive rainfall and flood flow dataset, understanding and calibration of design return periods may also change.What could be described as a 1900 cumec (a unit of flow measurement: one cubic metre per second) flood today is classified as a 1-in-100 year return period flood for the Hutt valley; in 100 years' time, a 1900 cumec flood may be classified as a 1-in-20 year return period flood because floods of that size are now occurring more frequently.

Evaluating Flood Risk

Evaluating flood risk is necessary to assess the severity of defined flood risks, and also to assess the effectiveness of risk management options in reducing flood risk. Evaluating flood risk can be based on technical, financial, legal, social, humanitarian and equity considerations. These factors should be developed in consultation with all stakeholders in the risk management process.

Key factors in evaluating risk are:

- Seriousness, which is the effect of the flood risk in terms of the magnitude and nature of potential loss. For example, a flood risk involving a potential loss of life is more serious than a risk involving only economic loss.
- Manageability, that is, our capability to influence the magnitude and nature of the flood risk. Future flood risk is one of the most manageable risks and can be effectively and relatively inexpensively controlled by appropriate non-structural and structural measures.
- Acceptability, which is the ability of the community to perceive and accept flood risk. The community is more accepting of risks that it understands (ie, risks that have been clearly and effectively explained).
- Urgency, or the perceived need for action. If flood risk management is delayed, the risks to be managed may increase and become more expensive or difficult to manage, eg numbers of people and development in flood-prone areas may increase.
- Rate of growth, or the potential of the risk to increase in seriousness over time, eg when the development of flood-prone land continues without taking management measures to reduce the consequences of flooding (the future problem).

Appendix 4: Economic Analysis

Economic analysis is a component of floodplain management planning. It provides a common framework for assessing the effects of management options (positive or negative, social, environmental or financial), and may also be carried out with regard to a risk framework.

The economic analysis usually follows conventional cost-benefit procedures, including division into private and public sectors. An analysis should include social, environmental and equity costs and benefits, as far as these can be quantified. It can also be used to determine the optimum size of a single management measure or the optimum mix (and size) of multiple management measures. The "cost" of flooding itself needs to be included.

Economic appraisal deals mainly with tangible costs that can be easily quantified in dollar values (direct and indirect costs). However, an urban flood mitigation scheme may also be judged justifiable on largely social grounds; that is, because of the reduction in intangible costs and social and community disruption.

Benefits from flooding include the following:

- Improvements to soil fertility through the deposition of silt across floodplains used for agriculture;
- It is essential to the well-being, growth and breeding of many riparian plants and animals along river and creek systems;
- Quantities of sediment are moved to the coast, which prevents bed-level rise, replenishes the coastal sediment transport system and maintains healthy beaches.

Floodplain management measures that limit the extent of flooding or reduce the frequency and magnitude of flooding may diminish or even eliminate these benefits. These effects need to be assessed and taken into account.

Cost/Risk/Benefit/Environmental Effect Analysis

A cost/risk/benefit/environmental effect analysis is carried out to determine appropriate and economically justifiable levels of flood protection. In the study, all consequences are evaluated in dollar values. The flood damage to public and private properties is evaluated for a range of flood events and the Annual Average Damage (AAD) is calculated.

Life-cycle costs are used for this analysis, which are the costs to construct and maintain various management measures, and also the effects of the various management measures on the environment. The benefits that result from reducing flood damage can then be used to compare various management measures over the design life of the option, and to assist in the selection of a Defined Flood Event (DFE). Qualitative measures to assess and evaluate difficult risks are given in AS/NZS 4360:2004.

The advantage of a cost/risk/benefit/environmental effect analysis is that the economic consequences of flooding can be assessed relatively reliably and compared with the cost of mitigation measures, resulting in much easier decision making. Moreover, the effects of proposed new developments on the risk-damage relationship are relatively easily and reliably assessed in economic terms. This makes it easy to evaluate the effects of proposed new developments.

Flood Damage Assessment

Flood damage assessment requires evaluation and analysis of many categories of flood damage. These include the following:

- Tangible and intangible
- Direct and indirect
- Physical, psychological and emotional health
- Actual and potential

Tangible and Intangible

These are financial damages, which can be measured in monetary terms. Tangible damages include repair costs and loss in value of goods and possessions (direct damages), and loss of wages, sales and production losses, and extra costs incurred during clean up and in post-flood recovery (indirect damages). It is important to distinguish between individual financial losses and economic losses to region or district. "Actual" and "potential" damages are two further categories of tangible damages (refer to later section). Intangible damages include increased levels of physical and psychological illness and emotional distress caused by the flood. Economic studies must attempt cost/benefit to put a value on these, as they can be considerable.

Physical, Psychological and Emotional Health Costs

Flooding may cause a range of intangible costs on flood victims, including physical and psychological ill-health and emotional distress. Fully measuring these costs in financial terms is generally impossible, but they are significant to victims and to the post-flood recovery of the community. More work is required to attempt to quantify these types of costs.

Actual and Potential Damages

Actual damage is the damage likely to be caused by an actual flood. Potential damage is the maximum damage that could possibly occur if a flood happened. In assessing potential damages, it is assumed that no actions are taken by the flood-affected population to reduce damage, such as lifting or shifting items to flood-free locations and shifting motor vehicles.

"Damage reduction factors" are generally used to convert potential damage estimates to actual damage estimates. Two important parameters affecting the relationship between actual damage and potential damage are the length of the flood warning period and the flood awareness of the affected population. The longer the warning period, the greater the time available for evacuating goods and possessions, and the more flood-aware the population, the more effective these measures will be.

Average Annual Damage

Floods affecting a susceptible community vary in intensity and effect. More frequent floods are less severe and cause less damage than infrequent events. The Annual Average Damage (AAD) is a useful way to compare the economic benefits of various proposed mitigation measures. All cost factors, including construction, maintenance, environmental and social costs, have to be weighed up and evaluated to determine the costs and benefits of possible mitigation measures. Examining a range of floods and estimating the potential and actual damages is the method used to determine the AAD. The variation of flood damage with the annual likelihood of occurrence of the flood (AEP) is plotted, and the AAD is the integral of this plot.

Greater Wellington has used economic analysis to determine:

- the design standard;
- structural measures affecting local areas;
- non-structural measures guiding possible floor level restrictions.

Methods that calculate tangible and intangible damages have been used to measure the effectiveness of a proposed design standard or of individual measures. For example, a reduction in annualised damages from $8.5m to around $1m encouraged the selection of a reasonably high design standard for Hutt River. In this case, the economic benefit of structural options protecting individual river reaches are also calculated, meaning that the design standard can be varied appropriately for local river reaches; in other words, a risk-based approach.

Measuring saved damages is a tool used more recently to establish the viability of minimum floor level restrictions. This approach compares the costs of raised floor levels with the saved damages, based on a method developed by the Canterbury Regional Council. For the Hutt Valley, it would be economically beneficial to raise new dwellings in unprotected areas (without stopbank protection), in most cases well above a 500-year flood standard.

Benefit/cost analysis has also been used more widely for floodplain management planning decisions. The Hutt, Otaki and Waikanae FMP processes have incorporated social and environmental benefit/cost into decisions on the priority for timing upgrade works along the rivers.

Appendix 5: Flood Management Options

Below is a summary of some flood management options. Further options should be identified and investigated as part of any FMP.

Table 1: Flood Management Options Categories and Examples

River Management	Structural	Planning/Land Use Controls	Emergency Management
Gravel extraction	Selecting a Design Standard for Structural Measures	Zoning or Flood Hazard Areas on District Plan Maps	Flood education and information campaigns
Clearing vegetation in river beds and banks	Floodways	Restrictions on buildings, subdivision and land use in District Plan (eg, access, earthworks, minimum floor levels, activities)	Civil Defence and emergency management drills
Riparian planting	Stopbanks	Submitting/commenting/ advising on development/ subdivision proposals, including resource consent applications	Provision of flood hazard information and advice
Cross blading	Detention Dams	Floor Levels and/or Raising Floor Levels	Flood prediction and warning systems
Rock rip-rap	Floodgates	Voluntary actions promoting sustainable land use	Strategies in preparation for responding to flood events, including recovery

River Management

Channel Improvements

The capacity of a river channel to discharge floodwater can be increased by widening or deepening the channel, and by clearing the channel banks and bed of obstructions to flow. However, any such changes increase not only the flow velocity and flow depth, but can exacerbate bank erosion. Decisions to increase capacity should be backed by solid analysis of river hydraulics and sedimentation and erosion processes to ensure a balance is reached between capacity and potential erosion. The focus should be on edge protection works and ongoing channel management to maintain the design alignment. Increasingly, establishing riparian protection behind managed channel edges is a common practice.

Disadvantages from channel improvement measures include the following:

- They may speed up the transfer of floodwater downstream and can accentuate downstream flooding;
- The cost of maintenance may be high;
- Riparian habitat may be destroyed;
- Replacing naturally varying channel sections with a section of more uniform geometry may have adverse ecological, recreation and aesthetic effects.

Structural Measures

Structural measures are physical structures or works designed to protect people and assets from flooding, up to a specific standard.

Selecting a Design Standard

The design standard establishes the maximum flood event that new and upgraded structural works are designed to contain. It is also called the design flood event. The design flood event has a nominal probability of occurring in any one year, often called the return period (eg, the two percent or 50-year return period flood event). The return period of the design flood event indicates the maximum protection which the flood defence system can provide to floodplain occupiers.

Before selecting a design standard, the potential behaviour, hazard and damage of a range of flood events up to and including the PMF (probable maximum flood) should be investigated. In selecting the design standard, choosing too mild a flood would mean that adverse effects of larger floods are not mitigated, whereas choosing too severe an event would maximise the cost of management and mitigation measures, but might save increasing damages.

The design standard used for setting residential floor levels may not be appropriate for determining the location and floor levels of key infrastructure facilities, such as hospitals, electricity substations

and police stations. By definition, flood-prone land is all land flooded by the PMF. The design standard generally defines areas of land to which development and building controls apply.

Risk management should be taken into account when selecting the design standard. The risks and costs of floods of various sizes can be weighed against the benefits (ie, reduction in risk) of various management measures by considering the likelihood of occurrence of a range of flood events and their associated hazards (risks to life, health and damage), together with the cost and benefits of various management options.

In the Wellington Region, design standards are generally only selected for major rivers. The standards vary considerably, mainly depending on:

- Size and vulnerability of the directly affected community;
- Economic benefit/cost;
- Affordability;
- Regional council funding policy.

The standards typically vary between the 50- to100-year return period flood event for selected rural areas, and 100-year to rare event return period standards for urban locations. A rare event may have a return period of up to several thousand years. Examples include:

- 100-year return period event standard for the Otaki and Waikanae Rivers – where mixed urban and rural land use prevails.
- Mixed standard for the heavily developed Hutt River floodplain, varying between 100-year and rare event return period standard, but mostly based on a 440-year return period flood.

Standards for our predominantly rural floodplains tend to be variable, ranging from no standard to minor erosion protection, and up to a full 50- and 100-year return period flood standard for developed areas.

The majority of the Ruamahanga River does not have a design standard, with some locations near Masterton and downstream reaches varying between a 5- and 100-year return period flood standard.

In these catchments, a typically lower standard is influenced by the community's inability to pay. The focus in unprotected reaches is more on assessing erosion mitigation requirements on a case-by-case basis.

Stopbanks

Stopbanks are generally the most common measure used to protect existing development in flood-prone areas. The stopbank size (rather than height) is determined by factors that include economics (cost of stopbanks and potential damages saved), the physical limitations of the site and the ability to protect it with berm width and edge protection.

Even if designed for very large events, stopbanks can still fail through lack of maintenance, inadequate construction or unforeseen circumstances. Emergency management strategies that detail community preparedness and response are essential. When stopbanks are used for flood mitigation, the following matters should be considered:

- The likelihood of damage when the stopbank is overtopped or fails prematurely;
- The need for spillways (passages for surplus water) to be provided for detention dams;
- Costs of maintaining structures;
- Ensuring emergency management strategies for stopbank breaching or overtopping are in place;
- Ongoing community education to ensure that people are aware of the residual risk of overtopping, and emergency management strategies in place, so that people do not lapse into the belief that "stopbanks provide total protection against all floods";
- The potential of stopbanks to increase flood levels elsewhere on the floodplain;
- Drainage and discharge of local stormwater and runoff that collects within protected areas.

Stopbanks continue to be an important and effective management measure for existing flood problems. However, they are a partial solution that does not cover the full flood-risk spectrum, and should be supplemented by emergency management measures and/or other non-structural approaches, such as voluntary actions and land use controls in potential high-hazard areas. It is important to acknowledge that stopbanks can fail and communicate this to the community. Predicting flood behaviour in large events is often difficult and in the end it may come down to the best engineering judgement.

Detention Dams

Dams are generally provided for irrigation, domestic water supply and other purposes, including possibly providing flood reduction. It is usually difficult to economically justify a dam purely for flood mitigation. Even large dams can have a surprisingly

small reduction effect on severe floods for the following reasons:

- The surface area of the dam at spillway level is relatively small and the spillway capacity is large;
- The volume of water in a severe flood may be much greater than the storage capacity of even a large dam (eg, the Clyde Dam in 1999);
- Floods may result from rainfall in parts of the catchment that are not controlled by dams.

Dams may have adverse effects, including acting as sediment traps, which adversely affect the downstream and coastal areas dependent on the sediment supply, and the potentially significant environmental effects, including loss of habitat.

Land Use and Planning Controls

Land use controls should be formulated and resolved within the context of the political, social, economic and environmental priorities for districts within the region. District plans are used to identify the flood hazard and control the location and standards of development in flood hazard areas.

Controlling the use of land within hazardous areas of the floodplain can keep inappropriate future development away from high-risk areas of the floodplain.

Land Use

Land use provisions encompass policies and provisions in district plans or voluntary actions dealing with constructing buildings and structures, carrying out earthworks and using land.

Catchment-wide approaches are now being promoted and developed to lessen flood impacts and address residual risk. Some of the land use provisions being encouraged include:

- Maintaining appropriate land use practices in the upper catchment;
- Raising floor levels;
- Controlling the siting of buildings and excavation in the river corridor;
- Restricting habitable buildings, or commercial and industrial developments in high-risk areas;
- Restricting storage of hazardous substances;
- Requiring new bridges and associated floodway areas to meet the design standard;
- Promoting voluntary land use actions where land use restrictions are inappropriate.

Flood Hazard Maps

Hazard maps of the floodplain can be useful to both local authorities and emergency services agencies. In preparing hazard maps, hazard zones or areas should be defined broadly and any excessively detailed variation of hazard be "smoothed" out. Hazard maps may be incorporated into district plans.

Building Controls, Including Minimum Floor Levels

Building controls are the conditions that can be attached to building within flood hazard areas. Such controls are aimed at reducing the risk of a building being flooded above the floor level or adversely affecting flood behaviour, increasing the risk to life or property.

Floor level requirements have been promoted by Wellington Region's floodplain management plans and are generally more stringent than those promoted by the building code. The general intention is to match floor level requirements with the design standard. For the Otaki and Waikanae floodplains, new subdivisions require buildings to be sited above the 100-year flood level. Building sites must be free of the 50-year flood on existing lots.

The Hutt River Floodplain Management Plan promotes floor level requirements in higher risk areas. These include above the 100-year flood for new and redeveloped dwellings in existing developed areas, and the 440-year flood for new subdivisions in open-space areas. These principles only affect areas that would not be protected by upgraded flood defences. The Plan also promotes encouraging landowners to raise floor levels where requirements are not so stringent. Non-structural measures for the Hutt River attempt to take building requirements one step further than on the Kapiti Coast floodplains, with likely requirements to strengthen buildings where flow velocities may be significant.

Floor levels are given to the bottom of floor joists or concrete floor slab. Minimum floor levels tend to be applied to residential rather than commercial and industrial uses, although GWRC often recommends that commercial floor levels are raised to the same standard. Ultimately, the decision on whether a commercial floor is raised will also be affected by economics and commercial risk-taking considerations.

Freeboard

In setting floor levels, freeboard incorporates the following factors:

- Uncertainties in estimates of flood levels;
- Differences in water levels across the floodplain

because of "local factors" not included in hydraulic models;

- The cumulative effect of subsequent infill development;
- Increases in water level as a result of wave action – waves can be wind-induced (across fetches of open water) and wave-induced (powerboats and vehicles moving through flooded areas);
- Increases in water level as a result of debris effects and gravel build up in the river bed;

Incorporating freeboard also reduces the likelihood of sewer surcharges into buildings. Freeboard should not be considered an optional extra that can be excluded when calculating return periods for flood events or floor levels.

Note that allowances for climate change should be included as part of the design, and are not included in freeboard allowances.

Flood-Proofing Buildings

Flood-proofing refers to the design and construction of buildings with appropriate water-resistant materials, so that flood damage to the structure of the building itself (structural damage) is minimised when the building is flooded. While flood-proofing can minimise structural damage to flood-affected buildings, the residents and their possessions may still be adversely affected. This can also be applied to erosion-proofing.

House Raising

House raising may result in the minimising or avoiding of flood damage in high-risk areas. House raising and flood-proofing of buildings reduces:

- Personal loss;
- Risk to life and the costs of servicing isolated people who remain in their homes during floods;
- Stress and post-flood trauma.

Usually houses built with single or double brick or slab-on-ground construction are too expensive or impossible to raise. Houses best suited to raising are timber-framed and clad with non-masonry materials.

Voluntary Actions

In some flood hazard areas, it may be impractical or uneconomic to mitigate flood hazard through either structural or non-structural measures. In these cases, voluntary actions, either by private or public individuals/organisations, may be appropriate for protecting existing at-risk properties or reducing the residual risk in areas that will be protected by structural measures. Examples of voluntary actions include providing technical information and advice to the community about flooding effects and ways to reduce impacts. In some cases, voluntary property purchase may be an option.

For example, as part of the Floodplain Management Plan for the Waikanae River, two properties were purchased and the buildings removed. The areas were subsequently rezoned from residential to river zone.

Emergency Management

The emergency management approach is preparing the community to cope with flooding, and is a highly cost-effective way to reduce residual risk.

Emergency management has typically been a service provided to at-risk communities during flood emergencies. Recent reform is aimed more at building an environment of self-help and mutual support within communities so they are better able to manage their own emergency response. Emergency management programmes and procedures can be categorised into the four "Rs" of Comprehensive Emergency Management:

- *Reduction of Risk*: Strategies that reduce the chances of a hazard occurring, or lessen the consequences when it does happen;
- *Readiness*: Strategies that prepare for emergency response;
- *Response*: Strategies for counteracting the emergency when it occurs;
- *Recovery*: Strategies to return the community to how it was before the emergency.

Emergency management can complement voluntary actions and land-use options. These three non-structural measures can be used together as an option for communities to reduce the impacts of flooding. In the future, the Reduction of Risk and Readiness strategies may drive community acceptance of increasing use of non-structural measures.

The main tool for presenting residual risk information is flood extent maps. These particularly deal with over-design events, or those floods that break the structural flood defences.

Appendix 6: Evaluation Tools

Multi-Criteria Analysis (MCA)

Refer to Department for Communities and Local Government (2009): Multi-criteria Analysis – A Manual, London, UK. (http://www.communities.gov.uk)

> *This manual was commissioned by the Department for the Environment, Transport and the Regions in 2000 and remains, in 2009, the principal current central government guidance on the application of multi-criteria analysis (MCA) techniques. Since 2000, it has become more widely recognised in government that, where quantities can be valued in monetary terms, MCA is not a substitute for cost-benefit analysis, but it may be a complement; and that MCA techniques are diverse in both the kinds of problem that they address (for example, prioritisation of programmes as well as single option selection) and in the techniques that they employ, ranging from decision conferencing to less resource-intensive processes.*

Refer to Department of Infrastructure, Planning and National Resources (2005): Floodplain Development Manual – Appendix G Floodplain Risk Management Study Preparation, Sydney, Australia. (http://www.environment.nsw.gov.au).

The Greater Wellington Regional Council's purpose is to enrich life in the Wellington Region by building resilient, connected and prosperous communities, protecting and enhancing our natural assets, and inspiring pride in what makes us unique

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