

# Tauranga Taupo River - Catchment Management Plan

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# 1 Introduction

Environment Waikato has responsibilities in relation to flooding and river management within the Waikato region under the Soil Conservation and Rivers Control Act 1941 and the Resource Management Act 1991. These responsibilities are exercised by Environment Waikato's River and Catchment Services Group (RCS Group) (formerly the Asset Management Group).

In response to issues on the Tauranga Taupo River and, as part of a region wide project to confirm funding for soil conservation, river and flood management, (Project Watershed), a flood risk management plan was prepared in 2001. The objective was to identify the means of better managing flood events and minimising associated impacts on the settlements of Te Rangiita and Oruatua. The Tauranga Taupo River and Flood Management Scheme was adopted in 2002.

Applications were made for Resource Use and Land Use consents to implement the scheme. Following a consultation phase consents were granted, subject to conditions, most of which were designed to address the temporary environmental effects during works construction. However, to ensure long-term environmental benefits, two conditions required Environment Waikato to prepare a "Willow Eradication and Control Programme" and a "Catchment Restoration Plan" for the Tauranga Taupo River. These requirements are intended to be addressed by way of this Catchment Management Plan.

However, this Plan is also the opportunity to address requirements under the Local Government Act 2002 relating to wider community wellbeing namely the range of environmental, social, economic and cultural outcomes sought by the community.

## 1.1 Acknowledgement

Environment Waikato on behalf of the communities of Te Rangiita, Oruatua and Waitetoko wish to acknowledge the significant contribution made to this project by landowners on whose land, flood and erosion protection structures are located.

- Lake Taupo Forest Trust
- Tauranga Taupo Y Trust
- Department of Conservation
- Taupo District Council

Without the contribution of these landowners this project could not have been implemented.

## 1.2 Objectives/purpose of the plan

This catchment management plan is a guide to the future management of the Tauranga Taupo River and its catchment. As a strategic and long term plan, it establishes a vision for the next 10 years or more and sets out the strategies needed to manage the river and its catchment in a way that meets the aspirations of its stakeholders. It is anticipated that the plan will be reviewed every 5 years through a consultative process with stakeholder parties. The plan will provide the framework within which future prioritising of programmes are confirmed.

This plan has no statutory status at this time although it is intended to reflect the goals and desires of the local community and specific interest groups as articulated through ongoing consultation and liaison. The plan is intended to assist and support planning and decision making processes undertaken by the management agencies and river users.

At present there are no provisions within the Proposed Waikato Regional Plan or the Resource Management Act 1991 (and amendments) that provide statutory status to community or catchment management plans.

It is important to note that this plan could be regarded by consent authorities during consideration of resource consent applications as ‘other relevant information’, (Section 104(1) (c) of the RMA 1991).

This plan sets out a framework and defines the parameters within which future management planning and actions will take place for the Tauranga Taupo River.

## 1.3 Community outcomes

The goal for the Tauranga Taupo River Catchment is to achieve sustainable outcomes for the communities and stakeholders. Achieving the outcomes is a joint responsibility of the stakeholders and communities as outlined in the Environment Waikato’s Long Term Council Community Plan and annual works programmes.

Environment Waikato’s LTCCP sets different community outcomes for the different activities and services it provides, including the following:

1. Maintain access to clean water for recreation, cultural and commercial users.
2. Present and future generations have healthy and productive land and soil, and wise management practices to ensure sustainability and protect water quality.
3. The risks to people and property from natural hazards and accidents are minimised.
4. Stable and healthy rivers and streams, communities are protected through river management schemes, and the productive potential of land maintained.
5. The public amenity values associated with rivers will be secured and enhanced.

## 1.4 Stakeholder parties

Parties with an interest in the ongoing management of the river include:

**Table 1 Tauranga Taupo River - stakeholder interest groups**

Stakeholder	Nature of interest
The Tuwharetoa Maori Trust Board	Landowners, owners of bed of river and Lake Taupo, ratepayers
The Department of Conservation	Manager of public conservation land, responsibility for fishery management.
Lake Taupo Forest Trust (& New Zealand Forest Managers)	Landowners representative (Tauranga Taupo Y Trust, Kiko Farm and D2 block), responsible for management of forest, ratepayers.
Te Rangiita and Oruatua communities	Ratepayers, Beneficiaries of river works
Taupo District Council	Territorial local authority responsibility for local roading, stormwater infrastructure
Environment Waikato	Regional authority with statutory responsibility for river management, emergency management
Transit New Zealand	National roading infrastructure (SH1)

## 2 Stakeholder objectives

As a result of problems following the July 1998, October 2000 and December 2001 flood events, Environment Waikato undertook consultation with landowners, stakeholders and residents regarding flood risks on the Tauranga Taupo floodplain. The outcome was support to undertake a hazard risk assessment and to investigate options for a revised flood and river management scheme for the Tauranga Taupo River.

From 1999-2002 Environment Waikato was also consulting with stakeholders and communities within the entire Waikato River catchment, as to options to fund river management, erosion control and flood protection works in the catchment. Project Watershed was adopted in 2002 and provided the basis for funding these activities.

From these discussions, the primary stakeholder's objectives and interests, with regard to the Tauranga Taupo River are outlined below:

**Table 2 Tauranga Taupo River - stakeholder objectives**

Tuwharetoa Maori Trust Board	<ul style="list-style-type: none"> <li>• Protection of mauri of river and Lake Taupo</li> <li>• Flood hazards and risk reduced</li> <li>• Bank erosion minimised</li> <li>• Viability of rural land maintained</li> </ul>
Department of Conservation	<ul style="list-style-type: none"> <li>• Maintenance or improvement of the trout fishery</li> <li>• Maintenance or improvement of angling access and opportunity</li> <li>• Indigenous habitat maintenance and enhancement</li> <li>• Protection or enhancement of conservation values, in particular on public conservation land</li> </ul>
Rural & Forest Landowners	<ul style="list-style-type: none"> <li>• Maximise use of land</li> <li>• Management to minimise impacts on downstream communities</li> </ul>
Oruatua and Te Rangiita Communities	<ul style="list-style-type: none"> <li>• Flood hazards and risk reduced</li> <li>• Access to river maintained</li> <li>• Minimise visual impact of scheme assets</li> <li>• Adequate warning of flood events</li> <li>• Management of vegetation and debris</li> <li>• Ensure funding equity between stakeholders</li> </ul>
Taupo District Council	<ul style="list-style-type: none"> <li>• Maintain &amp; enhance recreational opportunities</li> <li>• Impact of scheme on Heu Heu Parade</li> <li>• Management of vegetation and river debris</li> <li>• Protection of infrastructure (i.e. roading and stormwater)</li> </ul>
Environment Waikato	<ul style="list-style-type: none"> <li>• Identify and manage natural hazards (management of risk)</li> <li>• Integrated river &amp; catchment management</li> <li>• Stable river banks and channel</li> <li>• Routine gravel and sediment management</li> </ul>

	<ul style="list-style-type: none"> <li>• River bank protection</li> <li>• Riparian management</li> <li>• Plant and animal pests</li> </ul>
Transit New Zealand	<ul style="list-style-type: none"> <li>• Avoidance of damage to roading infrastructure especially State Highway One bridge</li> </ul>

## 2.1 Vision for the Tauranga Taupo River

The vision for the River, which seeks to incorporate the objectives of all stakeholders, is as follows.

*To manage the river and its catchment in an integrated manner to achieve stakeholder objectives and community outcomes through a common vision of:*

- *Secure communities*
- *Healthy and stable catchment and river system*
- *Environmental and conservation values enhanced*
- *Recreational and amenity values enhanced*
- *Land productivity and value improved*
- *Cultural values relating to river system, floodplains and the Lake protected.*

Integrated river and catchment management to incorporate the following activities:

- Secure communities – Through identifying hazards, maintaining warning systems and hazard plans, reducing flood risks through construction and maintenance of works and managing residual risks.
- Healthy and stable catchment and river system – Reducing erosion and suspended sediments and blockages of the river system through erosion control, channel maintenance and improved management of the riparian margins. A range of options including both ‘soft’ and ‘hard’ engineering approaches will be considered.
- Environmental and conservation values enhanced – Through protection and enhancement of indigenous biodiversity and the natural character to the river and catchment.
- Recreational and amenity values improved – Through maintaining access to the river environs and ensuring the quality and extent of habitat for trout are protected.
- Land productivity and value improved – Through flood risk reduction, enhanced environmental values and improved recreational opportunities.
- Cultural values protected – Through recognition and protection of the mauri of the Tauranga Taupo River system and its environs.

## 3 Legislative and planning framework

This section is a summary of the legislative basis for the plan and the roles and responsibilities of the various stakeholders. Other legislative responsibilities in relation to funding are set out in Section 8.

### 3.1 Soil Conservation and Rivers Control Act (1941)

The Soil Conservation and Rivers Control (SCRC) Act (1941) has been replaced in part by the Resource Management Act (1991), but sections of the Act are still operative and are relevant to this management plan in respect of the responsibilities on regional councils (previously catchment authorities) in regard to flooding and soil erosion.

The objects of the Act are:

- (a) The promotion of soil conservation:
- (b) The prevention and mitigation of soil erosion:
- (c) The prevention of damage by floods:

- (d) The utilisation of lands in such a manner as will tend towards the attainment of the objectives of the Act.

## **3.2 Resource Management Act (1991)**

Part II of the Resource Management Act (RMA) 1991 and (Amendments) outlines the purpose and principles of the Act as defined in sections 5, 6, 7, 8.

- Section 5 outlines the purpose of the Act to promote sustainable management of natural and physical resources.
- Section 6 deals with Matters of National Importance.
- Section 7 addresses Other Matters.
- Section 8 relates to the Principles of the Treaty of Waitangi.

(Please refer to **Appendix 1** for excerpts from the Part II of the RMA.)

## **3.3 Regional Policy Statement (October 2000)**

The Waikato Regional Policy Statement (WRPS) provides a framework for resource use, which enables the regional community to achieve its social and economic aspirations, within the capacity of the environment. Where resource quality is high, it is the intention of objectives and policies to retain high resource quality. Where resource quality has been degraded through inappropriate use, the quality of such resources is intended to be improved over time.

Under the WRPS, Environment Waikato has a primary role for river and hazard risk management.

The key sections of the Regional Policy Statement that apply to this management plan relate to:

- land & Soil
- water
- indigenous biodiversity
- natural hazards
- structures (Infrastructure)
- monitoring of the RPS

## **3.4 Proposed Waikato Regional Plan (updated January 2004)**

The Proposed Waikato Regional Plan contains policy and methods to manage the natural and physical resources of the Waikato Region. It implements the Regional Policy Statement. The Proposed Plan is not yet operative and is currently subject to reference to the Environment Court, which means that the Plan's current status varies, depending on Appeals received. Resource users need to also consider the Transitional Regional Plan.

The key sections of the Proposed Waikato Regional Plan that relate to this management plan include:

- matters of significance to Maori
- water quality, flows and levels
- damming and diverting
- wetlands
- structures on the beds of rivers and lakes
- river and lake bed disturbance
- accelerated erosion.

### **3.5 Civil Defence and Emergency Management Act (2002)**

Under the Civil Defence Emergency Management (CDEM) Act 2002, Civil Defence emergency management is a function and responsibility of regional, district and city councils. Local authorities throughout New Zealand have joined together on a regional basis to form Civil Defence Emergency Management Groups (CDEM Groups). These groups, in partnership with emergency services and other organisations, are responsible for emergency management locally.

Eleven local authorities within the Waikato Region have joined together to establish a CDEM Group. Each Council is represented by one elected member who is the Mayor/Chair or delegated elected representative. The CDEM Group works together to minimise the potential effects of emergencies, prepare the people to respond to emergencies and help the community to recover as quickly as possible following an emergency. The Lake Taupo catchment is part of the Waikato Regional CDEM Group.

### **3.6 Conservation Management Strategy**

The Department of Conservation under the Reserves and Conservation Acts manages the Oruatua Recreation Reserve, Oruatua Conservation Area, Manowharangi Bay Recreation Reserve and Tauranga Taupo River Marginal Strip all of which adjoin the Tauranga Taupo River.

The Department is responsible under the Conservation Act 1987 for the preservation of indigenous freshwater fisheries and the protection of recreational freshwater fisheries and freshwater fish habitats. The Department also has responsibility for advocating for the conservation of natural and historic resources in general; and, where not inconsistent with conservation, advocating for recreation.

The *Tongariro/Taupo Conservation Management Strategy* and *Taupo Fishery Sports Management Plan* implements the Department's responsibilities. It contains provisions relating to the protection and enhancement of:

- public conservation land
- indigenous biodiversity
- trout habitat
- natural character
- recreation opportunities
- angling opportunities

### **3.7 Taupo District Plan**

Territorial authorities' functions under the RMA include:

- the preparation of objectives and policies for the integrated management of the effects of the use, development and protection of land and associated natural and physical resources
- control of the effects of land use, including the implementation of rules for the avoidance or mitigation of natural hazards and the management of hazardous substances
- control of subdivision
- noise control
- control of activities on the surface water of rivers and lakes.

## 4 Tauranga Taupo River and its catchment

The purpose of this section is to describe the catchment and specifically, the existing 'baseline' conditions within the catchment.

### 4.1 Catchment description

#### 4.1.1 Location

The Tauranga Taupo River (Map 1) runs from the Kaimanawa Ranges into the south eastern shore of Lake Taupo. After the Tongariro River, it is the largest of the eastern Taupo rivers, with a catchment covering approximately 230 square kilometres. Much of the catchment area is in steep mountainous terrain. The settlements of Oruatua and Te Rangiita lie on the floodplain of the river along State Highway 1 close to Lake Taupo.

#### 4.1.2 Vegetation

The primary vegetative cover of the catchment is indigenous native forest cover of the Kaimanawa Forest Park, managed by the Department of Conservation and exotic plantation forestry of the Lake Taupo Forest Trust managed by New Zealand Forest Managers (Turangi).

The lower floodplain on the left bank is a mixture of exotic forestry and pasture (grazed and fodder crop), contains the communities of Oruatua and Te Rangiita and network infrastructure (i.e. roading and electricity).

**Table 3 Tauranga Taupo River catchment – land use**

Land use	Percentage of catchment
Indigenous forest & alpine tussock	67.5%
Exotic production forest	30.3%
Pasture	0.8%
Quarry	0.2%
Urban / settlements	0.1%
Roading	0.3%
Shrub	0.4%
Other	0.4%
<b>Total</b>	<b>100%</b>



Map 1 Tauranga Taupo River location map



## 4.2 River system description

The Tauranga Taupo River is approximately 45 kilometres long from its headwaters down to Lake Taupo. The river drops some 1,243m over this length, from RL 1600m to RL 357m. The river can be divided into two main reaches, based on steepness and vegetation cover, being the upper river reach and the lower river reach. The following is a description of the physical characteristics of each of the reaches.

### 4.2.1 Upper river

The upper river is the reach above the Te Rangiita Quarry. This reach is approximately 38km long dropping some 1,200m, with an average slope of 3.2%. The reach is characterised by steep mountainous areas in native vegetation of the Kaimanawa Forest Park, steep to rolling areas in exotic plantation forestry and associated forestry infrastructure (roads, bridges and landings).

The upper Tauranga Taupo River is predominantly a constrained single channel confined within steep incised banks and has a relatively steep gradient. These physical characteristics are reflected in the hydraulic and morphological terms as high velocity, small time of concentration and high erosive energy that shifts the bed and bank materials downstream. While the Tauranga Taupo is a high energy river, it does not tend to alter its course within this reach, due to its incised nature and heavily vegetated stable catchment. However, these effects are transferred downstream within the flatter reach of the river.

### 4.2.2 Lower river

The lower river and associated floodplain is located below the Te Rangiita Quarry and is approximately 7km long dropping some 43 meters, with an average slope of 0.6%. This reach is very flat compared to the upper reach and receives high energy flows loaded with bed material and debris. Hence, it is in this reach that the river tends to meander, creating a number of secondary channels and ponding areas that the river utilises to absorb the energy and volume of flows. The lower reach of the river is characterised by:

- unstable main channel with significant erosion and deposition during flood events
- unpredictable changes in the course of the main channel
- wide floodplain with multiple overflow points and relict river channels

It should be noted that these features are part of the natural floodplain and delta building processes of a dynamic river, this historically demonstrated by floodplain building and transport of substantial quantities of shingle and debris.

Under normal flow conditions the sediment transport load of the river consists of sands and silts in suspension transported through the lower reaches to the lake. However, floods mobilise significant bed loads and are the dominant channel forming process. The lower river has the ability to change course during flood events due to the relatively limited capacity of the main channel, and the type of riverbank and floodplain material which is susceptible to erosion.

Sediment deposition/ aggradation and cutting/ degradation of the river bed are natural processes on a floodplain and can influence the location of overflows, secondary channels and breakouts. While not an ideal location for development, it is within this reach that the main development has occurred historically. Hence, the flood control schemes and works are located within this reach.

# 5 Flood hazards and flood protection scheme

## 5.1 Natural hazards

The Tauranga Taupo River catchment is subject to a number of natural hazards, including earthquakes, volcanic eruptions and flooding. The catchment is also prone to erosion and slips due to the nature of soils forming the ground top layers of the catchment, as they include volcanic ash, pumice and porous gravel and sand.

Seismic activity within the Taupo Volcanic Centre is monitored primarily by a network of five seismometers that surround Lake Taupo. Earthquakes recorded in the Lake Taupo were concentrated south of the lake, but several earthquakes occurred beneath the central part of Lake Taupo. This is an area where few earthquakes have been recorded since 1985.

The catchment is located in the vicinity and below the Central North Island volcanoes. Volcanic eruptions generate millions of cubic metres of fine sediments and ash, which are spread over the whole area surrounding the volcanoes, some of which is received within the Tauranga Taupo River catchment. No quantification of these quantities has been undertaken, however, these quantities could significantly affect the sedimentation, depending on the wind direction and size of the eruption. A recent study undertaken by NIWA on the Tongariro River suggests that eruptions in this locality could be expected once every two years. (Refer to NIWA Client Report: CHC2005-002, January 2005, The Higher Lower Tongariro River). Resultant fine deposits are washed down the river into the Lake, with some remaining within the floodplain. Generally, volcanic hazards are not addressed within this management plan but are highlighted, as they can have significant implications on the communities of the catchment.

River flooding and, to a lesser extent, high lake levels do have a more direct effect on the urban and rural settlements and infrastructure within the catchment. Flood hazard investigations and risk assessment have been undertaken by Environment Waikato and the Taupo District Council, including works, to reduce the flood risks. Addressing these risks by way of flood control schemes and ongoing river and catchment management is the subject of this plan.

## 5.2 Recent flood history & flood hazard risk

Major flood events in the Tauranga Taupo River catchment in 1958 and 1964 prompted investigations as to the provision of flood protection for the communities of Oruatua and Te Rangiita. Several options and schemes were determined by the then Waikato Valley Authority (WVA) in 1966 and 1975 but were not adopted due to funding constraints upon the WVA and the Taupo County Council.

A proposed scheme was adopted 1981 and partially implemented. Works included the construction of stopbanks in the vicinity of Kiko farm, formalisation of the natural overflow at Maniapoto Bend (Kiko Overflow) to allow peak flows to bypass the settlements of Te Rangiita and Oruatua and the construction of the Kiko Culverts under State Highway One.

Floods in July 1998, October 2000, December 2001, May 2003 and February 2004 have drawn attention to the risks to both rural and urban land from flooding. The December 2001 flood broke through into the excavated quarry area and formed a new course for the river. This breakout effectively de-watered a substantial length of the previous course of the river and changed the balance of flooding and flood risk and substantially affected access to the trout fishery.

In December 2003 the river was put back into its previous course (that course largely defined by cadastral survey) with the construction of a closure embankment at the breakout point into the quarry. Significant works were undertaken to improve the hydraulic efficiency of the natural spill area at Maniapoto Bend and a grassed spillway channel was formed and the capacity of culverts under State Highway 1 were increased.

The February 2004 flood resulted in some changes in the channel and activation of a number of erosion sites. There were no major changes in channel alignment during the flood event however it seems that a significant volume of sediment and debris was mobilised from within the river channel.

The area affected by floods of the Tauranga Taupo River is shown on the flood hazard map below. This map is based on historical survey of flooded areas following the 1964 flood. It should be noted that the 1958 flood was higher than this flood, but no actual survey data as to the extent of the flood is available.

*Note: The extent of flooding (boundary lines), especially at the upstream end (southern end) of the river are not exact, however represent best approximation of the extent based on historical maps.*

## **5.3 Approach to flood hazard risk management**

The underlying approach taken by Environment Waikato has been to manage and minimise the flooding risks to urban and rural land located on the natural floodplain of the lower Tauranga Taupo River. However, there is always a residual risk associated with settlements located on a natural river floodplain that cannot be mitigated solely by the construction of physical works.

The approach focused on optimising the channel capacity of the river through and under the State Highway bridge and distributing the balance of the design flow across the floodplain. The design concept replicates the natural flooding in that it retained the majority of the flood ponding areas and overflows at key locations, however in a controlled manner. This involved flow diversions via spillways and ponding on both banks of the river, extension of the stopbanks on the left bank of the river and new stopbanks on the right bank. Closure of the quarry breakout also formed a central part of the overall management approach.

It was noted at the outset that in addition to physical works, it was necessary for Environment Waikato and stakeholders identify and apply other hazard management tools such as land-use and management, contingency planning, vegetation management and monitoring and maintenance works to achieve the community outcomes. This is a primary objective of this management plan.



**Map 3 Flood hazard map: flooded area pre-scheme**

## 5.4 Hydrology and river hydraulics

### 5.4.1 Flow regime

The Tauranga Taupo has a total catchment of 230 square kilometres with the upper catchment in indigenous forest/scrub and most of the remaining catchment in exotic pine forest.

Flows of the Tauranga Taupo River have been continuously recorded since February 1976 at a gauge at Te Kono accessed off Kiko Road (map reference T19: 636-472). The gauge site is located approximately 7 kilometres upstream of the river mouth.

Flood Hydrograph analysis of the four largest floods on record indicate that floods on the Tauranga Taupo River typically have a single peak and that the bulk of the flood lasts between 12 to 18 hours (Tonkin & Taylor, AEE). It should be noted that the estimates for flood return periods are being continually refined as more data becomes available.

The assessment of flood hazard in the lower Tauranga Taupo River was undertaken on the following basis:

- an analysis of the frequency and size of historical floods recorded between 1976 and 2001
- a general review of the historical behaviour of the river channel and floodplain, particularly its course changes over time and the assessed distribution between in-channel and various overbank/breakout flows in times of flood
- establishment of a computational hydraulic model of the river, based on available topographical data, including a specific survey of river cross-sections, and a variety of information on observed flood levels and flow patterns
- hydraulic modelling of the river and floodplain for various return period flood events, assuming that the river system was restored to its pre-quarry-breakout state
- testing and confirming through hydraulic modelling, the design of flood protection measures for protecting the principal assets at risk

The following Table 4 provides the design flows at key locations along the river channel, where protection and control structures are constructed.

**Table 4 Tauranga Taupo flow distribution for a range of flood sizes**

Flow at key locations (m <sup>3</sup> /s)	Flood return period (years)						
	Mean annual flood	5	10	20	50	100	200
Te Kono gauge	150	197	235	271	318	353	388
Overflow into quarry via spillway	0	0	1.5	11	30	45	62
Kiko overflow (spillway and side inflows)	23	45	60	72	82	91	99
Right bank overflow – across SH1	0	0	0	0	0	12	20
Under SH1 bridge	125	146	164	175	209	235	246

## 5.5 Flood protection and control works

### 5.5.1 Elements of the scheme

A central issue to determining the approach to flood risk management was setting of the level of protection to be provided to urban and rural properties on a natural floodplain. Such determination recognised that flood risk could be alleviated but not excluded in the context of an active river with an aggrading shingle or gravel bed and subject to substantial floods from a mountain catchment.

The scheme has been designed to a 1 in 50-year flood standard, in terms of protection to the urban areas and to a 1 in 20 year standard, for the State Highway and those rural areas not in the quarry or vegetated section of the floodplain.

In general, the 400 mm freeboard provided on stopbanks protecting urban areas is expected to contain around the 1 in 100 year flood. Rural areas, other than the regularly flooded river reserves, should begin to experience overland flows with floods in excess of the 1 in 20 year approximate flood i.e. the quarry area and Kiko plantation swale area. The following table sets the design standards of the different elements of the scheme:

**Table 5 Tauranga Taupo design standard**

Scheme element	Design standard/ flows	Overtopping flows in 50-year
<b>Right bank</b>		
Quarry closure bank	50 – year (318 m <sup>3</sup> /s)	No Overtopping
Closure bank spillway	<10- year (235 m <sup>3</sup> /s)	1.5 m <sup>3</sup> /s to 30 m <sup>3</sup> /s
Quarry attenuation	50 – year	30 m <sup>3</sup> /s
Eastern stopbank	50 – year (209 m <sup>3</sup> /s)	No overtopping
Eastern stopbank spillway	>50 – year (209 m <sup>3</sup> /s)	No overtopping
SH1 diversion bund	51 to 200 year	
<b>Left bank</b>		
Maniapoto bend	Ensure stability and ensure no river diversion into Kiko	
Maniapoto bend bed control and diversion bank	Ensure design cross section is stable and flows distributed between main channel and Kiko spillway	
Kiko spillway	< Annual (120 m <sup>3</sup> /s)	23 m <sup>3</sup> /s to 82 m <sup>3</sup> /s
Kiko spillway to Twin Barn	20-year (175 m <sup>3</sup> /s)	
Western stopbank	50-year	No overtopping
Heuheu Parade floodwall	50-year	No overtopping

Consideration has also been given to managing the effects of floods in excess of the design standards. Some damage is to be expected to non-critical components but key elements such as the closure bank and Kiko spillways and the urban stopbanks are designed not to fail catastrophically in extreme flood conditions.

The elements of the Tauranga Taupo River Flood Protection & River Management Scheme located within the lower floodplain of the river are shown on the following map. Detailed description of the elements is in the Appendix II of the document.

### 5.5.2 Flood hazard reduction

Following completion of the scheme works, the flood hazard will be reduced and managed. The catchment and river management annual works programme will aim at ensuring the stability and reliability of the scheme works. The following map shows the flood hazard extent following the completion of works.



Map 4 Flood protection scheme elements



## Explanatory note:

**Primary floodplain (floodway)** represents the main river channel and associated floodplains containing and attenuating the flood flows.

**Secondary floodplain (floodway)** represent the area where overland flow occurs naturally and/or is controlled by way of designated spillways. The Kiko spillway area would be expected to flood annually. The remaining area is subject to gradual inundation in events equal to or exceeding the 20-year event. The wetland and farmland area between the Lake and the State Highway 1 experiences flooding from the Lake and from events exceeding the 10-year event, when the State Highway at Kiko culverts is overtopped. Not all of this area will experience flooding.

# 6 Management issues

## 6.1 Resource & landuse consents

Environment Waikato (River and Catchment Services Group) is a holder of a number of consents relating to the construction and maintenance of flood protection structures on the Tauranga Taupo River. Tables 6 and 7 outlines these consents and their terms.

**Table 6 Tauranga Taupo River catchment - forest activity resource consents**

Consent No:	Activity consented	Location	Term (years)	Review date
100836	Clear fell harvest <i>Pinus radiata</i> at a rate of approx 800 to 1000 hectares per annum	Lake Taupo forest	10 yrs	June 2008
110163	Undertake harvesting and associated earthworks within 9980 ha of Lake Taupo Forest	Lake Taupo forest	10 yrs	June 2014
110164	Construct stream crossings within 9980 ha of Lake Taupo Forest	Lake Taupo forest	34 yrs	June 2038

**Table 7 Tauranga Taupo River – EW resource consents**

Consent No.	Activity consented	Location	Term (years)	Review date
108324	Construct erosion control structures, weirs, spillways and river sill works and to undertake ongoing maintenance of those structures as required in the bed of the Tauranga Taupo River for flood hazard control works.	Hingapo Rd & SH1 – Te Rangiita	35 yrs	April 2038
108325	Extract gravel and shingle, and to disturb the bed of the Tauranga Taupo River generally in associated with flood hazard control works.	Hingapo Rd & SH1 – Te Rangiita	10 yrs	April 2013

108326	Divert flood waters by way of stopbanks, and divert the flow of the Tauranga Taupo River by way of a constructed diversion channel, river sill works and undertake ongoing maintenance, all in association with flood hazard control works.	Hingapo Rd & SH1 – Te Rangiita	35 yrs	April 2038
108697	Construct and use culverts and to undertake works in association with Kiko Culverts, associated with flood hazard control works.	Hingapo Rd & SH1 – Te Rangiita	35 yrs	April 2038
109978	Construct, use and maintain erosion control structures in the bed of the Tauranga Taupo River.	Tauranga Taupo River – Oruatua Reserve	35 yrs	March 2039
111087	Placement of additional erosion control structures comprising rock riprap, a timber flood wall and an earthen stopbank in and on the bank of the Tauranga Taupo river for flood protection purposes.	Tauranga Taupo River – Heu Heu Parade	35 yrs	Nov 2039
111088	Divert water by way of a flood control wall and stopbank for flood protection purposes.	Tauranga Taupo River – Heu Heu Parade	35 yrs	Nov 2039
RM020637 – Landuse Consent	To undertake river control works within Flood Hazard Area – Stage One.	Near Kiko and Hingapo Roads, Te Rangiita.	N/A	N/A
RM030115 – Landuse Consent	To undertake river control works within Flood Hazard Area – Stage Two.	Near Kiko and Hingapo Roads, Te Rangiita.	N/A	N/A
RM040478 - Landuse Consent	To construct a footpath, car parking and establish landscape works on land at Heu Heu Parade, Oruatua, Taupo.	Heu Heu Parade	In perpetuity	N/A
Landuse Consent	To raise a footpath adjacent to SH1 Te Rangiita to assist with flood protection works.	SH1 – Te Rangiita	Lodged with TDC	

## 6.2 Maintenance & management of works

**Objective:** *to outline the maintenance requirements for flood protection structures on the Tauranga Taupo River.*

The Tauranga Taupo River maintenance programme will consist of:

- annual inspection of scheme stopbanks
- crest level survey of scheme stopbanks 5 yearly
- general maintenance of stopbanks every 10 years
- twice yearly channel condition assessment to assess debris, bank erosion etc.
- regular cross sectional surveys, at least 5 yearly, of the river channel at key locations
- annual channel maintenance works programme, including blockage removal
- post flooding inspections of all scheme structures

- annual aerial inspection of the catchment, including establishment of fixed photo points

River inspections will provide information that will allow Environment Waikato to prepare specific programmes directed at:

- maintenance of structures
- vegetation management (planting for erosion control or removal)
- debris management
- gravel management

Table 8 provides cost analysis per annum for maintenance activities described above.

**Table 8 Tauranga Taupo River: estimated annualised maintenance costs**

Maintenance costs	Task	Frequency	Cost/ annum
Embankments	Condition survey	yearly	\$532
	Crest level survey	5 years	\$560
	General maintenance	10 years	\$1,120
Main channels	Condition survey	6 months	\$4,480
	Cross-section survey	5 years	\$10,780
	General maintenance (incl. blockages removal)	1 year	\$14,000
	Gravel mgt as required	5 years	\$14,000
All assets	Post flood inspection of all assets	6 months	\$1,680
	Annual aerial inspection	yearly	\$3,500
General	Riparian mgt/planting & spraying	yearly	\$4,900
Rock rip-rap	Condition survey	yearly	\$182
	Crest level survey	10 years	\$98
Culverts	Condition survey	yearly	\$168
Oversight	Support to working Group, general planning	yearly	\$14,000
Depreciation	Reserve for assets replacement	yearly	\$15,400
<b>Total (exclusive GST)</b>			<b>\$85,400</b>

## 6.3 Channel management

**Objective:** *to maintain the stability of the river and floodplain in terms of its capacity and ability to perform within the design parameters of the scheme. This will be achieved by ensuring that the main channel and identified overflow channels are free from obstruction caused by vegetative debris and gravel where these have the potential to increase flood levels, are causing erosion or damage to scheme structures.*

Maintaining the stability of the Tauranga Taupo River especially its lower reach is a complex task due to the characteristics of the river. Achieving this outcome requires attention to gravel management, bank protection, channel maintenance and the ongoing vegetation and riparian management works.

### 6.3.1 Gravel & sediment management

**Objective:** *to maintain the capacity of the main river channel and prevent river bank erosion by managing gravel and sediment where possible to reduce obstructions to the main channel and overflows channels.*

As indicated earlier, the river bed is dynamic and bedload and sediment movement is a natural process characterising this river. During major flood events considerable quantities of bed and bank material are moved and deposited through the system, changing the channel cross sections and river hydraulics. This needs to be managed to ensure that the scheme works will perform as designed.

Any management strategies to manage or remove gravel deposition areas within the Tauranga Taupo river floodplain must take into account:

- permission of the owners of the river bed
- permission of adjoining landowners for access
- management of the fishery (impacts on spawning and rearing habitat, trout access and fishing opportunity)
- potential impacts on flood hazard risk

Environment Waikato will initiate a gravel management assessment which will include the gathering of appropriate technical and survey data and then use this information to scope a gravel management plan in the 2005/06 year to ascertain the gravel management requirements. The purpose of this process will be to assist in the preparation of a consent application if required. Commercial opportunities for the extraction of gravel may be promoted in consultation with the river bed owners or other interested or affected parties.

If it is determined that gravel extraction is required Environment Waikato will prepare and submit a resource consent application or assist a commercial entity, partnership or organisation(s) to apply for resource consents to extract gravel from the river channel.

### **Upper river**

Due to the constrained nature of the channel and lack of suitable access, it is not envisaged that active gravel management will be undertaken in the upper reach of the Tauranga Taupo River. However future assessments will clarify if any intervention is required in the upper reach.

### **Lower river**

During consultative meetings with the community and stakeholders regarding the formulation of this plan gravel management was identified as the top priority issue that needs to be resolved. There is a general feeling within the community that unless gravel management is addressed elevated bed levels and increased channel meander could cause significant problems in the lower reaches of the river.

In previous decades the Tauranga Taupo river system has been impacted by the extraction of gravel from the quarry and from the river channel itself. It is considered that a long term programme of gravel management in the main river channel will decrease the risk of a channel breakout during flood events and limit the advance of gravel deposits towards the lake.

Environment Waikato currently holds resource consent to extract gravel and shingle from the Tauranga Taupo River in association with flood control works. This consent allows extraction for the construction of flood protection works and expires in April 2013. Additional consents would be required to cover long term ongoing extraction.

To determine the nature of gravel and sediment deposition in the lower river, a detailed monitoring operation will be initiated and will involve:

- annual aerial inspection.
- regular channel monitoring (twice yearly and post flood inspections cross section surveys) to determine the location and volume of gravel deposition areas.
- identification of key gravel extraction areas for a regular extraction programme.
- identification of access to gravel deposition areas.
- necessary landowner approvals.

- regular cross sectional surveys, at least 5 yearly, of the river channel at key locations to determine areas of sediment deposition and erosion.
- LiDAR aerial laser survey to be carried out in November 2005. This survey will provide Environment Waikato with the levels of the river bed including gravel deposition areas relative to river bank and stopbank levels.

From this monitoring information Environment Waikato will determine whether gravel needs to be extracted on an ongoing basis and where it should be taken from to best achieve the objectives and visions of the stakeholders of this plan. EW supports the gathering of information to determine the precise nature of the gravel management issue that is the need, the quantity and the location of potential extraction activities. Until these scientific studies are undertaken any firm plans for the management and extraction of gravel would be premature.

It is anticipated that if it is necessary to extract gravel from the river channel, that it would be removed from dry areas on the inside of bends when the river is at normal to low flow levels. Typically, gravel would be removed to a level approximately 200 millimetres above average water level. Gravel could be used for further river works (with the permission of the owners) or stockpiled for use or sale by the owners.

Extraction of gravel from the river would involve use of excavators, loaders and trucks necessitating the forming of adequate access to the sites.

Environment Waikato will make every effort to gather appropriate technical data and information in the 2005/06 year to ascertain the scope of the gravel issue. The purpose of this data will be to assist in the preparation of a consent application if required. If it is determined that gravel extraction is required Environment Waikato will prepare and submit a resource consent application or assist a commercial entity, partnership or organisation(s) to apply for resource consents to extract gravel from the river channel.

### 6.3.2 Bank protection works

**Objective:** *to protect the bank from accelerated erosion, particularly where there may be adverse impacts on channel capacity, river alignment or the integrity of flood protection structures.*

Bank protection works are required in several locations to prevent river bank erosion. Protection works will generally take the form of willow layering, live willow groynes, willow plantings or plantings of other suitable riparian species and rock armouring as required.

All existing areas of rock bank armouring shall be inspected annually and works carried out to maintain the integrity of the structures as appropriate.

Areas of newly activated bank erosion will be inspected and appropriate course of action determined and implemented following consultation with stakeholder.

### 6.3.3 Channel maintenance

**Objective:** *To manage the Tauranga Taupo river channel in a way that maximises channel capacity and minimises impacts on the integrity of the flood protection structures.*

The channel of the Tauranga Taupo will be monitored by aerial inspection, ground based inspections, post flood inspections, cross sectional surveys and LiDAR surveys.

- Cross sectional surveys of the main river channel will allow Environment Waikato to assess and monitor gravel movement within the river system.
- Post flood inspections will identify immediate damage to flood protection structures, channel obstructions or bank erosion.

- Removal of obstruction will be carried out annually following inspections and assessment of the works needs.

### 6.3.4 Riparian management

**Objective:** *to manage riparian vegetation in a way that minimises bank disturbance and any adverse impacts on flood flows while protecting river banks and flood protection structures from erosion.*

Appropriate management of riparian vegetation can provide stability for river banks, enhanced aquatic habitat and a reduction in nutrient losses to surface water.

#### Upper river

The upper channel is relatively stable and riparian vegetation is unlikely to be disturbed where it is located within the Kaimanawa Forest Park administered by the Department of Conservation.

A significant area of the upper catchment is owned by the Lake Taupo Forest Trust and administered by New Zealand Forest Managers. The majority of this land is utilised as a production forest resource and consequently management of riparian vegetation of the main river channel and tributary channels is regulated by resource consent conditions. Regular monitoring inspections of harvesting operations and auditing of consent conditions is undertaken by Environment Waikato.

Riparian setbacks in the upper catchment range from 50 -200 metres from the main river channel and tributaries. Resource Consent monitoring inspections have not identified vegetation disturbance or soil disturbance issues in the production forest area of the catchment.

#### Lower river

The lower river is more prone to channel movements and breakouts than upper catchment. The objective for the lower river is to seek to ensure that there is appropriate vegetation to provide erosion protection to the river banks, especially in susceptible areas such as outside bends of the river. Selective use of suitable riparian species will be encouraged including the planting and management of improved willow species (sterile hybrid clone shrub and tree willows - Booth, Matsudana or similar) for erosion control purposes.

Riparian vegetation particularly improved willow species need to be managed in a way that will not compromise the integrity of or reduce the efficiency of flood scheme assets, for example the Kiko Spillway and swale. A Mature improved willow tree can be coppiced or pollarded and the branches used for further plantings. Coppicing willow species also reinvigorates the tree growth cycle and prolongs the life expectancy.

Should indigenous species that have erosion protection capabilities be identified then they may be used in preference to improved willow species. The Department of Conservation has indicated it will not allow the planting of willows on public conservation land because it is inconsistent with purpose and principles for which the land is held.

Control of wilding willows may be required in key areas in the wider flood plain outside the immediate river channel. For example if the Te Rangiita Quarry was invaded by wilding willows it may compromise its role for attenuating flood flows and risk the spread of invasive wilding species downstream in a flood event. Any control within the Te Rangiita Quarry or any other site will require the support and approval of the respective landowners.

## ***Willow management***

**Objective:** *To establish a co-ordinated approach to management of invasive wilding willow (salix) species while efficiently utilising the soil conservation properties of improved willow species for erosion control.*

*Problem:* Infestations of wilding willow species in the lower river the growth and particular need to be controlled. Uncontrolled growth of self sown invasive species may obstruct the river channel or result in accelerated erosion of river banks.

Willows at key locations in the lower river have a particularly important role in controlling bank erosion (on outside bends and high risk erosion areas).

To address erosion problems on the outside bends the introduction of improved willow species will be progressively implemented. The use of appropriate indigenous riparian cultivars will be considered at low impact sites.

*Solution:* Willow eradication and control plan.

The Department of Conservation and New Zealand Forest Managers have existing vegetation management programmes in place to address growth of invasive wilding species.

The Department of Conservation has over several years implemented a willow aerial spraying programme to maintain angling access to the river and to protect in stream values. These operations target juvenile and wilding crack and grey willow species that are growing on inside bends of the river or in the river channel.

New Zealand Forest Managers (NZFM) has also undertaken aerial spraying operations to control willow species in the lower river. NZFM have undertaken these operations to comply with Forestry Stewardship Council (FSC) accreditation requirements that require control of potentially invasive weed species such as crack and grey willows.

This plan outlines a proposed willow maintenance and management protocol between EW, Department of Conservation and NZFM to enable ongoing vegetation management in a manner that meets the objectives of the respective parties.

Willow management objectives:

- to establish and maintain protective vegetation in priority areas (see Map3).
- to maintain channel free of vegetative obstructions.
- to maintain angling access to the river.
- to control potential seed sources of invasive willow species
- to progressively replace wilding invasive willows with improved varieties.

To meet these objectives EW will prepare and undertake an annual willow/debris removal programme based scheme and channel inspections outlined in the maintenance section of the plan. Provision will be made for rapid response in cases of major obstruction where vegetation or debris is causing severe bank erosion and/or damage to structures.

The planting and management of improved willow species is seen as the key medium to long term management option to address erosion at key points in the Tauranga Taupo River system. Willows are currently the most effective vegetative control mechanism for riparian erosion; however this may not always be the case. Should more improved varieties or alternative species (exotic or indigenous) these will be considered for use.

The use of willow species is not without issues including the need to manage plantings to ensure tree vigour and health is maintained over time. Pruning, pollarding and coppicing are valuable tools for the management of willows in the medium term.

Willows can be vulnerable to pests especially the Willow Sawfly. The Sawfly feeds on willow leaves and defoliates trees during the growing season resulting in loss of tree growth and vigour. At the time of writing sawfly is not present in the Lake Taupo Catchment however if it was to become established control operations will be required.

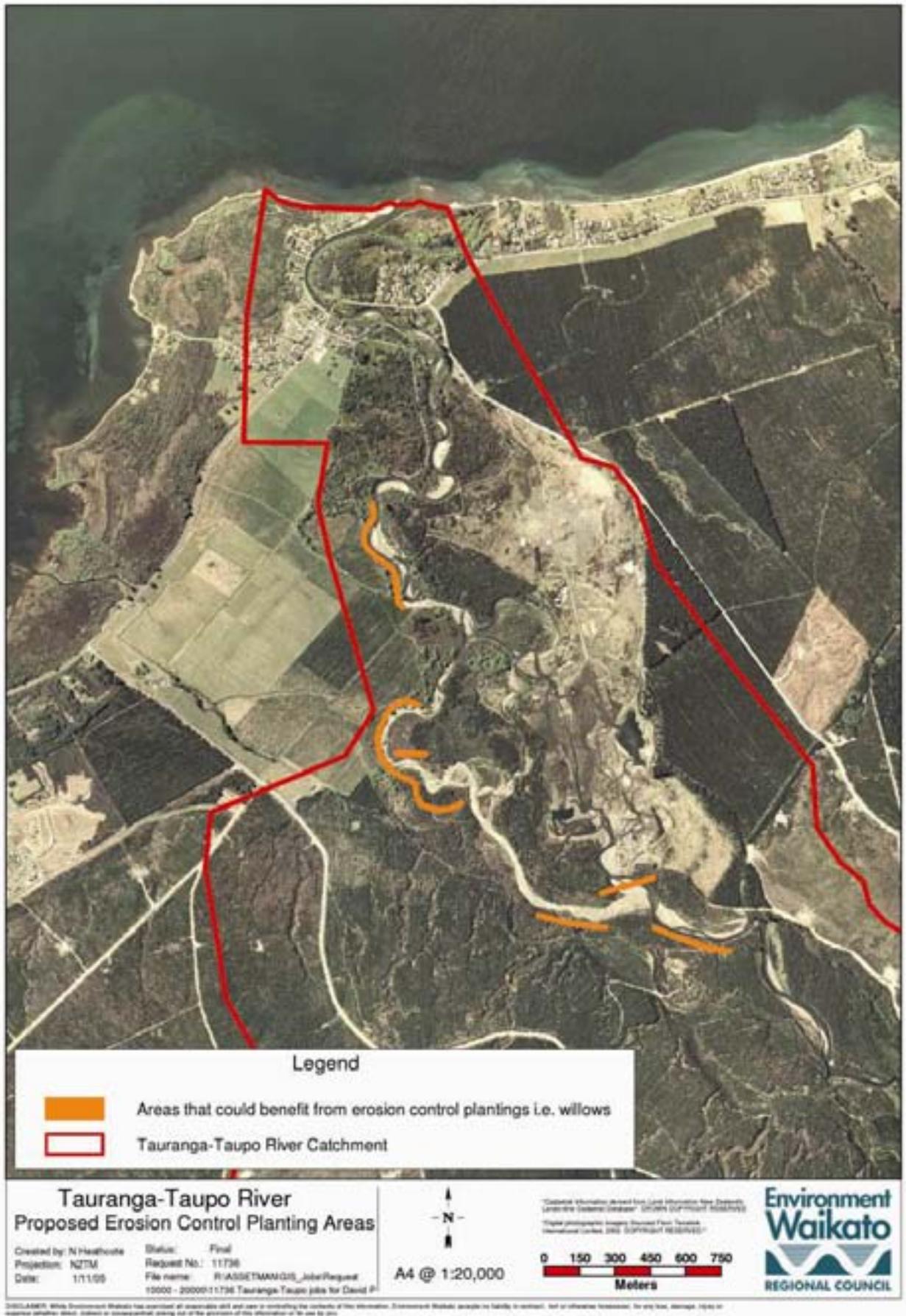
Planting of improved willow species, willow management and maintenance activities will commence in the 2005/06 year with plantings in the vicinity of the Maniapoto bend and removal of approximately 100 metres of willows on the right bank of the river below the State Highway One Bridge.

#### **Proposed willow management protocol**

- Vegetation including willows on inside bends of the river or in the river channel to be controlled where practical by aerial spraying, ground spraying or mechanical removal. Replanting of some areas with improved willow species may be appropriate.
- Mature vegetation on outside bends of the lower river or in areas where there is high erosion risk will be retained. Agreement will be sought from the parties as to nil control in these areas unless specified. Mature vegetation will eventually be replaced with improved willow species.
- High risk erosion areas are identified as: Maniapoto Bend, Kiko Spillway, Maniapoto Bend Diversion Bank, Twin Barns area, around and opposite the Quarry Closure bank.
- Progressive removal of wilding invasive willow species from of high risk erosion areas and replanting with improved willow varieties will be programmed.
- Removal of invasive willow species in the wider flood plain as required in consultation with respective landowners.
- In areas planted with improved willow species EW will undertake to control regrowth of wilding invasive species during establishment.
- Environment Waikato will seek to seek to achieve the progressive removal and replacement of wilding willows with improved varieties over 15 years commencing in 2005 (subject to funding availability).
- Pruning, thinning or pollarding of improved willow species to promote health and vigour can also provide a local source of plant material if required.
- Vegetation control timing and activities will be discussed through the working group and agreement reached on an annual programme of operations.
- The use of appropriate indigenous riparian species will be considered for use in the control of bank erosion once appropriate cultivars becomes available.
- 10 working days notice to be provided to DoC, NZFM and EW of proposed vegetation control activities.

#### **In-channel vegetation**

Twice yearly and post flood inspections of the river will be carried out by Environment Waikato staff and/or contractors to assess channel condition. In-channel vegetation and debris that could restrict flood flows result in bank erosion or damage the scheme assets will be pruned, coppiced, thinned or removed where practical and within the annual budgetary provisions available.



**Map 6 Proposed location of erosion control plantings**

## Restoration of disturbed sites

*Objective: to ensure appropriate rehabilitation of disturbed sites by introduction of primarily indigenous species to reduce the impacts of potential weed reinvasion and to improve the biodiversity of construction areas.*

### 6.3.5 Rehabilitation of construction sites

Rehabilitation of disturbed sites will focus on the winter immediately following vegetation control or earthworks activities and will generally take the form of replanting appropriate native or exotic riparian species, re-grassing (if appropriate) or left to promote natural regeneration.

Disturbed areas will be tidied up with machinery prior to replanting. Where an area is to be re-grassed it shall be either hydro-seeded or manually sown with grass seed and fertiliser will be applied at recommended rates. Re-grassing will be undertaken in either the Spring (September/October) or Autumn (March/April) growing season following construction.

Any damage to native vegetation by accident, or by way of necessity during vegetation management or construction activities, will be mitigated by replanting new native plants in the same areas, or areas in the close vicinity of the damaged plants.

If native planting is required, species for planting at the rivers edge include:

- Native sedges - *Carex spp*
- Toetoe - *Cortaderia fulvida*
- Flax - *Phormium tenax*

Species for the flood plain up to the permanently dry (rarely flooded) zone include:

- Ribbonwood – *Plagianthus regius*
- Lemonwood – *Pittosporum eugenioides*
- Kohuhu – *Pittosporum tenuifolium*
- Cabbage Tree – *Cordyline australis*

In the zone above the flood plain, a large variety of native and exotic trees may be planted. Given the location of many of the Lower Tauranga Taupo River sites in the flood plain it is not envisaged that many of these plants will be required. However a list is supplied for the purposes of this plan and could provide a further reference during ongoing river management works including rehabilitation of other work sites.

To realise optimum soil conservation benefits it is recommended that plantings be widely spaced so that grasses can grow in-between them (when the trees have matured). Spacings could vary from 5 metres for native plants to 15 metres for hybrid willow species.

### 6.3.6 Maintenance of rehabilitated areas

Widely spaced plantings in fenced areas will provide growing space for weeds so ongoing vigilance is required to prevent weed invasion. Vegetation maintenance will be programmed for the following 2-3 years to maintain rehabilitated areas until they are reasonably well established.

Bi-annual monitoring inspections will be carried out to determine the scale of reinvasion, and therefore if any maintenance activities are required.

Release spraying or manual release activities will be undertaken where rank grass and weed growth threaten planted areas.

Weed control and maintenance activities will generally take the form of:

- Chemical control (Ground based using Glyphosate, Escort, Brush Killer or similar)
- Manual control (hand pulling weeds)
- Mechanical control (mowing)

## 6.4 Catchment/land management

*Objective: to ensure management of the wider catchment of the Tauranga Taupo River to minimise downstream impacts.*

Vegetative cover and land use practice can influence the intensity of flood flows and associated sediment transport in the lower Tauranga Taupo River.

### 6.4.1 Indigenous vegetation – Kaimanawa Forest Park

The undisturbed native vegetation of the Kaimanawa Forest Park has considerable hydrological benefits for the management of flood flows in the Tauranga Taupo River through interception and attenuation of peak rainfall.

### 6.4.2 Production forestry – Lake Taupo forest

Production pine forestry covers 30.3% of the river catchment (approximately 6570 ha) and is the major productive land use in the catchment. Roads and landings provide access to individual blocks for silvicultural activities (pruning and thinning) and harvesting operations. Forestry operations require the use of heavy machinery to fell, process and transport logs.

Production plantation forestry has been demonstrated to provide significant hydrological benefits for catchments over the total length of a forest rotation in terms of interception and retention of peak flows. In a production forest there are relatively short periods of time when the hydrological benefits are reduced during harvesting and replanting resulting in higher run off rates. In the long term, it is considered that production forestry has a positive impact on the management of the river and peak flood flows. However, as indicated, this requires active attention being given to the way in which the forest is managed particularly in such a catchment with the characteristics of the Tauranga Taupo River.

The production forest in the Tauranga Taupo catchment is situated on land owned by the Lake Taupo Forest Trust and managed by New Zealand Forest Managers. Resource consents are held by NZFM for soil and vegetation disturbance, forest harvesting and associated infrastructure (landings, roads and bridges) in the catchment. A list of consents held for forestry operations are set out in Table 7.

The activities authorised by the above consents are regularly monitored by Environment Waikato Consent staff. Compliance with consent conditions is also achieved through the supply of the post harvest audits and provision of aerial photos showing operational areas and boundaries by the consent holder.

Debris from pruning and thinning activities in the lower reaches of the river, particularly in Te Rangiita Forest could have implications for the efficient operation of the Kiko Spillway, swale and culverts during significant floods. Transport of pruning debris from swale area during floods could result in debris restricting capacity of the Kiko Culverts under State Highway One, undermining the operation of the spillway with potential impacts on SH 1. Environment Waikato will discuss management of pruning and thinning debris with the New Zealand Forest Managers to ensure that debris remains clear of the spillway and swale areas to prevent transport and blockage during floods.

While there are significant hydrological benefits of afforestation of the upper catchment there is potential for adverse effects from poor forest management (for example inappropriate harvesting or earthworks) which could result in on site and downstream impacts. This management plan seeks to promote best practices through the use of

industry guidelines and consent conditions. The use of best practice is fully supported by the managers of the forest.

Conditions relating to forestry activity include:

- Works undertaken in accordance with:
  - resource use consent application information.
  - Logging Industry Research Organisation - NZ Forest Code of Practice.
  - EW technical publication - Design Guidelines for Earthworks, Tracking and Crossings.
  - internal environmental management systems (except where otherwise directed by a consent condition).
  - waahi tapu policies.
- Continuous areas of indigenous vegetation occurring on land between 0.5 and 5 hectares may be removed, felled or burned provided:
  - EW agrees in writing and the land is appropriate for the establishment of production forestry or is impractical to retain the vegetation because of forest operations.
  - the vegetation is not required to maintain or enhance water quality or for soil conservation purposes.
  - the vegetation has minimal ecological value and indigenous riparian vegetation shall not be removed within 5 metres from either side of stream channels.
- Provision of appropriate sediment controls to control flows from roading, landings
- Submission of an annual operational plan for each year of operation and including maps of sufficient scale and detail to show proposed:
  - earthworks
  - operational boundaries including ground contours
  - existing and unstocked riparian/other areas
  - areas of 0.5 > 5 hectares of indigenous vegetation proposed for clearance
  - location of rivers and watercourses relative to vegetation removal and earthworks.
  - changes to the plan during the year forwarded at the time of the change.
- Regular provision of aerial photographs clearly showing stand boundaries, riparian and/or indigenous vegetation interface for areas where harvesting activities have occurred (at years 2, 5, and 10 of the consent).
- All works undertaken to ensure that:
- Specific authorised activities shall not increase the concentration of suspended solids in rivers above 25 grams per cubic metre after reasonable mixing and a distance less than 200 metres downstream from the activities, except where the suspended solids concentration in the rivers unaffected by activities is greater than 25 grams per cubic metre.
- All disturbed vegetation, soil or debris placed in a position where it will not enter any waterbody to the extent that it causes diversion, damming or erosion or destruction of aquatic or riparian habitat.
- Rehabilitation of disturbed areas to limit/prevent soil erosion and sediment run-off during harvesting operations.
- Provision of post-harvest audits to assess compliance with the conditions of this consent, maintaining a minimum of one year's records.
- All machinery operated in a manner which ensures that potential spillages of fuel, oil and similar contaminants are prevented from entering any water course. Refuelling and lubrication activities carried distant to any stream or river such that any spillage can be contained so it does not enter any water body.

As stated earlier in this Plan the Lake Taupo Forest is regarded as a good example of sound environmental management, particularly in regard to soil conservation and sediment control practices.

### **6.4.3 Urban and pasture**

Urban and pasture areas generally have higher run off rates than forested areas of a catchment. However, in this instance, these areas are too small to have any significant impact on flood flows.

### **6.4.4 Te Rangiita quarry**

The Te Rangiita Quarry fulfils a valuable role in the management of peak flows in the Tauranga Taupo River by providing a limited storage area for flows over the Closure Bank Spillway. This area has a positive impact on the management of flood flows in the river.

## **6.5 Emergency response**

*Objective: To have measures in place to enable timely and appropriate response to emergency events.*

### **6.5.1 Flooding**

#### **Community risk awareness and preparedness**

Environment Waikato aims to increase local awareness of river management issues through the formation of the Tauranga Taupo River Working Group (see suggested representation, Section 9) and by encouraging interagency (Tuwharetoa, EW, DoC, Transit, TDC) liaison.

Environment Waikato will also promote awareness of flood hazard and risk management through the publication of newsletters.

There will be a role for the Taupo District Council in regulating land use through the provisions of the District Plan, particularly as it relates to flood hazard areas and the Building Act.

#### **Emergency management**

Through the Waikato Regional Civil Defence Emergency Management (CDEM) and locally through the working Group, Group will liaise with TDC, DoC, landowners, community groups and Transit New Zealand regarding emergency management for the Tauranga Taupo River communities.

When heavy rainfall warnings are received, stakeholders and nominated landowners and residents are notified by email, phone or fax. EW will coordinate emergency response efforts with regard to flood hazards via the provisions of the Waikato Regional Flood Hazard management plan. There is also the ability to retain contractors on standby to assist with flood response efforts.

As at March 2005, 1000 sandbags are stored at the Taupo District Council (TDC) emergency management depot in Taupo (off Spa Road), approximately 2000 sandbags are stored in the former Oruatua Fire Brigade Shed at the rear of the Tauranga Taupo Challenge service station and 1000 sandbags are stored at the TDC operations depot in Turangi (Dekker Drive).

#### **Flood warning systems**

Environment Waikato through its internal Hydrotel monitoring system continually receives updates from the Tauranga Taupo River gauging station at Te Kono. Information is available on the EW website.

## 6.5.2 Other hazards

Structural assets of the scheme are susceptible to damage from volcanoes, earthquakes and landslides.

In the event of the volcanic eruption Environment Waikato will undertake a condition survey of the Tauranga Taupo River channel at the end of the eruptive phase and will undertake channel clearance from sediment and ash deposits if necessary.

In the event of an earthquake Environment Waikato will undertake a post event inspection as soon as the area is deemed safe, of all scheme structures and an aerial inspection with a qualified engineer to identify any damage and programme repair works.

There is a low risk of a landslide (soil and vegetative debris) in the upper catchment that could block the upper river channel and result in flash flooding that could be higher than the design capacity of the scheme.

## 6.5.3 Monitoring and reviewing

Environment Waikato will ensure ongoing maintenance and upgrade of its river gauging station at Te Kono, as funds are available. Environment Waikato will also investigate the possibility of installing additional river monitoring equipment if required and where practical.

The aspects of emergency management plan will be reviewed every 5 years.

## 6.6 Future considerations

There are several issues that will need to be addressed over the next 10-15 years of the operation of the Tauranga Taupo River scheme:

### 6.6.1 State Highway 1 bridge and highway alignment

Development within the floodplain has reduced its storage capacity and raised flood levels in general. Transit NZ manages a significant asset at the lower end of the catchment, including State Highway 1 and its associated bridge over the river.

Constructed in the 1950's, the bridge was designed to pass the mean annual flow of 150 m<sup>3</sup>/s, with some (400- 500 mm) freeboard. The bridge design was based on the catchment conditions at the time and the recognition that the Tauranga Taupo River floods across a wide floodplain, which could not be contained within the main river channel. This was also recognised in the flood protection scheme design concept by designating overland flow paths (spillways) in specific areas to maintain the natural flooding characteristics of the river.

These spillways are located at the quarry, Maniapoto's Bend along Kiko Road and immediately upstream of the Bridge along the SH1. Spillways are designed as flood control elements to operate at different levels and ensure that the remaining flow will pass under the bridge, without compromising the structural integrity of the bridge.

In the long term, Transit NZ has plans to realign the SH1 and construct a new bridge further upstream of the existing bridge. It should be noted that the recently released draft 10-year State Highway Plan did not include this project, which implies that no improvement to the current bridge is likely to occur in the foreseeable future. In the meantime and until the bridge is replaced, the issues of debris blockage and accumulation of gravel under the bridge need to be addressed by appropriate catchment management and annual maintenance works.

The Catchment Working Group will liaise with Transit NZ in regard to assistance in maintaining the waterway capacity under the Bridge until such time the realignment

project is completed. In addition, the Group will actively promote raising the priority of replacing the bridge on Transit's list of projects to ensure that it is undertaken as soon as possible.

## **6.6.2 Climate change**

There is evidence that there will be impacts of climate change over the next century in the form of more intense and frequent storm events. This may require review of aspects of this plan in the future.

## **6.7 Environmental considerations**

### **6.7.1 Fishery (provided by the Department of Conservation)**

The Tauranga Taupo River is renowned for its trout fishery and is the second most important river in the wider Taupo Fishery. Over the 2000/2001 season anglers expended nearly 30,000 hours of effort catching 10,450 large trout. The fishery generates approximately three million dollars a year for the local and regional economies.

The natural river processes provide ideal conditions for the trout population and the manipulation of the river channel is potentially damaging to the health of the fishery. It is essential that any structures do not impede the access of trout migrating up the river for spawning. Many gravel deposition areas provide ideal spawning habitat and gravel management needs to occur outside the winter months (May to October inclusive) to protect this function. Any activities in the river bed to remove or manage gravel deposition areas are regulated by the Resource Consent process and are required to be undertaken outside this timeframe.

Young trout spend 18 months rearing in the river before migrating to Lake Taupo and hence works in the summer months also need to be carefully managed to ensure that they do not adversely impact on either trout rearing habitat or invertebrate food sources. Except where absolutely necessary to protect flood control structures, gravel abstraction should not be undertaken in the wet. Vehicle Crossings should also be avoided where possible or where necessary, minimised.

The substrate of the river is relatively fine and much of the cover needed by the fish as protection from predators and the provide escape from the main flow is provided by in stream debris. The removal of debris for flood control needs to be assessed against the loss of juvenile trout habitat.

The spread of invasive willows will inevitably reduce in stream values by causing the channel to narrow, the bed to rise and sediment to accumulate in the root masses. Willows also restrict angling access and except where there is a direct benefit to bank stability willows should be managed or removed.

The Tauranga Taupo is highly valued by anglers for its natural character and the experience it offers. Unlike large areas of the nearby Tongariro Rover which have been highly modified, the Tauranga Taupo River retains its natural charm. This would be significantly affected by widespread bank erosion protection works, gravel removal and additional track access.

With the permission of the adjacent landowners the Department of Conservation has recently set up a new car park and track system that enables anglers to park south of Oruatua and walk along the river as far upstream as the Rangers Pool. Unlike other rivers in the Taupo fishery, it provides an opportunity for anglers to put their day pack on their back and walk as far as they choose rather than being able to drive to each pool. This also reduces the likelihood of accidental and deliberate trespass onto surrounding land which has been a major concern to the owners in the past.

Any vehicle access created for river control works needs to be carried out in such a way that it does not exacerbate the risk of unwanted vehicle use and trespass on private land.

### **6.7.2 River ecosystem**

Environment Waikato will seek to ensure that any works on the banks of the river or in the river channel do not compromise existing ecosystem values for the river channel, river margins, and floodplain and wetland areas.

This is required under Environment Waikato's existing consents.

### **6.7.3 Wetland**

Provision of flood waters to recharge the Tauranga Taupo Wetland is included in scheme design. The location of a culvert pipe through the west stopbank was agreed in the consultation process and allows diversion of a portion of flood waters into the wetland.

## **6.8 Other considerations**

### **6.8.1 Pressure for land use change**

Environment Waikato and partners in the Lake Taupo Water Quality Project are seeking to minimise land use change particularly where this could result in an increase in nutrient leaching to ground water and Lake Taupo, or have adverse hydrological impacts.

These impacts would largely be the result of conversion of land currently in forestry to pasture for intensive grazing purposes (i.e. dairy farming). Loss of forest cover can significantly reduce the absorptive capacity of soil and the amount of interception from forest vegetation. Soil compaction from livestock treading can also increase the amount and rate of run off during adverse weather events.

Current intensive livestock farming systems on pumice soils can result in significant nutrient losses to ground and surface water. These losses could increase levels of nitrogen that can promote nuisance weed growth in the river itself and contribute to reduced water quality in Lake Taupo.

### **6.8.2 Pressure for increased urban development**

Increasing land use pressures in high risk areas can be expected in the future. This will need to be carefully managed particularly within the terms of Taupo District Council's District Plan.

### **6.8.3 Pressure for vehicles access to the river environment**

Vehicle access created for contractors to carry out river control works will be carried out in such a way that it will not exacerbate the risk of unwanted vehicle use and trespass on private land.

Any vehicle access formed for the purposes of construction of vegetation control, erosion control and/or flood protection works will be blocked off on completion of the work programme to the satisfaction of the landowner. Environment Waikato will work with New Zealand Forest Managers, Lake Taupo Forest Trust, The Department of Conservation, the Tauranga Taupo Y Trust and any other landowners adjacent to the river to ensure that any unintended vehicle access as a consequence of Environment Waikato work programmes is restricted.

# 7 Biosecurity

## 7.1 Animal pest control

The control of animal pests in the upper catchment (particularly Possums) is regarded as essential in meeting the objectives of this plan. Such control reinforces the whole of catchment approach needed since the loss of vegetative cover may potentially impact on the hydrological behaviour of the catchment area.

Typical control options for Possum infestations include:

- aerial 1080 drops
- manual trapping lines
- use of bait stations

Given the rugged and largely inaccessible nature of the upper catchment area to vehicles it would be anticipated that aerial 1080 drops combined with follow up trapping lines would be the most cost effective option.

Environment Waikato will liaise with the respective groups and agencies in regard to reaching agreement as to ongoing animal pest control programmes.

## 7.2 Plant pest control

As above, liaison with other groups and agencies will assess the extent of plant pests in the catchment (particularly those in addition to the willows discussed earlier) and appropriate control programmes put in place.

Control of Plant Pests in the Waikato region is covered by the regional Pest Management Strategy (RPMS) 2002-2007. This plan outlines a number of plant pests in three categories:

Eradication Plant Pests: Service Delivery by EW (e.g. Climbing Spindle Berry, Old Mans Beard)

Containment Plant Pests: Occupier controlled (e.g. Gorse, Broom, Pinus Contorta)

Nuisance Plant Pests:

- Plants banned from sale, propagation or distribution under the National Plant Pest Accord (e.g. Grey Willow, Japanese Honeysuckle, Wandering Jew)
- Plants not covered by the National Plant Pest Accord (e.g. Buddleia, Blackberry, Himalayan Honeysuckle, Crack Willow)

Environment Waikato advocates voluntary control and provides advice and information on the threats of 'nuisance plant pests' to interested land occupiers and other interested parties. While Region-wide control would be impractical and too costly and landowner rules to control them generally unrealistic, there is benefit to individuals and communities who wish to control isolated infestations of plant pests.

A number of plant pests are banned from sale, propagation and distribution under the National Pest Plant Accord. Their inclusion in the Accord signals that they are undesirable plants. They comprise a mix of forest invasive climbing vines, ground cover plants, production pests, aquatic plants and wetland colonisers.

Specific plant pests identified by the Department of Conservation that are a threat to native vegetation in the Tauranga Taupo River catchment are:

- Crack and grey willow
- Gorse
- Briar rose
- Japanese honeysuckle

- Pinus pinaster
- Cotoneaster
- Barberry

## 8 Funding and rating

The funding arrangements for river management and flood protection works on the Tauranga Taupo River are adopted under the Project Watershed Funding Policy, dated June 2002. This policy was adopted following a public submission process and subsequent changes made to the initial document.

The key principles associated with the Project Watershed Funding Policy are as follows. These principles apply to the funding of all river and catchment activities across the Waikato River catchment.

Funding Policies must be in accordance with relevant legislation. These include the Local Government Amendment Act (LGAA) 1996 and the Rating Powers Act 1988.

### 8.1 Local Government Act (LGA) 2002 and the Local Government (Rating) Act 2002

The purpose of LGA 2002 is to set out the purpose and powers of local government in New Zealand. The LGA (Rating) 2002 sets out the financial provisions to enable compliance with the LGA (2002).

Section 101 (3) of the LGA 2002 states that the funding needs of the local authority must be met from those sources that the local authority determines to be appropriate, following consideration of:

- a) in relation to each activity to be funded,
  - i) the community outcome to which the activity contributes to, and
  - ii) the distribution of benefits between the community as a whole, any identifiable part of the community, and individuals, and
  - iii) the period in or over which those benefits are expected to occur, and
  - iv) the extent to which the actions or inaction of particular individuals or a group contribute to the need to undertake the activity, and
  - v) the costs and benefits, including consequences for transparency and accountability, and
- b) the overall impact of any allocation of liability for revenue needs on the current and future social, economic, environmental, and cultural well being of the community.

The LGA 2002 Part VIIA requires local authorities to work through a three step process when making funding decisions.

Step 1 requires councils to allocate costs of particular functions to direct users, ratepayers, categories of ratepayers, and the community generally. The following principles must be considered:

- the public good principle
- the user/beneficiary pays principle
- the intergenerational equity principle
- the exacerbator pays principle

In the second step, local authorities must modify the allocation of costs from the first step having regard to fairness and equity, transitional impacts, and any other lawful policies of the local authority.

During the third step, councils must select the funding tools they will use with regard to implementation and practicality issues.

Other Environment Waikato funding principles: (refer Section 5 of Funding Policy)

- Landowners and other resource users must bear a responsibility for negative effects on the catchment created by their use of land and water resources.
- Provision of works and services under Project Watershed provides a range of benefits, varying from specific local works providing direct protection to local landowners to major river system programmes providing more widespread benefits.
- Specific direct benefits are to be identified, with works and services funded by those benefiting.
- Flooding is a natural phenomenon; however its effects can be modified by human actions.
- Flood protection works provide a specific benefit to local areas. It is required by law that landowners contribute to flood protection works relative to the benefit they receive.
- Project Watershed will make funding provision for the ongoing maintenance of river and catchment assets.
- Acknowledgement of Tangata Whenua interests in a whole of catchment approach

Funding apportionment adopted for the Tauranga Taupo River under Project Watershed (June 2002) having taken into account the legislative requirements and the principles described, are as follows for the various categories of work.

**Table 9 Flood protection capital (construction) works**

Rating	%
Local protection rate (according to land classification to follow)	75%
Other rating – Waikato region, Waikato River catchment, Taupo zone	25%
	<b>100%</b>

**Table 10 River management capital/maintenance of flood protection works**

Rating	%
<b>Local protection rate</b> (according to land classification)	50%
Waikato regional rate	15%
Waikato River catchment	11%
Lake Taupo zone	15%
Contributor	9%
	<b>100%</b>

A full description of the process followed in deriving the funding apportionments for the Tauranga Taupo River, is set out in the document *'Project Watershed – Waikato River and Catchment Services – Level of Service and Funding Policy'* June 2002 (Docs#752002).

## 8.2 Land classification and benefit analysis

The Local Protection Rate is determined by the Land Classification and Benefit Analysis. This classification maps those areas of the Tauranga Taupo River floodplain that are at risk of flooding and ranks those areas according to the level of risk and therefore benefit received from the scheme. The classification map has been prepared based on historic records of flood events. As expected, generally those areas closest to the river will receive greatest benefit from the scheme works and attract the higher rate.

See Appendix II for a commentary on the Land Classification and Benefit Analysis. A description is also provided as the contributor and alleviator principles applying under Environment Waikato Funding Policy.

## 9 Management Plan control

Environment Waikato considers that ongoing community and stakeholder involvement is essential in the implementation of this Plan. It is proposed that this be achieved through the establishment of a Tauranga Taupo Catchment Working Group.

The Working Group is intended to comprise representatives of the following:

- Tuwharetoa Maori Trust Board
- Environment Waikato
- Department of Conservation
- New Zealand Forest Managers
- Landowner/resident representatives
- Transit New Zealand.

The day to day management of the scheme will be carried out by Environment Waikato staff and contractors as outlined in this plan. The Catchment Working Group will:

- provide input to the annual river related work programmes for the river
- monitor implementation of the Plan
- provide a forum for exchange of information and discussion
- assist in the formulation of comment or submissions to regional and district planning processes, as appropriate

Timing and frequency of meetings will be confirmed by the Working Group.

## 10 Draft programme 2005/06

- Control of willow vegetation for approximately 100 metres on the right bank of the river below the SH 1 Bridge. This works will be undertaken as part of the maintenance programme for the scheme. Works will be carried out with Hydraulic excavator with appropriate 'grab and grip' fittings and experienced cross cutters. Willow debris will either be burned on site or removed from site.
- Construction of the Gradient Control Structure in the vicinity of Maniapoto Bend. This is the last component of the capital works programme. This project will ensure the efficient operation of the Kiko Overflow spillway during flood events. The gradient control structure will involve importation of material (large rock) to form a weir across in the bed of the river. This will result in significant but brief disturbance of the river bed at Maniapoto Bend in the summer of 2005/06.
- Weed Control, grassing and planting of the East stopbank. Following concerns passed onto Environment Waikato from New Zealand Forest Managers a

significant amount of Gorse seedling were noticed on the East Stopbank adjacent to Hingpo Road. It appears as though a seed source was brought in the either machinery constructing the stopbank or in the stopbank material itself. The juvenile Gorse was sprayed on the week of 17 October 2005 and once these die off a follow up spray will be carried out prior to mowing the area and regressing where appropriate. Further weed control will be required prior to native replanting in the winter of 2006.

- Commencement of willow management programme including removal of undesirable species of willows, planting of improved willow species in high risk erosion areas (where appropriate).
- Removal of vegetative debris from the river channel where appropriate. Any vegetative debris removal will result from data gathered during routine monitoring inspections, generally post flood.
- Commission a LiDAR survey, an aerial laser survey of ground levels together with other river and lakeshore surveys in November 2005. Review data obtained to assist in the formulation of a Gravel Management Plan.
- Commission cross sectional surveys of the river channel to provide information on sediment and bed load movement and deposition within the lower reaches of the Tauranga Taupo River channel.
- Investigate options for obtaining Resource Consents for gravel extraction. This will include discussion with owners of the river bed, adjacent landowners, ratepayers, fishery managers and interested commercial operators.

# References

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Green, P.; Carlyon, G. and Slee, J. 2002: *Tongariro/Taupo Conservation Management Strategy 2002-2012*. Department of Conservation, Turangi.

# Appendix I Excerpts from Part II of the Resource Management Act 1991 (and Amendments)

## Section 5: Purpose

The purpose of this Act is to promote the sustainable management of natural and physical resources.

In this Act, "sustainable management" means 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 –

- Sustaining the potential of natural and physical resources (excluding minerals) to meet the reasonably foreseeable needs of future generations; and
- Safeguarding the life-supporting capacity of air, water, soil, and ecosystems; and
- Avoiding, remedying, or mitigating any adverse effects of activities on the environment.

## Section 6: Matters of national importance

In achieving the purpose of this Act, all persons exercising functions and powers under it, in relation to managing the use, development, and protection of natural and physical resources, shall recognise and provide for the following matters of national importance:

- The preservation of the natural character of the coastal environment (including the coastal marine area), wetlands, and lakes and rivers and their margins, and the protection of them from inappropriate subdivision, use, and development:
- The protection of outstanding natural features and landscapes from inappropriate subdivision, use, and development:
- The protection of areas of significant indigenous vegetation and significant habitats of indigenous fauna:
- The maintenance and enhancement of public access to and along the coastal marine area, lakes, and rivers:
- The relationship of Maori and their culture and traditions with their ancestral lands, water, sites, waahi tapu, and other taonga.

## Section 7: Other matters

In achieving the purpose of this Act, all persons exercising functions and powers under it, in relation to managing the use, development, and protection of natural and physical resources, shall have particular regard to –

- Kaitiakitanga:
- The efficient use and development of natural and physical resources:
- The maintenance and enhancement of amenity values:
- Intrinsic values of ecosystems:
- Recognition and protection of the heritage values of sites, buildings, places, or areas:
- Maintenance and enhancement of the quality of the environment:
- Any finite characteristics of natural and physical resources:
- The protection of the habitat of trout and salmon.

## Section 8: Treaty of Waitangi

In achieving the purpose of this Act, all persons exercising functions and powers under it, in relation to managing the use, development, and protection of natural and physical resources, shall take into account the principles of the Treaty of Waitangi (Te Tiriti o Waitangi).

# Appendix II Elements of the scheme

## **Te Rangiita quarry closure banks and spillway**

The closure embankment was designed to be constructed of sands and gravels excavated from shoal deposits over a 2-km downstream section of the channel at the time of breakout into the quarry.

For seepage control the bank and abutments were faced with an upstream blanket of compacted ash. A rockfill and gabion spillway formed through the crest of the embankment is designed to pass up to 30 m<sup>3</sup>/s of flow for ponding in the quarry area during a 1 in 50 year flood event. The range of discharges at lesser return periods is given in Table 4 above.

The closure bank extends through subsidiary channels to a higher terrace at its right (upstream) abutment and is returned to the armoured riverbank at its downstream end.

The crest elevations of the spillway and the embankment have been reviewed using data from significant floods in May 2003 and February 2004. The design drawings in Appendix II show the lengths, levels and structural details.

The structure is to be regularly monitored after floods and particularly after spillway discharge.

## **Maniapoto's bend, Kiko spillway and culvert**

One of the basic precepts of the overall design was the maintaining of spillage out of the river in the vicinity of Maniapoto's Bend and its discharge across country to the lake. The requirement for maintaining spillage is recorded in the conditions of approval relayed by NZ Forest Managers on behalf of the landowners and the Lake Taupo Forest Trust.

In the design process due account was taken of the natural bank overflows at Maniapoto's Bend, including those from the left bank relief channel system fed from bank overflows further upstream either side of the Pump Pool. The elevations of the two sections of rockfill bank protection at Maniapoto's Bend have been set at the same reduced level as the natural banks.

In addition to setting the sill levels, which determine the onset of spillage in flood conditions, the lengths of spillway crests along Maniapoto's Bend and on the rockfill spillway at the head of the Kiko spill swale were designed to pass the appropriate peak spill flows under specific flood conditions. These values were derived from field observations and modelling and are set out in the Table 4 above.

Two key factors recognised as crucial in ensuing such spillages were:

- i) controlling the existing natural spillage down the secondary right bank channel (Drawing 01), changes in which would influence nearby left bank spills
- ii) maintaining the appropriate river elevations in flood conditions causing spillage into the relict left bank channel, both from the vicinity of the Pump Pool, and from Maniapoto's Bend

Accordingly, provisions were made in the scheme concept for grade controls to be constructed at the head of the secondary channel at the quarry outfall in the main river channel and downstream of Maniapoto's Bend. Although not constructed under the main contract of works, provision of these structures remain consented at the time of writing.

Following the swale erosion during the May 2004 flood, the spillway design was upgraded from a natural vegetated sill to a rockfill chute and apron structure to match the eroded channel. The crest at the head of the chute is 40 m in length, with rockfill chute and apron sized to carry up to 80 m<sup>3</sup>/s, or 2 m<sup>3</sup>/s/m.

Over some 80 m between the apron and an armoured vehicle crossing, the bed of the swale channel is vegetated with *carex* species rushes to ensure the fullest practicable erosion protection for the channel at the outlet of the spillway. Over the next 340 m, the swale bed is lined with gravels of mean diameter 35 mm designed to resist flow velocities of up to 1.8 m/s. For the final 300 m, the swale has been topsoiled, seeded and fertilised to provide erosion resistant vegetation.

Where the swale joins the existing drainage system, flows spread out either side of a relatively narrow drain channel. Preserving the natural vegetation (bushes, rushes etc) in this channel contributes to slowing flow and settling out of finer materials. For the final 500 m to the Kiko culvert under the highway, flood flows will typically spread out over pasture, with the retention time reduced to less than a day by the enlarged culvert capacity. (Design drawings showing details of these structures are attached in Appendix II).

One of the concerns expressed by NZ Forestry Managers and landowners through the consultation process was the frequency of the flooding of the low-lying pastures and pine plantations immediately south of the State Highway and east of Kiko Road. It was evident that overflows from Maniapoto's Bend through the pine plantations were being retained on the low-lying land by the inadequate capacity of the twin 1200 mm diameter culverts under the highway, which discharge into a channel excavated to the lake.

As the culvert and the highway are managed by Transit NZ, it accepted responsibility for increasing the capacity and installed additional double barrel 1600 mm diameter culverts. When combined with the capacity of the existing twin 1200 mm culverts, the total discharge at Kiko is of the order of 20 m<sup>3</sup>/s. Floods such as the 30 m<sup>3</sup>/s to 40 m<sup>3</sup>/s peak overflow in May 2003 are passed within a day, which has the desired effect and also substantially reduce the frequency with which the highway itself would be overtopped, e.g. as experienced in 1998 and December 2001.

### **Western stopbank**

Taupo District Council records show that a stopbank had been constructed over some 350 m in the vicinity of Cox and Goldthorpe's gravel extraction plant, when the river channel had been further west than its present course in that area. This stopbank had the effect of reducing but not eliminating floods overflowing from ponding in the Oruatua Reserve. Subsequently a 500 m intermediate stopbank was added extending to State Highway 1, to prevent Kiko overflows from moving north-east towards Oruatua. Overflows still occurred out of the reserve including overtopping of the main stopbank, across the DoC leased pastures and the highway, causing flooding of Oruatua residential properties.

For protection of Oruatua, the existing stopbank was raised and extended eastwards to Tuki Street. The crest levels of the overall stopbank running from the Twin Barns to Tuki St were based on the results of hydraulic modelling and have subsequently been reviewed with evidence from the May 2003 and February 2004 floods.

Material for topping up and extending the stopbank came from initial excavation for the Kiko Swale and consisted mainly of silty sands and pumice compacted by track rolling by sheep's foot and roller. Topsoil was re-spread over the finished embankment and grassed. However, subsequent experience has shown that it is susceptible to stock damage and topping up with compacted ash is will form part of the future maintenance programme. Stock access on the stopbank should also be excluded and/or limited in the future. During flood ponding, seepage has been noted downstream of a section of the previous stopbank and is to be treated with inverted filters as part of future works.

In consideration of environmental aspects of the wetland which lies north of the highway and drains to the lake, an undertaking was given to the landowners of the Punawhakaata Trust to provide for a flow into the wetland during flood conditions, as previously occurred naturally. An 825 mm culvert was installed through the western stopbank and a "mini swale" or ditch excavated along the western boundary of the pasture, discharging through two existing 750 mm dia culverts under the highway into the wetland. The discharge capacity of the 825 mm culvert is controlled by a simple stoplog arrangement at the intake in order to control flooding of the pasture land.

The left bank of the river immediately upstream of the bridge experienced considerable erosion during the flood event of May 2003. This caused reduction of the DoC reserve, which acts as a buffer to the Tuki Road properties and outflanked the SH 1 Bridge southern abutment protection. Rock fill protection was undertaken by Environment Waikato as an additional work to the scheme and was funded by Transit NZ.

### **Eastern stopbank**

Flooding of Te Rangiita over the past decade had been caused by overflows from the right bank of the river, across Hingapo Rd and thence across the highway into the area of Macs Rd. A new stopbank has been constructed parallel to Hingapo Rd and then swinging west to the bridge, parallel to the highway. Crest levels have been set from the results of hydraulic modelling; with 400 mm freeboard above the design 50 year flood level.

After stripping of topsoil and root debris, the bank was constructed with an upstream and crest facing of compacted brown ash from the Bridge Quarry further up the Tauranga Taupo River, over a core of compacted sands and gravels sourced from the Te Rangiita quarry.

Approaching the bridge the river had significantly eroded its right bank, leaving only some 7 metres to the edge of the highway at one place. Bank protection works along the eroded section was added to the scheme works and undertaken. It was found to be impracticable to build a conventional stopbank without significant reclamation of the river bank; the final design incorporates a 100 m length of timber floodwall constructed immediately against the new rockfill bank protection, leaving some 5 metres of verge along the highway.

To allow for the possible blocking of the bridge with floating debris and to cater for floods in excess of the nominal 1 in 50 year capacity of the bridge, the timber wall has been set at an elevation parallel to the modelled river flood slope, such that it would begin to spill with flows in excess of 1 in 50 year flood or in the event of (partial) blockage of the bridge. The crest of the timber wall is therefore set 400 mm lower than the adjacent stopbanks.

Closer to the bridge an additional 50 m of embankment crest has been lowered to form a supplementary spillway. Flows from both spillways will cross the highway and discharge into the lower lying floodplain downstream of the bridge, which will also be flooded naturally in such conditions due to backwater effects from the river downstream of the bridge.

Existing drainage of the highway, other than by gravity to the northwest or directly to the river, consists of one cesspit along the northern kerb and drainage through a pipe under the highway towards the river. This had never been connected to a flap-valved outlet, and the opportunity was taken to make that connection underneath the new stopbank and to collect runoff from between the highway and the new stopbank. Hence the previous flooding of the highway from backflow from the cesspit has been prevented.

At the upstream end of the eastern stopbank two large pine trees were being undermined by the river and were removed. Local bank erosion was treated by tipped

rockfill over filter fabric and tied into existing rockfill bank protection immediately downstream.

Along the riverside of the stopbank, concentrations of overland flood flows along the stopbank toe have been controlled by forming two spurs of vegetation debris.

The updated design provides for another element to prevent flooding of the properties on the north side of the highway from spillway discharges over the stopbank by raising the footpath along the highway and providing appropriate access ways to private property. Landuse Consents have been applied for and are currently under consideration.

### **Heuheu Parade stopbank/floodwall**

During recent floods, water lapped onto the seal of Heuheu Parade giving clear evidence that the road would be overtopped in the design flood. While sections of the river bank had been protected by rockfill placed by Taupo District Council over the years, two unprotected sections immediately downstream of the bridge were experiencing active erosion, and the rockfill bank protection was completed under the main contract.

The limited space between the top of the bank and the edge of the road precluded construction of a conventional earthfill stopbank and after protracted consultation with the local residents, a timber wall was installed against the back of the rockfill, backed by compacted ash. Earthfill embankments of compacted ash are provided at each end of the timber wall.

The remaining space is being developed for an amenity area by the District Council. One cesspit and outlet pipe is provided under the wall, fitted with a flap valve to ensure the drainage of a concave section of Heuheu Parade.

### **Remaining works**

While the proposed scheme works were substantially completed by February 2005, there still remain two elements to be constructed at Maniapoto bend and the Eastern stopbank, as indicated under these sections. These elements include:

- a. **Bed Control Structure** - This structure will be located at Maniapoto bend to ensure a stable river cross section. The structure is designed to ensure that the Kiko Spillway will operate at the design flow and control the flows in the main river channel downstream. Overflows on the right bank are controlled by the existing re-division bank.
- b. **SH1 Diversion Bund** - This is a low bund, some 0.5-m high on average, designed to divert flows over the Eastern Stopbank Spillway in events exceeding the 50-year event back into the river downstream of the SH1 Bridge. The location of this bund is along northern side and on the footpath adjacent to SH1. This will ensure that the urban residential area of Te Rangiita is protected in the extreme events when the spillway operates.

## Appendix III List of native and exotic plant species for site rehabilitation

NATIVE	EXOTIC
<ul style="list-style-type: none"> <li>• Mingimingi – <i>Coprosma propinqua</i></li> <li>• Karamu – <i>Coprosma robusta</i></li> <li>• Wineberry – <i>Aristotelia serrata</i></li> <li>• Akeake – <i>Dodonaea viscosa</i></li> <li>• Koromiko – <i>Hebe stricta</i></li> <li>• Cabbage Tree – <i>Cordyline australis</i></li> <li>• Mahoe – <i>Melicytus ramiflorus</i></li> <li>• Tree Daisy – <i>Olearia virgata</i></li> <li>• Ribbonwood – <i>Plagianthus regius</i></li> <li>• Lemonwood – <i>Pittosporum eugenioides</i></li> <li>• Kohuhu – <i>Pittosporum tenuifolium</i></li> <li>• Karo – <i>Pittosporum crassifolium</i></li> <li>• Five Finger – <i>Pseudopanax arboreus</i></li> </ul>	<ul style="list-style-type: none"> <li>• Birches – <i>Betula spp</i></li> <li>• Locust – <i>Robinia spp</i></li> <li>• Elder &amp; Sycamore – <i>Acer spp</i></li> <li>• Oaks – <i>Quercus spp</i></li> <li>• Rowan – <i>Sorbus spp</i></li> <li>• Firs – <i>Abies spp</i></li> <li>• Cedars – <i>Cedrus spp</i></li> <li>• Spruce – <i>Picea spp</i></li> <li>• Ashes – <i>Fraxinus spp</i></li> <li>• Poplars, not large growing varieties – <i>Populus spp</i></li> <li>• Olive – <i>Elaeagnus spp</i></li> <li>• Western Red Cedar – <i>Thuja plicata</i></li> </ul>

# Appendix IV The benefit classification contributors/alleviators

The benefit classification derived by the Classifier for the Tauranga Taupo River is as below:

Class	Ratio	Description
LPTT 1	100	URBAN - Land at most risk from flooding. Oruatua and western end of Te Rangiita.
LPTT 2	80	RURAL – enclosed in the stopbanking at Oruatua and area east of Hingapo Road. Will receive a higher level of benefit relative to the greater part of the rural floodplain.
LPTT 3	35	URBAN - Balance of urban area in the floodplain excluding lakefront. Historic flooding has occurred in large events.
LPTT 3A	25	Lakefront in similar area to LPTT 3.
LPTT 4	28	RURAL – balance of rural area east of Hingapo Road – susceptible to flooding in the larger events.
LPTT 5	10	RURAL - Developed land south of Oruatua being Kiko Farm/Forest. Some benefit received.

## Contributors and alleviators

Under the Environment Waikato Funding Policy contributors and alleviators are defined as follows:

- Alleviator** Landowner or resource user whose property characteristics or effects of resource use (including land use) reduce the need for specific works and services.
- Contributor** Landowner or resource user whose property characteristics or effects of resource use (including land use) contribute to the need for EW to carry out specific works and services.

The following extracts are also taken from the Project Watershed Funding Policy Document.

## Contributors to the need for the service

The contributor principle is used to assess the degree to which the characteristics or use of the land, or the actions of the occupiers of that land contribute to the need for flood protection, river management and soil conservation works and services.

The physical characteristics of properties and the past and present actions of the occupiers both affect maintenance costs. In the past, occupiers have assumed they have had a right to discharge water from their properties. The amount of water being discharged is increasing as a result of continued pastoral development and drainage improvements.

Water discharge has occurred not only on the flat areas of the greater Waikato catchment, but also in rolling and steeper districts where shallow gullies and swampy flats have been drained. Over recent years, the expansion of intensive livestock farming into steeper areas has been one of several factors driving this continued trend.

Ratepayers in hill country areas are assessed as being liable for Project Watershed rates both as beneficiaries and contributors. As beneficiaries, they experience the same indirect benefits as others in the lower areas of the catchment and which have been attributed to all ratepayers through the general rate and the catchment and zone differentials. These indirect benefits include public safety, security of transport links and

reduced inconvenience, recreational benefits, aesthetic benefits and secondary economic benefits arising from the wider range of land use options Project Watershed assets provide.

In addition to receiving benefits (either direct, indirect or both) properties throughout the greater Waikato catchment are also liable as contributors. This is generally because the development of these properties to pasture and the continuation of this land use has increased the 'speed' with which water runs off these properties, increasing the peak flows in streams and rivers further down the catchment. This affects flooding and erosion, requiring higher flood banks and increased pumping head.

The contributor assessment is based on comparing the current land use to the 'natural' state of the catchment. The development of land to its current use has led to changes in soil erosion and runoff characteristics. Other activities also affect the erosion and runoff characteristics of the catchment and river system.

Mean annual flood peaks from catchments that are developed to grazed pasture have increased flows by 60 percent, compared with a native bush land use. Land in urban, industrial, commercial or roading increases the storm water runoff significantly over that from pasture or bush/forest, due to the proportion of impervious surfaces.

For the purposes of applying the contributor assessment for the funding system, a broad comparison of current land uses and activities has been carried out in relation to the 'natural' or benchmark land use, including native forest, wetland and tussock. Plantation forest is also assumed to have similar hydrological characteristics to native forest.

### **Alleviators**

The need for or costs of maintaining scheme works can be alleviated by the characteristics or use of properties, or the actions of the occupiers. Where land is still essentially in its undeveloped state or has either reverted to native bush or swamp cover, or been planted in exotic forest, it is considered to be neutral in effect. Council considers that, where the alleviation effect of land uses or activities are of sufficient scale, then the contributor differential will not be levied on the qualifying area. Environment Waikato considers that, from both hydrological effect and administrative efficiency, 10 ha of land in qualifying uses is the minimum required to qualify for rating relief. Landowners affected will be able to apply to Environment Waikato to have this recognised.

For the purposes of this policy, plantation forestry is considered to have the same hydrological characteristics as native forest cover. It is recognised that cut over forest will have a diminished alleviator effect, however if the area is replanted, this reduction is only likely to occur for four to six years. In this situation it is proposed that the rate relief would remain in place, so long as the block was replanted.

The alleviator effects of hydro electric power generation operations and infrastructure have been taken into account in assessing the contributor effect.