Whakatane Waimana Floodplain Management Strategy - Stage 1

Review of the current flood hazard from the Whakatane and Waimana Rivers and existing responses

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E mahi ngatahi e pai ake ai te taiao

Foreword

Concern for the security of the Whakatane and Waimana floodplains is the reason behind Environment Bay of Plenty's preparation of a floodplain management strategy. This floodplain management strategy reviews what the flood hazards are in the floodplains, what flood protection is provided to people and property living on the floodplains and what, if any, additional protection needs to be provided.

Floodplain management strategies are not the same as Civil Defence Emergency Management (CDEM) Plans. Under the Civil Defence Emergency Act 2002 each regional and local council must prepare plans detailing how they will manage catastrophic events such as volcanic eruptions, tsunami storms, earthquakes and fires.

Construction of flood defences began in the catchment in 1965 and this was complete by the early 1980's. Since that period components of the flood defence system have been reviewed but not all together. This floodplain management strategy reviews the flood protection system for the Whakatane Waimana catchment only. It identifies potential weaknesses in flood protection and plans for the ongoing security of future generations.

The executive summary provides an overview of the report.

Part one describes the nature of the floodplain, and the measures put in place to best manage floods of date. The resulting issues for future floodplain management are collated in the conclusions section at the end of Part one.

Part two identifies the flood problem by summarising a number of studies that have been undertaken to quantify the potential flood risk and impacts. Alongside these studies are the actual recorded impacts which resulted from July 1998 and July 2004 floods. The issues from Part one and Part two are summarised at the end.

Part three summarises all the issues identified in the previous two sections. Part three outlines what subsequent stage two and three aim to achieve.

The floodplain management strategy reports make reference to floods in terms of say the '50 year flood' or '100 year flood'. These terms refer to the chances of a flood occurring of a certain size over a given period of time. Hence for example if a flood flow of a certain size occurred once every 50 years on average, the chances of another flood of this size or greater in any one year is said to be 1 in 50. Predicting random events such as flooding is an approximate science. The following examples may help put risks of flooding of the Whakatane Waimana floodplains into context:

Burglary in any one year	1 in 16
Drawing the ace of spades in any one draw	1 in 52
Peak discharge in Waimana River on 2 July 1998 was 1,100 cumecs	*1 in 60*
Infant mortality	1 in 119
Peak discharge in Upper Whakatane River, July 2004 was 2,893 cumecs	*1 in 120*
Contracting heart disease in any one year	1 in 1000

(Source: non italic data from Wellington Regional Council, 1996)

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Executive Summary

The underlying aim of floodplain management planning is to reduce the susceptibility/exposure to flooding to persons and property that exist within the scheme catchment. The aim of this stage one report is to identify and describe existing flood issues within the Whakatane and Waimana catchments, outline existing flood protection measures, identify potential hazards and elements at risk and identify what mitigation options are needed.

This stage one study revealed that flood protection service level requirements are in general being met for the scheme. Plans for managing flood risk already exist within the catchment and these are being implemented by Environment Bay of Plenty through the schemes asset management plan. The purpose of this floodplain management strategy is to review current practices and plan for the future flood protection needs of the catchment.

Several risk areas were identified within the scheme and stakeholders need to consider whether the level of risk is acceptable. Several tasks need to be completed in stage two before the questions raised in stage one can be answered. Questions raised are the basis of several recommendations outlined in Table 3.1 found in Part 3 of this report. Table 3.1 also nominates the stakeholder responsible, the output required and implementation timeframe. It includes but is not limited to confirmation of assumptions made in stage one, review and provision of flood protection measures provided by utility owners and further geotechnical investigations on stopbanks.

For stakeholders in Lower Whakatane and protected by the 100-year urban stopbanks, the main question to be answered is: are stakeholders satisfied with the current service level provided by the urban stopbanks? Currently the probability of at least one stopbank breaching from a total of 8 potential breach sites on the right (urban) stopbank is 11%. This assumes the low point in the Yacht Club stopbanks has been raised. Environment Bay of Plenty plans to complete the stopbank raising in 2006/07. The probability of at least one stopbank breaching from a total of six potential breach sites along the left (rural) stopbanks (below cross-section 17L) is 17%.

For stakeholders in Upper Whakatane and Waimana where little, if any, stopbank protection is provided the main question to be answered is: do stakeholders wish to increase the service level of protection and the corresponding local share costs to achieve these higher service levels?

The decision making process will be progressed in Stages 2 and 3 of this floodplain management strategy. Stakeholders will be consulted at each stage of the floodplain management process to obtain their feedback, decisions and approval of options.

In the Stage 2 report Environment Bay of Plenty will:

- report on the outcome of recommendations made in this stage one report
- identify the flood mitigation options that are available to reduce the flood risks identified
- if necessary, provide an economic and environmental evaluation of the options

In Stage 3, Environment Bay of Plenty will confirm the stakeholders' choice of mitigation options, prioritise strategies and set in place a programme to implement the choices made.

Part 1: Managing the Whakatane Waimana Floodplains

1.1 Introduction

The original Whakatane River Scheme provides 100 year flood protection along the lower 12.8km of river, partial flood protection and channel improvements along the upper 30.4km of the Whakatane River and 28.8km of the Waimana River. In addition the scheme improved drainage for approximately 4000–6000 hectares of the eastern Rangitaiki Plains. Construction of the main river scheme protection works occurred between 1965 and 1981.

River scheme assets include major urban and rural stopbanks, canals, drains, floodgates and pump stations. Locations of scheme stopbanks are shown on Figure 1.14. Management of scheme assets are described in the Whakatane-Waimana Asset Management Plan (EBOP, 2006).

River scheme assets do not include municipal stormwater reticulation assets such as stormwater culverts and pump stations. Those assets are owned and maintained by Whakatane District Council and described in their Asset Management Plans.

In 2001 the total catchment population was approximately 32,800 and projected population growth is expected in areas protected by urban stopbanks. To date the scheme flood protection works have protected the urban population from flooding however it is due for review. A scheme review can identify where improvements are necessary and facilitate implementation so that future populations can enjoy ongoing flood protection.

Environment Bay of Plenty is preparing a strategy for the long term and sustainable management of flooding in the Whakatane River catchment. This is called a floodplain management plan. This plan is to be known as the Whakatane Waimana Floodplain Management Strategy (WWFMS).

Floodplain management strategies provide sustainable long term flood risk management which integrates structural and non-structural options, asset management, funding sources and community input to take the scheme into the next 50 or so years. The floodplain management strategy (FMS) will be a plan which is a blueprint. It will propose the level of protection (or service) that the community (or stakeholders) wish to adopt. It will estimate costs, propose who will pay, prioritise work and suggest possible timing.

This FMS will bring all these aspects together in an integrated way. The WWFMS is not intended to become a statutory document in itself but rather provide direction and act as an input to Environment Bay of Plenty's Regional Plans and the Whakatane Waimana Asset Management Plan. It also provides input to the District Plan and Emergency Management Plans produced by Whakatane District Council.

1.2 Objective

The purpose of this report is to complete the first of three stages that constitute successful floodplain management practice as outlined in the "Floodplain Management Planning (FMP) Guidelines" (OPUS, 2001).

The aim of stage one is to establish the context for the flood hazard in the Whakatane and Waimana floodplain. Stages two and three are the subject of separate reports where mitigation options are identified and developed further.

As a complete document the WWFMS will ideally:

- be available and understood by the whole community
- have the support of stakeholders
- contain structural and non-structural measures to mitigate the risk of flooding
- be consistent with central and local government legislation

1.3 Planning Framework

A floodplain management planning methodology is proposed in Figure 1.2. It is based on the framework provided in the FMP Guidelines.

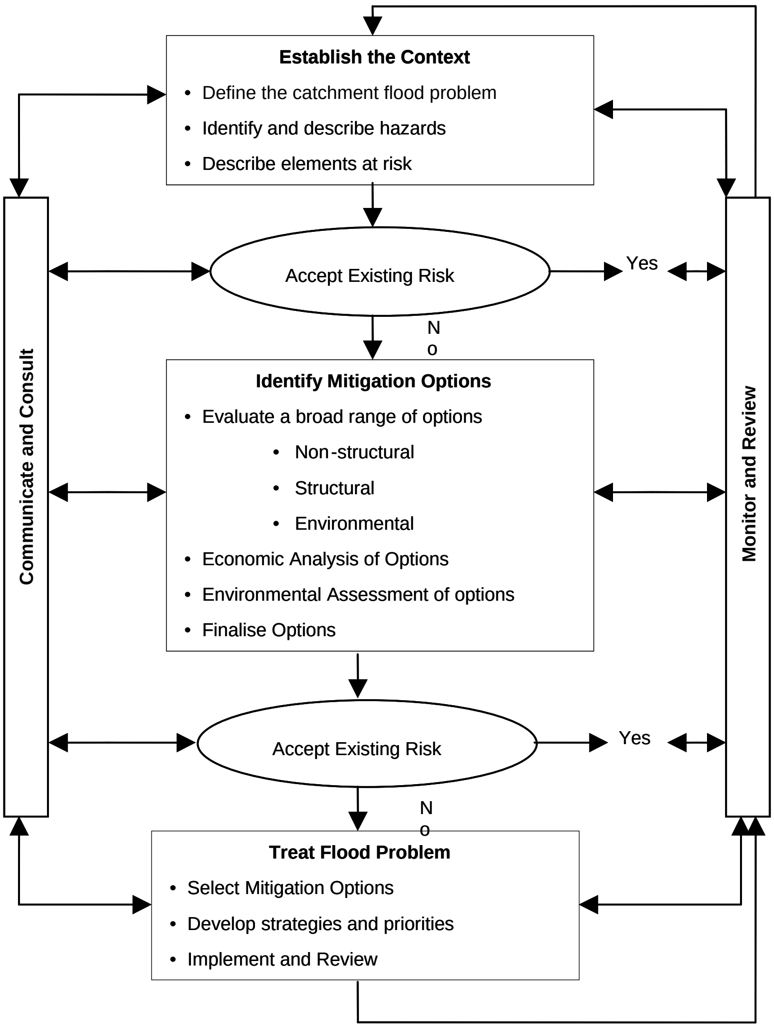

Figure 1.1 Floodplain Management Planning framework

1.4 Stages of Floodplain Management Planning

The stages of floodplain management planning are:

- Stage 1 – Establish the Context for Flood Hazard
- Stage 2 – Identify Mitigation Options
- Stage 3 – Treat Flood Problem

This Stage 1 report will deal with the first of the three stages listed above. it will comprise three parts as follows:

Part 1 – provides a description of the catchment's characteristics, its history of flooding and Environment Bay of Plenty's response by implementing appropriate flood protection measures. It summarises the results of recent reviews and assessments carried out on flood protection measures implemented to date.

Part 2 –outlines the results of flood modelling and presents the results of several *potential* stopbank breach scenarios and associated level of risk. It details the affects of the two most recent major floods namely the July 1998 and July 2004 flood events. Potential damages that may result from large floods and stopbank breaches are estimated and flood hazards are identified.

Part 3 – will summarise the key issues identified in the previous two parts and present a list of tasks that need to be completed in stage two so mitigation options can be identified.

1.5 The Output

The project is to produce a non-statutory strategy of co-ordinated measures designed to achieve the floodplain management plan objectives.

The strategy could be regarded as an umbrella document that:

- Draws on a number of different plans, procedures and polices,
- filters out relevant provisions of these, and
- massages them or adds to them to produce an integrated approach to dealing with the flood hazard

Once completed the WWFMS will outline the responsibilities of the respective stakeholders listed below:

- Bay of Plenty Regional Council
- Whakatane District Council
- Commercial and Industrial interests
- Landowners (including urban and rural communities, Federated Farmers)
- Utility Service Providers (e.g. Horizon, NGC, Telecom)
- Boat Owners (e.g. Marina, Yacht Club, Rowing Club, Jet Boat owners)
- Department of Conservation (DoC)
- Tangata Whenua
- Any relevant non-governmental organisations (e.g. Fish and Game)

As indicated in the planning framework Figure 1.2 consultation with key stakeholders is a foundation requirement to ensure the success and acceptability of the FMS.

The relationship between the WWFMS and other local authority plans is summarised in Figure 1. 2.

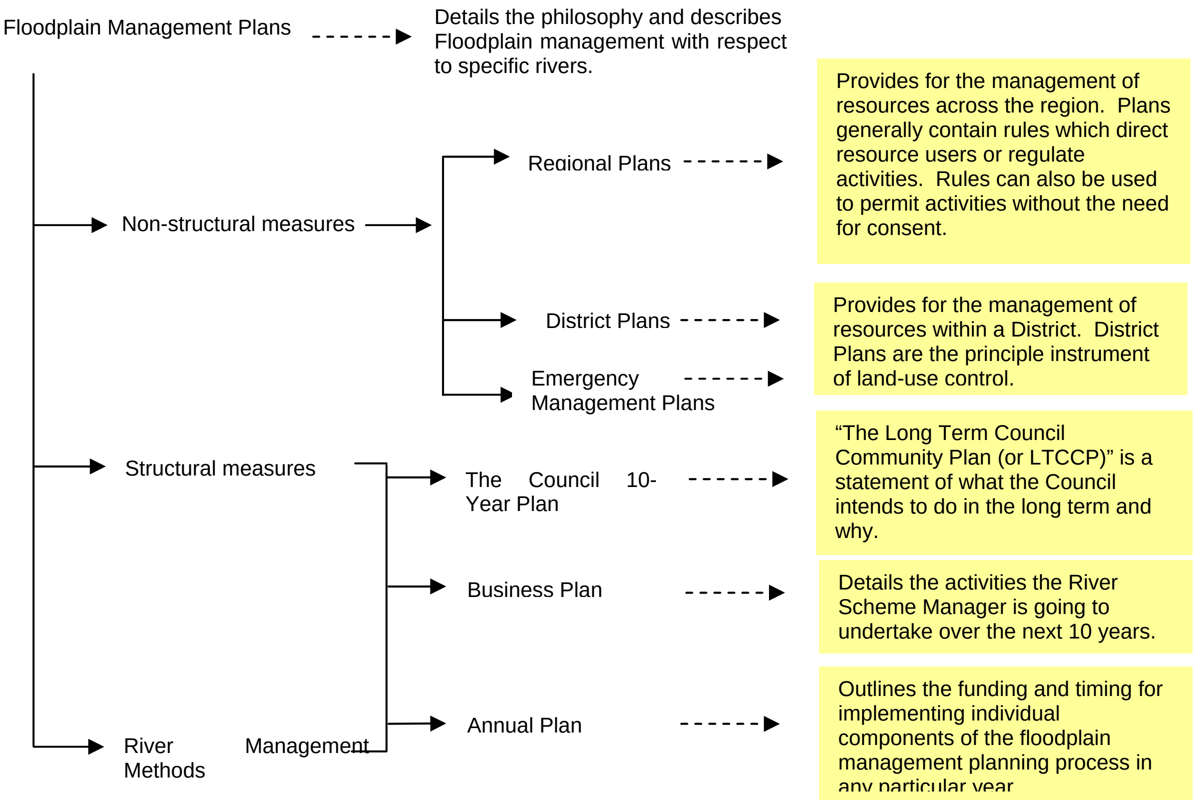

Figure 1.2 Relationship between Floodplain Management Strategies and local authority plans.

1.6 The Whakatane Catchment

The Whakatane River system itself broadly comprises two main branches; the Waimana River and the Whakatane River (see Figure 1.3). The Waimana Catchment covers 440 km^2 extending 77 km from the confluence to the upper tributaries, while the Whakatane area above Valley Road recorder covers approximately 1100 km^2 and extends 112 km to its upper tributaries. Both catchments are relatively narrow and the tributaries are short and steep, draining extensive bush covered catchments.

The two branches rise in the Huiarau and Ikawhenua Ranges some 113 km inland and run due north along the Waimana and Whakatane fault lines until they converge at Taneatua, 26 km from the sea. Below this point streams flowing from the foothill catchments augment the river. The main foothill streams are the Owhakatoro (74 km^2), the Waiho (89 km^2), Te Rahu (30 km^2), Wainui Te Whara (6 km^2) and Wairere (3 km^2).

The former Bay of Plenty Catchment Commission (BOPCC) commented on flooding issues associated with the streams and canals feeding into the Whakatane River:

The Waioho and Te Rahu flow in from the west and give rise to serious flooding problems where they traverse the Rangitaiki Plains while the Wainui and Wairere cause similar problems in the Borough of Whakatane. Further downstream, two large drainage canals the Kopeopeo and Orini flow in from the west. These waterways are the drainage outlets for 15,000 acres (or 6,070 ha) of flat land and most water is pumped from this area. (BOPCC, 1957, pg 1)

1.6.1 The Waimana River

The Waimana River valley floor is narrow and has few areas of river flats in the upper 48 km, but after leaving the main range the floor widens and for the next 19.5 km the river channel is wide and braided.

The final 13 km of the Waimana River are through a gorge with the exception of the last 1.6 km, where it empties out of the gorge on to the valley floor just upstream of the confluence with the Whakatane River.

1.6.2 The Whakatane River

The Whakatane River rises in the Huiarau Range and quickly drops into a deeply incised valley and with the exception of small areas of rolling hill country at Ruatahuna and Maungapohatu; there are no significant river flats for the next 64 km until the river flows out of the main range at the upper Ruatoki Valley.

At this point the valley floor widens out to an average width of 1,600 meters before widening out again at the limeworks. At the same time, the catchment cover changes from indigenous forest at the ranges (which incorporate the Urewera National Park) to scrub and grasslands of the foothills.

Below this for the next 6.5 km the river has developed a wide meander belt with considerable areas of shingle bed and marginal river flats.

Below the Ruatoki Bridge, which is 32.6 km from the sea, the river is generally more confined until it reaches the confluence with the Waimana.

Downstream of the confluence the river continues for another 3.5 km before it reaches the Pekatahi Bridge and below this the river is stop banked.

The Whakatane River system flows along the graben that is located where the volcanic zone intersects the coast. Geological investigation suggests that the graben is subsiding at a rate of 2–3 mm per year (Gibbons, 1990, pg 1). Normally settlements of this nature would reduce the amount of freeboard available for flood protection purposes however since flow capacity is relative to the channel cross-sectional profile capacity assessment becomes independent of region wide settlement.

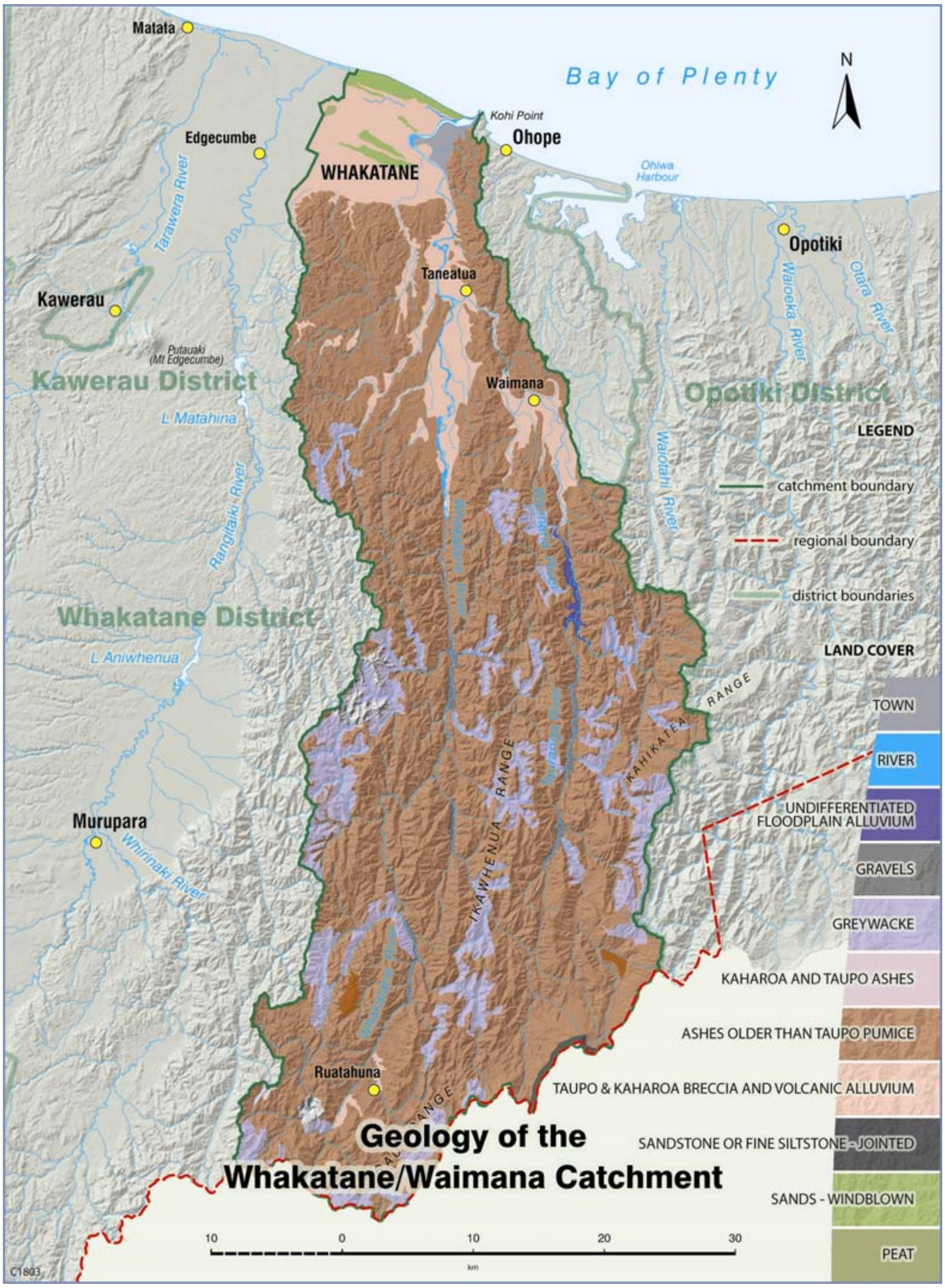

Figure 1.3 Geology of the Whakatane Waimana catchment.

1.7 Land use

Land cover and usage affects run-off, which affects the magnitude of flooding. For example urban areas, which tend to have more impermeable surfaces typically increase runoff and flood risk. Heavily vegetated areas, such as forestry on the other hand tend to reduce run-off and lower the flood risk. A map of land usage for the Whakatane Waimana catchment is shown in Figure 1.4.

1.7.1 Rural

AgFirst (2004) carried out a rural land-use survey of the Whakatane-Waimana Catchment in September 2003. The results are shown in Table 1.1 below.

Table 1.1 Rural land uses

Land Use	Area (ha)	Productive ha	% Productive Land-use
Indigenous and exotic forest	153,698		
Dairy farming	12,793	12,793	65.6%
Drystock farming	5,870	5,870	30.1%
Unproductive	2,160		
Small holdings	2,015		
Scrub	1,022		
Cropping	842	842	4.3%
Total	178,400	19,505	

Excluding Indigenous forest, the most common land-use is dairy farming, which represents 66% of the productive land area. Drystock farming and cropping represent 30% and 4% respectively. A survey undertaken in 1958 indicated a similar use of productive land with dairying at 68% (include cropping) and drystock at 32%.

The Whakatane-Waimana River catchment extends as far south as Ruatahuna, situated in the upper catchment 75km from the coast. The majority of productive land (98%) is situated in the lower Catchment within 25 kilometres of the Bay of Plenty coast.

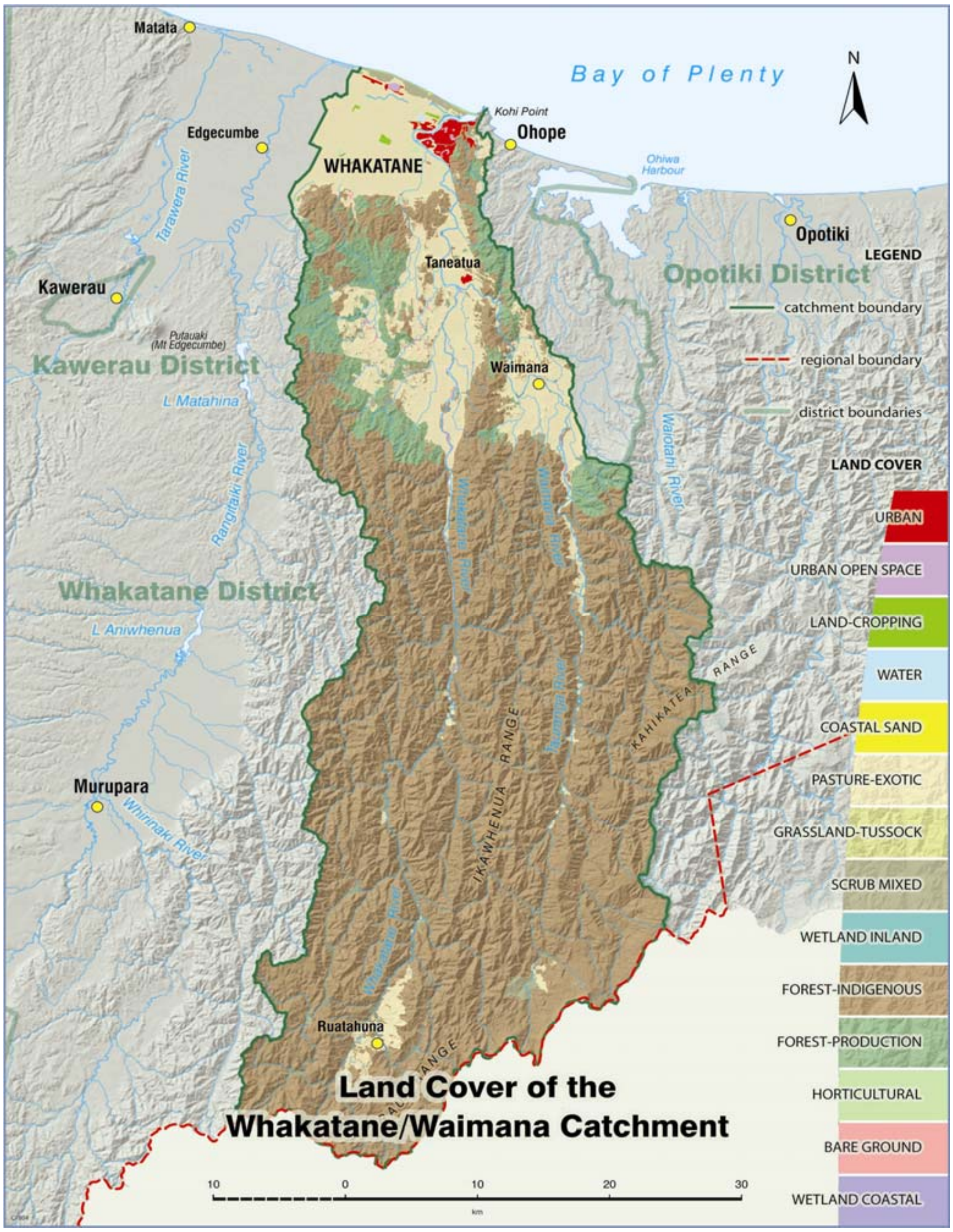

Figure 1.4 Land usage in the Whakatane Waimana Catchment.

1.7.2 Urban

Urban areas comprise residential, commercial and industrial uses. The residential urban environment comprises the largest component of the settlements and townships in the Whakatane District.

(a) Residential

In 2001 the population in the Whakatane urban area was 15,024.

The Proposed Whakatane District Plan states:

The urban population grew 9.5% for the period 1986 – 1996. 83.2% of all district population growth has been in the urban areas of Whakatane and Ohope[1]. This rate is below the national average for that period (10.6%) but when it is compared with the availability of land within the urban area there is a need to provide additional land for the coming 20 years.

The most significant proportional growth within Whakatane-Ohope (1991-2001) occurred in Coastlands, Ohope and Orini. Decreases in population were experienced in the outlying urban areas and settlements of…Taneatua.

The population growth figures suggest that whilst the traditional urban area centre of Whakatane has a relatively stable population size, the surrounding fringe areas, particularly the urban coastal areas, are growing. This is growth is in part due to internal migration within the district (Proposed Whakatane District Council District Plan, 2003, pg 11).

Regarding the flood hazard, the Proposed Whakatane District Plan says, "Within the Whakatane district, areas most vulnerable to flooding are Whakatane Township, Edgecumbe, Waimana and the Rangitaiki Plains" (Proposed Whakatane District Council District Plan, 2003, pg 41).]

Whakatane's urban areas are protected by stopbanks and the Proposed Whakatane District Council Plan has performance standards, which control activities carried out in the vicinity of the stopbanks (refer Section 4.1.5 of the District Plan). Performance standards are also provided in Section 4.4.1 of the District Plan to protect dwellings from flooding and inundation. Minimum floor levels are stipulated in the plan to protect urban areas in Whakatane and Coastlands that are prone to flooding.

Outlying non-urban residential areas such as Waimana and Taneatua do not currently have stopbank protection but Whakatane District Council do set minimum floor levels (Refer Section 1.12.1 of this report). Ruatoki has a stopbank on the true right downstream of Ohutu Bridge. At some point in the future stakeholders in these rural areas will need to consider if the current level of protection provided is acceptable.

(b) Commercial

The existing business environment is concentrated in distinct areas. Within the Whakatane Waimana catchment these are the main Whakatane Town centre, its peripheral areas and the Kopeopeo area. These areas are protected by urban stopbanks.

Whakatane Town centre area comprises retail, office, business services, restaurants, entertainment facilities, and community services. These facilities are oriented to intense pedestrian activity and characterised by high visual environmental quality.

On the periphery of the Whakatane and Kopeopeo town centres are located a range of wholesale, retail and business and trades services.

[1] Note that Ohope is not within the Whakatane Waimana catchment.

(c) Industrial

Carter Holt Harvey Ltd, a board mills site, is the major industrial site in Whakatane. This activity represents a significant long-term asset for Whakatane District. The mill is a major user of goods and services and provider of employment in the District. The mill is protected against flooding by an urban stopbank.

Business activities in Whakatane of a more industrial nature such as manufacturing workshops, warehouses, works depots are located in relative isolation from other urban activities. They are located in Valley Road, Te Tahi Street and Gateway Drive.

1.8 Hydrology

1.8.1 Hydrology Data

Based on Environment Bay of Plenty's latest Environmental Data Summaries (December 2000) the following hydrological data sets are available for the Whakatane River system catchments:

- River level records for the Waimana River at the Gorge site (from 1951 to present)
- River flow records for the Waimana River at the Gorge site (from 1950 to 1980 only), the Ranger Station (from 1995 to present) and at Ogilvie Bridge (from 1969 to 1995).
- River level records for the Whakatane River at three sites namely at the Town Wharf (from 1987 to present), Whakatane (from 1953 to present) and Huitieke (from 1987 to present).
- A river level recorder is available for the Upper Whakatane River (at Ohutu Bridge, located upstream of Ruatoki) however it requires a rating to produce equivalent flow monitoring data. Having flow rating data for the Ohutu Bridge gauge will help to confirm flood modelling results.
- River flow records for the Whakatane River at Whakatane (from 1953 to present).

Tables 1.2 and 1.3 gives a fuller set of return period floods for each river, based on data available between the periods stated above.

Table 1.2 Predicted Peak Flood Sizes in the Waimana River (at the Gorge Recorder)

Return Period (years)	Waimana at Gorge Flow[2] (m^3/s)	Waimana at Ranger Station Flow (m^3/s)	Waimana at Ogilvie Bridge Flow (m^3/s)
100	1,240		
50	1,050		388– 390
20	820		331 – 332
10	670	432 – 695	287 – 288
5	520	394 – 530	241
Mean Flow	20	9	8

Table 1.3 Predicted Peak Flood Sizes in the Whakatane River (at the Valley Road Recorder)

Return Period (years)	Whakatane[3] Flow (m^3/s)
300[4]	3,390
200	3,180
100	2,820
50	2,450
20	1,960
10	1,580
5	1,190
Mean Flow	57.2

1.8.2 Global Warming Impacts

Environment Bay of Plenty is presently undertaking a study to determine its policy covering provision for global warming in the regions river and drainage schemes.

Global warming has the potential to increase the magnitude, level and frequency of flooding and so the capacity of existing flood protection assets must be reviewed periodically when the new flood data becomes available.

At present Environment Bay of Plenty evaluates the potential effects of global warming on a case by case basis (Blackwood, 2005). Assessment of effects considers:

- certainty of available information
- cost of retrofitting new or renewed structures
- assets design life span

[2] These flow estimates were calculated by P L Blackwood using GEV with historically censored data (1998).
[3] This flow estimate is for the Valley Road recorder calculated by P L Blackwood 19/02/04 using Jenkinson's EV11 method.
[4] The Q300 is the "over design flood". This flow will be equivalent to a 100-year flood by year 2080.

1.8.3 Sea Level Rise

The Intergovernmental Panel on Climate Change (IPCC) issues projections on the impact of global warming on sea levels at five yearly intervals. In 2000 the IPCC predicted increases between 0.15m – 0.2m by 2050AD and 0.43m by 2100AD.

Whilst there is some scepticism by a minority of scientists on the quantity and local variations, it is fact that in New Zealand sea levels have risen by an average of 1.2mm per year since 1900AD.

Environment Bay of Plenty has adopted the IPCC estimates for the purpose of the Proposed Bay of Plenty Regional Coastal Environment Plan.

Currently, some provision for sea level rise is included in some of the schemes. The impacts of this are limited to the lower reaches of the river and are small compared to the magnitude of storm surges. This policy will be reviewed on completion of the study.

1.8.4 Increased Frequency and Magnitude of Flooding

A second, but less quantified adverse effect of global warming is that the frequency and magnitude of high intensity rainfalls are expected to increase.

Dr Andy Resinger, from the Ministry of the Environment, in his visit to Environment Bay of Plenty advised that the frequency of floods of a particular size are estimated to increase between zero and four-fold by the year 2070AD.

In response to an enquiry, whether adopting a doubling in frequency was prudent, Dr Resinger indicated that would be a reasonable approach.

A doubling in flood frequency by the year 2070 would mean that the currently estimated 200-year flood magnitude would become the 100-year flood. Effectively this means that the estimated magnitudes of the 100-year (1%AEP) discharge on the Whakatane River at the Valley Road recorder site are:

- Current 1%AEP 2820 cumecs
- 2070 AD 1%AEP 3180 cumecs

This is a 12% increase and equates to a rise in flood levels of around 300mm in the reach of river from the Landing Road Bridge to the river mouth.

Currently no policy or provision exists for taking account of increasing frequency and magnitude of flooding. It is important that when key structures and those that are difficult to retrofit (e.g. flood walls) come up for construction or renewal that they are designed for likely intensification of flows during their lifetime. However, at this point there is little information on the required provision, and any provision should be critically examined. This aspect will be reviewed on completion of the study.

1.8.5 Impact of Interdecadal Pacific Oscillation

The Interdecadal Pacific Oscillation (IPO) is a climate cycle affecting the majority of the Pacific. This cycle has more immediate impact on flood frequency than global warming and is to be considered in any future review of flood protection assets.

The IPO cycle is strongly correlated to heavy rainfall and floods in the Bay of Plenty resulting in successive “benign” and “active: phases. These phases persist for 20 to 30 years. The cycle shifted to a “benign” phase in the mid-1970’s and subsequently to an “active” phase around 1997-98. For the Whakatane River, which has a long term average flow of 876.3 cumecs the flow during the ‘active’ period, is expected to be 1002.1cumecs (+14%) and during the ‘benign’ period it is 738.5cumecs.

The influence on the larger floods is more pronounced (as demonstrated in a report by Dr Alistair I McKercher, NIWA in Tephra) and a full report on this matter will be prepared in the near future.

The impact is that we can expect a series of floods with above average magnitude over the next 20 years.

1.9 Historical Flooding

Flood level data has been recorded since 1994. Prior to this period flood level information was obtained from local residents and it is apparent that exceptionally high floods occurred in 1906 and in 1925. Little is known about the 1906 flood but records of latter floods are available and these are provided below.

Flood protection structures were constructed as part of the Whakatane Major River Scheme in the period 1965 – 1981.

A timeline graph showing historical floods and their magnitude are provided in Figure 1.5. A description of flood events follow.

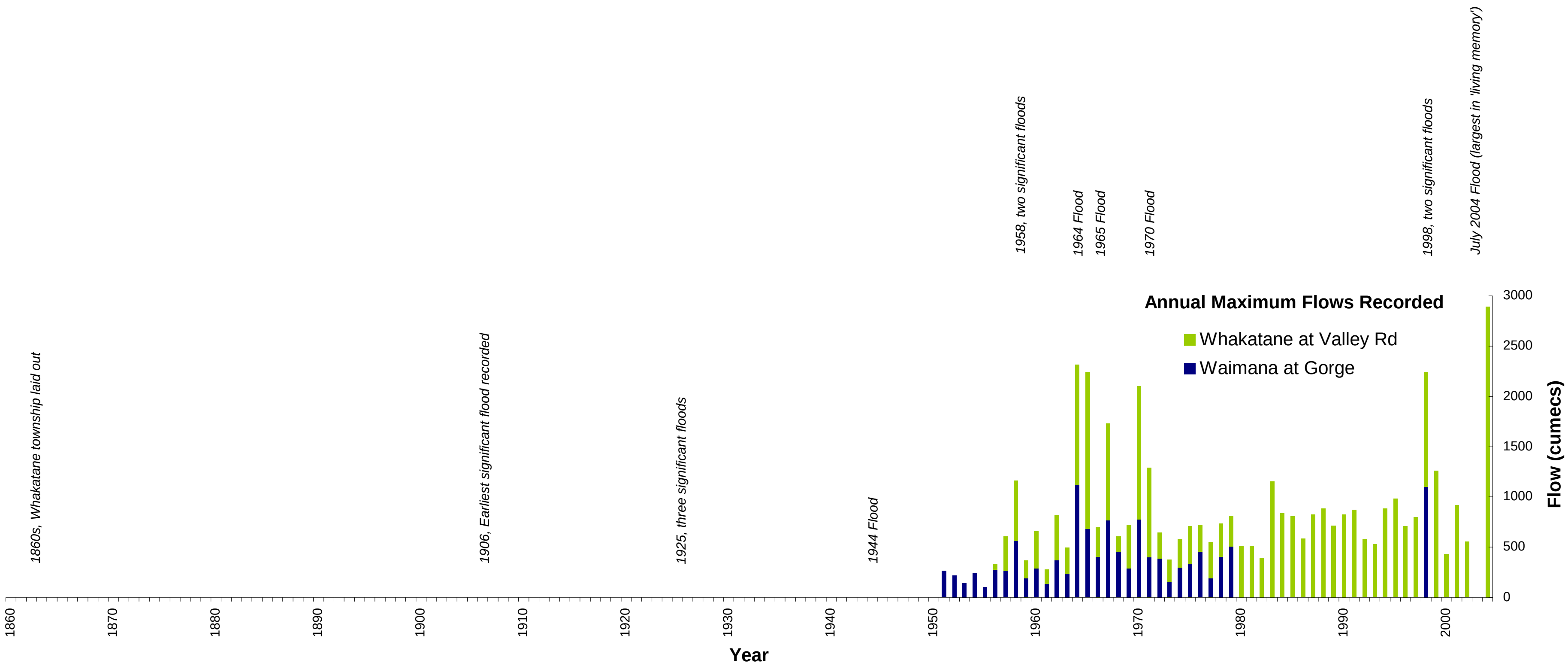

Figure 1.5 Flood History of Whakatane and Waimana Rivers

1.9.1 22–24 May 1925

The biggest floods experienced for twenty years caused extensive and widespread flooding throughout the district. Although the Whakatane River was in high flood, the town of Whakatane was dry, but the water, however, came to the wharf level. At Poroporo, just outside the town, a large portion of land was inundated and some settlers had to leave their homes (Cowie, pg 41, 1957)

1.9.2 24 – 25 June 1925

At Whakatane, the Whakatane River overflowed its banks at several places and inundated large areas (Cowie, pg 42, 1957)

1.9.3 28 – 29 June 1925

Further flooding of the Whakatane and Rangitaiki Rivers, following heavy rain caused extensive inundation over the Rangitaiki Plains. 30,000 acres were flooded and considerable damage was done to pastures, stock and fences. Roads suffered severe damage, and many small bridges were washed away. (Cowie, pg 42, 1957)

1.9.4 23 February 1944

The township of Whakatane was isolated by floodwaters when the Whakatane River overflowed its banks, and many acres of farm and swamp land were under several feet of water. Minor flooding of shops and business premises occurred. The river was level with the top of the wharves, which are normally 5 feet above the river level even at high spring tide (Cowie, pg 44, 1957)

According to a report by Bay of Plenty Catchment Commission (BOPCC) a peak discharge of 55,000 cusecs (1557m3/s) was estimated for this 1944 event. The report added, “local residents on the upper river above the recording station state that this flood was not as high as the 1925 flood” (BOPCC, 1985, p12)

Figure 1.6 Flooding of The Strand during 1944. The Union Bank is now a car sales yard.

1.9.5 25 February 1958

The Whakatane River rose to a gauge height of 21.25 feet at a discharge of 45,000 cusecs (1274m^3/s). It was the highest magnitude flood since 1944. An area of approximately 3,000 acres was flooded on the plains and considerable damage occurred to river protection works in various locations (BOPCC, 1985, p12).

1.9.6 24 December 1958

Three thousand acres of farmland flooded during a flood event of 35,000 cusecs (991 m^3/s). "This flood caused loss of production and crops as it occurred at the peak of the season's production" (BOPCC, 1985, p12).

1.9.7 11 March 1964

The Bay of Plenty Catchment Commission reported this event as follows:

The first *warning of a possible flood came at 10 a.m. on the 11 March when it was reported that the roads into Waimana were under water, and it was anticipated that the flood at Waimana would exceed the 1944 flood. The rain ceased at midday and ironically the sun shone for the remainder of the day. By this time the Waimana River had overflowed the road leading from Taneatua to Ruatoki and was over the Waimana Gorge Road upstream of the water level recorder.*

The Whakatane River started to rise more rapidly after lunch and flood waters were soon backing up the Waioho Stream and overflowing into the Waioho – Te Rahu area.

By 3 p.m. the Whakatane River had overflowed both banks at the Old Traffic Bridge and the Waimana River had cut all access to Opotiki at a point above the recording station. In the Waimana Gorge floodwaters had swept away the walkway into the recorder tower together with a large portion of road and several telephone poles.

The Waimana River peaked at 6 p.m. at a gauge height of (23.31) with a discharge of 40,000 cusec (1133 m^3/s) from 170 square miles, and the Whakatane River peaked at the recorder station at 10 p.m. at a gauge height of 24 feet with a discharge of 70,000 cusec (1982 m^3/s) from 601 square miles. By that time water was overflowing to a depth of 4 – 5 feet on the left bank at Rewatu Road, had filled the area behind the Waiho Stopbank and had broken through in several places, adding a considerable flow to that already flowing back up the Waiho Stream.

The position in the Borough around lower Churchill Street, Bridge Street, Hinemoa Street, Riverside Drive and James Street was relatively serious and several houses had water through them. At midnight, although the water level had commenced to drop at the recorder station, floodwaters had completely filled the 6,000 acres area east of Te Rahu Stream and were still rising in the town. The Te Rahu stopbank then burst in two places at midnight and the water commenced to spread further westward, ultimately covering 14,000 acres of land on the Plains. The flood levels in the Borough peaked at 2 a.m. on the 12th by which time 50 houses had water through them and a great number were surrounded by water. (Figure 1.10 in this report shows the extent of flooding along the lower Whakatane River during this period).

A feature of the flood was the very high sediment concentrations in both rivers. In locations where velocities were decreased due to obstructions, silt deposits were up to 3 feet deep.

Reliable residents at Taneatua state that the flood was the highest ever known, up to 20 " higher than the 1925 flood (BOPCC, 1985, p13 – 14).

The extent of flooding in the March 1964 event over the lower Whakatane catchment *is shown in Figure 1.10.*

1.9.8 February 1965 Flood

A major flood occurred whereby the mean rainfall over the Whakatane catchment was 8.92 inches over 36 hours. This was equal to a peak discharge of 68,000 cumecs (1926m^3/s).

Figure 1.7 Photo from over the Board Mills looking towards Whakatane West Station (i.e. the Rangitaiki Plains) (February 1965)

1.9.9 1970 Flood

A major flood occurred of 2065 cumecs (equivalent to a flood return period of 36 years)

By 1993 the majority of flood protection works were completed for the Whakatane River Major Scheme.

1.9.10 1–16 July 1998

Over the period 1 – 16 July 1998 the Bay of Plenty and in particular the eastern Bay of Plenty was subjected to heavy rainfall. During this 16-day period four storms caused four flow peaks in the Bay of Plenty Rivers.

In October 1998 NIWA carried out a peer review of an Environment Bay of Plenty report on the meteorology and hydrology of the July 1998 floods (Ellery, 2000). NIWA concluded:

It is clear that the 1998 16-day duration flood events in the Whakatane and Waioeka rivers have return periods around the 100 year mark, possibly greater for the Whakatane River. It is likely that the Waimana event exceeded 100 years and may have been as extreme as a 200-year flood. …the unprecedented flood damage in the Bay of Plenty, and the largest flood volumes into neighbouring Lake Taupo during July 1998 since records began over 90 years ago, provide additional evidence that the July 1998 Bay of Plenty floods had return periods exceeding 100 years.(NIWA, 1998, pg 4).

Figure 1.8 Whakatane Heads at the boat ramp where the carpark is completely submerged (2 July 1998)

Figure 1.9 Bank erosion at Ruatoki. Threatened stopbank being realigned by excavator (17 July 1998)

At the top of catchments rainfall gauges recorded about one third the average annual rainfall within that period. Rain gauges further downstream recorded 20% the total annual rainfall. Between 1–16 July 1998 the Whakatane – Waimana catchment received 803mm rainfall. This represents 33% of the mean annual total rainfall. In comparison the rain gauge at Huiarau ranger station located at the top of the Whakatane catchment recorded 412mm in the same period. This latter figure represents 15% of the mean annual total rainfall. (Environment Bay of Plenty, 1998)

General observations were that:

- Rivers rose quickly – at rates of up to one meter per hour. Both Waimana (at the ranger station) and Whakatane (at Valley Road) rivers peaked at six meters above usual levels. (Environment Bay of Plenty, 1998)
- All major rivers were flooding at the same time
- The Waimana catchment produced almost exactly 50% of the flood peak, despite being the smaller of the two principal tributaries. This reflected rainfall being centred over the Waimana Waioeka divide.

1.9.11 **14–18 July 2004**

Heavy rain began falling in the Bay of Plenty on Thursday, 15 July 2004 and continued for the following three days. In the period between 14 and 18 July some 284mm of rainfall was recorded at the NIWA rain gauge located in Edgecumbe. This rainfall caused widespread flooding throughout the region effecting Edgecumbe, the Rangitaiki Plains, Whakatane and Opotiki. The extent of flooding in the lower Whakatane catchment is shown in Figure 1.11.

On Sunday, 19 July the Whakatane River peaked early in the morning at around 7.7m above normal levels at the Valley Road gauge just above Whakatane Township (ENVIRONMENT BOP Press release, 20/07/04). The floods did not overtop the main urban stopbanks protecting Whakatane Township. These stopbanks, which include freeboard, are designed to withstand the 100-year return period flood event. The importance of maintaining adequate freeboard was highlighted when flow magnitude in the Whakatane River was assessed by Environment Bay of Plenty. Assessment showed that the peak flow in the upper Whakatane River was 2893 cumecs, which is equivalent to a 116 year ARI (rounded to 120 year ARI). However flow was greater than 2893 cumecs in the lower reaches due to the very high Waioho flows (Environment Bay of Plenty email G Ellery to P Blackwood, 14/10/04). It is understood that a much greater flow came down the main Whakatane River than in 1998.

Unfortunately the suburb of Awatapu did flood owing to a malfunction of the main pump station. Flood waters resulted from Wainui Te Whara Stream run-off and overtopping of the internal stopbanks that surround the suburb.

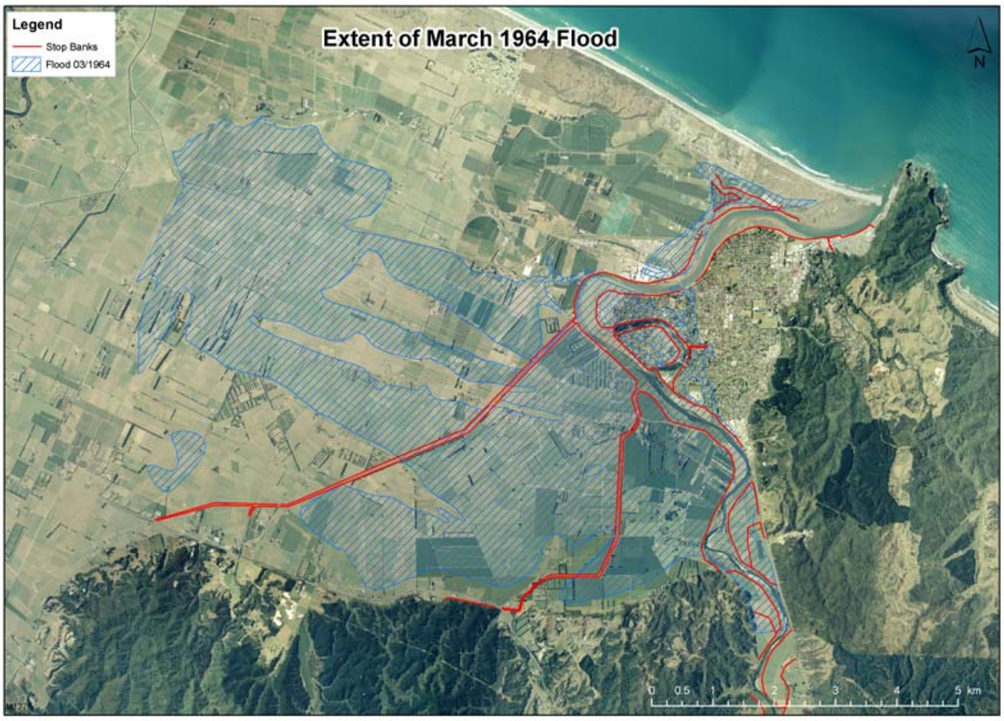

Figure 1.10 Extent of 1964 floods prior to Whakatane Major Scheme works being implemented.

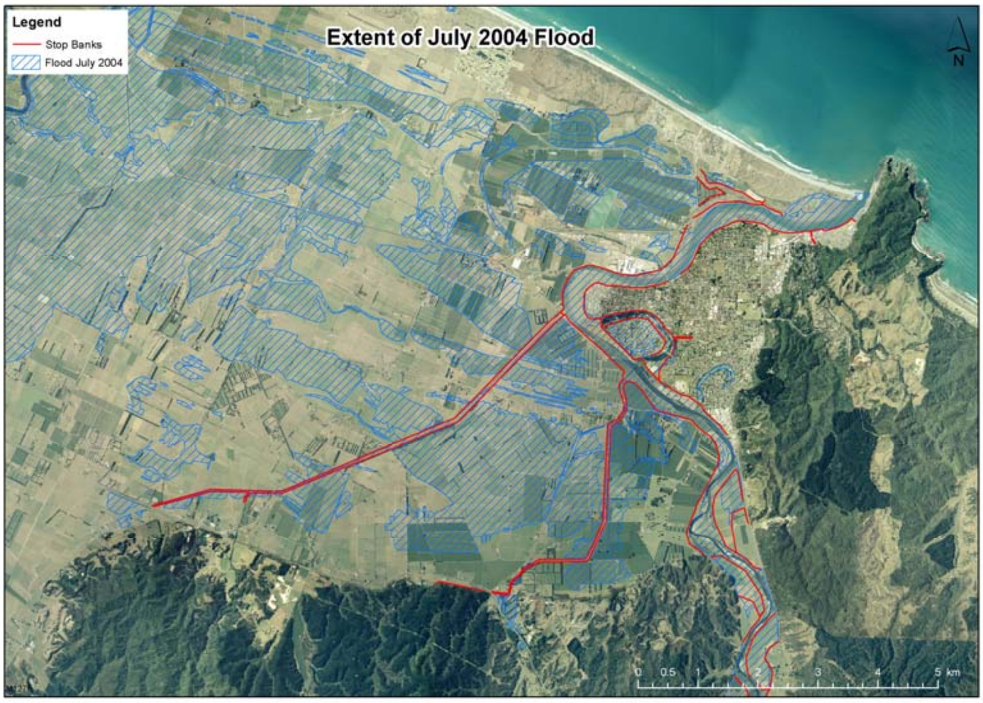

Figure 1.11 Extent of floods on 19 July 2004. Note map does not show extent of flooding at the height of the storm. Urban areas are now better protected by 100 year stopbanks compared to 1964.

Flood response and recovery work for the Whakatane – Waimana scheme was initially estimated to total $3.3M (ENVIRONMENT BOP Press release 23/8/04) however by December 2005 this estimate had risen to approximately $5M (Crabbe, 2006). These cost estimates were only for repairs to the flood protection assets and included replenishing rock edge protection, repairing fences to stop stock accessing scheme plantings, de-silting canals and drains.

Figure 1.12 Suburb of Awatapu under floodwaters. The Whakatane River is in the background, Awatapu Lagoon in foreground (18 July 2004)

Figure 1.13 Sandbagging outside the Fishing Club on Muriwai Drive. This helped prevent floodwaters spreading to Whakatane township (17 July 2004)

1.10 Response to Flooding: Structural Works

Structural measures involve constructing physical works designed to contain floods and limit erosion. In essence structural measures are constructed to keep the river away from people, possessions and development and constitute the more traditional tools for reducing flood risk.

The Whakatane River Scheme is a river and drainage scheme that includes; substantial stopbanking of the main river and some major tributaries, floodgates, gravity and pumped drainage outlets, considerable channel edge (bank) protection and plantings and flood proofing. The scheme includes the Waimana and Whakatane Rivers and the Te Rahu, Waioho and Wairere Tributaries.

The aim of the original scheme was to provide 100-year flood protection along the lower 12.8 km of river, partial flood protection and channel improvements along the upper 30.4 km of the Whakatane River and 28.8 km of the Waimana River, and improved drainage for approximately 4,000 – 6,000 hectares of the eastern Rangitaiki Plains.

Previous to the scheme extensive flooding was a common event for the low lying areas generally north of the Awakeri – Taneatua railway line, from the western drain in the west to Waioho Stream and up the Whakatane River valley (refer to Figure 1.10). Whakatane Borough was subject to flooding on the western side, and indeed was unable to be developed for housing until after the construction of the nearby stopbanks and channel control works.

Scheme construction commenced in 1965 and was completed in 1981. A scheme review of the lower Whakatane River protection works was undertaken in 1985 following the availability of further hydrologic and hydraulic data. This resulted in some further works, which were completed in 1993.

A review of the middle reaches of the Whakatane and Waimana Rivers was undertaken in 1992 (Titchmarsh, 1992). The resulting programme of works included clearing, training groynes, layering, trenched willows, planting and fencing to return the rivers to a stable meander pattern in terms of width and alignment.

1.10.1 Stopbanks

The Whakatane River Scheme comprises approximately 85.9km of stopbanks built along the Whakatane riverbanks and some major tributaries. The stopbanks were initially constructed in 1965 and the last major stopbank works were completed in 1993.

The ability of the stopbanks to contain floodwaters to at least design capacity depends on how well they have been constructed and maintained.

Figure 1.14 shows location plan of existing urban and rural stopbanks in the catchment.

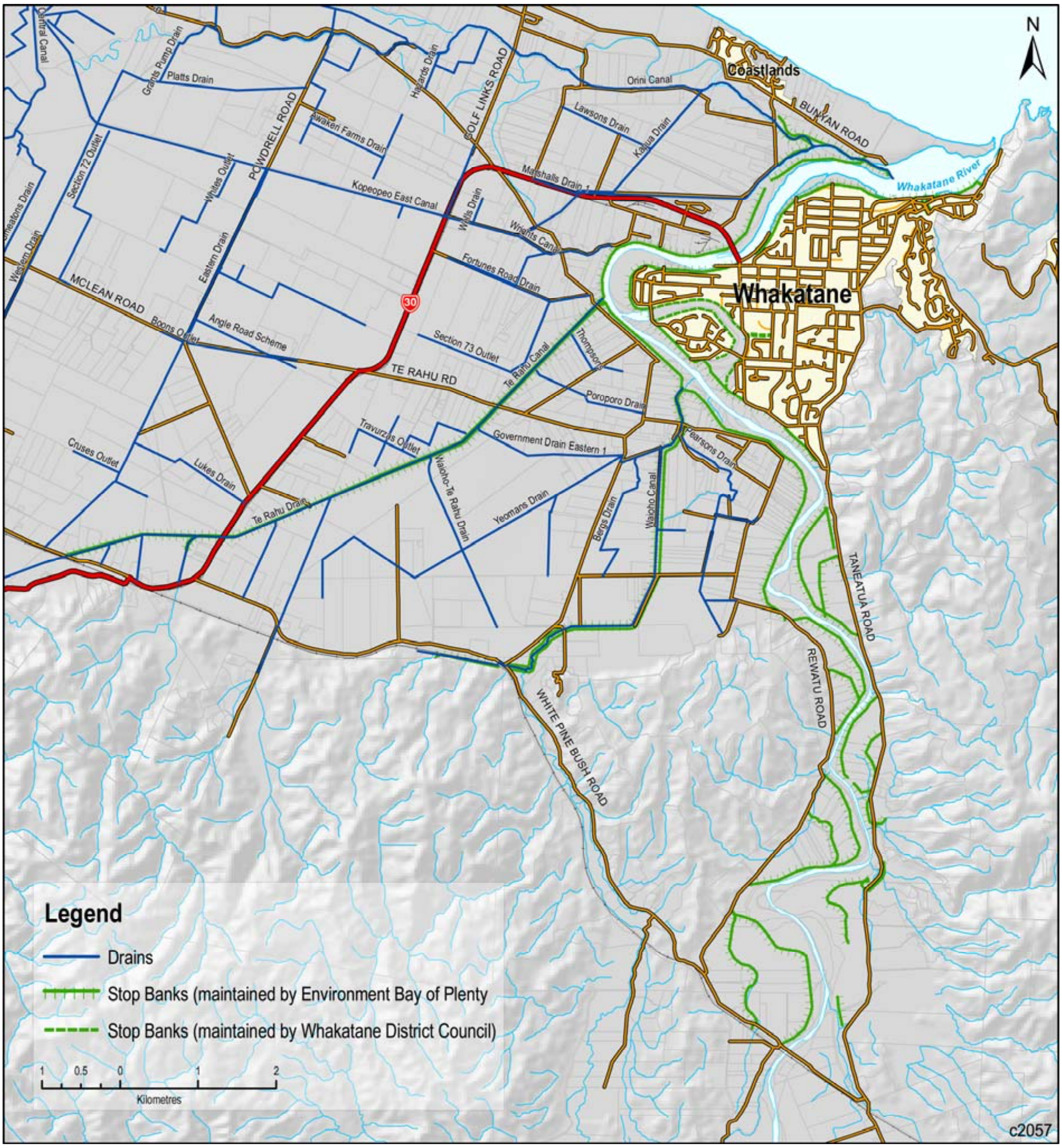

Figure 1.14 Location plan of urban and rural stopbanks in Whakatane River Scheme.

1.10.2 **Stopbank Capacity**

The Whakatane River Scheme has been subject to several capacity reviews between 1963 and 2005. Programmed stopbank capacity reviews are a requirement of the Whakatane Asset Management Plan. Appendix 1 provides a summary of reviews carried on the Whakatane and Waimana Rivers plus its feeder canals. These have resulted in physical works to return the stopbanks to a level that meets the schemes design service levels as shown in Table 1.3.

Table 1.3 Design service levels for Whakatane River scheme stopbanks

Location	Design Service Level
Downstream of Yacht Club	100 year plus 600 mm freeboard
Whakatane Right Bank (above Yacht Club)	100 year plus 800 mm freeboard
Whakatane Left Bank Below Landing Road Bridge	100 year plus 500 mm freeboard
Whakatane Left Bank Above Landing Road Bridge	100 year plus 500 mm freeboard
Waioho Stream	100 year plus 600 mm freeboard
Te Rahu	100 year plus 600 mm freeboard
Kope Canal	5 year plus 270 mm freeboard

Recently the capacity of the Whakatane and Waimana Rivers were reviewed and a condensed version of the results outlined in section 2.2. New design water levels were calculated using MIKE 11 software and results compared with latest survey levels on the stopbanks.

Capacity review results of Whakatane River tributaries follow:

- Design levels of the Kopeopeo East canal system were reviewed in 1995 (Surman). As a result some 2km of stopbanks on the right bank upstream of Powdrells Road were topped up in 2003 to meet the 270mm freeboard requirement.

  In 2003 water levels of the Kope–Orini canal system were calculated for a 50 year flood event and compared with the five year design standard. This was done to determine floor levels for potential housing development in the catchment (Bailey & Arts). The Kope–Orini canal system consists of the Kopeopeo East canal and Orini canal and the Eastern Drain. Results indicate that the canal system is likely to overflow and minimum floor levels have been recommended for the immediate vicinity.

- Design levels of the Waioho Stream and Te Rahu Canal were reviewed in 2003 (Pak).

  Results of the Waioho Canal modelling have shown that in a 100year event stopbanks between Butler's Bridge and Titoki Bridge start to overtop in places. The freeboard is less than required over most of the canal's length, except downstream of Rewatu Road Bridge. Top-ups are required where the available freeboard is less than 50% of the required freeboard, which is the case over a length of approx. 2.2km on the left bank and 2.1km on the right bank.

  In the reach of the Waioho Stream between Butler's Bridge and White Pine Bush Road (SH2), including the Catchwater Drain downstream of State Highway 2, the 100year protection is insufficient in places as well. Top-ups of existing stopbanks and the construction of new stopbanks are required. The estimated costs for these works are $50,000.

  Results of the Te Rahu study show that when the 100 year flood level in the Te Rahu combined with a 20 year flood level in the Whakatane then the Te Rahu stopbanks overflowed in several places and available freeboard is insufficient over a large part of the modelled reach. Stopbank top-ups are therefore required. The extent of the required top-ups is yet to be assessed in detail.

In 2006 a supplementary study was undertaken for the performance of the Te Rahu pumps (Pak, 2006). The study confirmed the pumps met current service level requirements wherein the Te Rahu basin was drained within three days.

The internal Awatapu Lagoon stopbanks overtopped during the July 2004 floods. Whakatane District Council owns the internal stopbanks and is thus responsible for its capacity review and remedial work. Whakatane District Council has initiated investigations to determine what additional flood protection measures are required to reduce the threat of Awatapu Lagoon stopbanks overtopping in a design event. Whakatane District Council has set aside a sum of $980,000 in 2006/07 to implement flood protection works in Awatapu.

1.10.3 Stopbank Condition

The condition of stopbanks is reviewed regularly by Environment Bay of Plenty. Reviews have resulted in physical works to return the stopbanks to a level that meets the scheme design service levels.

In November 2002 Riley Consultants prepared a report outlining remediation options for the two highest priority areas identified in their July 2002 report (Riley Consultants, 2002). The sites are at Barry Avenue Pump Station and Red Conway Park. The recommended options for each site are:

- A filter drain surrounding the stormwater pipes and encircling the existing basin structure at the Barry Avenue Pump Station site.
- A low gabion retaining wall, with associated earthworks to flatten the batter slope at the Red Conway site

Inspection of the Whakatane stopbanks after the July 2004 floods showed them to be in a generally stable condition. No overtopping or breaches were reported during the event. Some damp areas and “boils” were identified on the downstream face at the Barry’s Ave pump station. Remedial work at Barry Avenue and Red Conway Park was completed in June 2005.

1.10.4 Concrete Flood Walls

Concrete walls carry out the same function as the stopbanks. They are constructed when physical constraints prevent construction of stopbanks.

The concrete walls described in Table 1.4 are all in good condition and are inspected on a regular basis. Any structural defects are repaired promptly.

Table 1.4 Design service levels for Whakatane River scheme concrete walls

Location	Design Service Level
Downstream of Yacht club	100 year plus 600 mm freeboard
Whakatane Right Bank (above Yacht Club)	100 year plus 800 mm freeboard
Wairere Stream Left and Right Bank	100 year plus 500 mm freeboard

1.10.5 Structures

The Whakatane–Waimana Rivers system has several floodgates, pump stations and a sluice gate. Environment Bay of Plenty own, maintain and operate the:

- Kope Orini and Te Rahu floodgates
- Kope Orini, Te Rahu and Fortunes Rd pump stations

Environment Bay of Plenty own and carry out major maintenance on some 141 minor outlet structures located in stopbanks lining the Whakatane River and its tributaries. Whakatane District Council is responsible for carrying out minor maintenance and operation of those outlets located within the urban area.

Whakatane District Council own and maintain fully:

- The urban outlet structures passing through scheme stopbanks that are connected to Whakatane District Council pump stations eg Barry's Ave Pump Station
- The outlet structures passing through the internal Awatapu Lagoon stopbanks.

Details are described in the Whakatane Waimana asset management plan.

Inspection and maintenance is carried out regularly on the system structures and working parts. At present all structures retain their structural integrity.

1.10.6 Edge Protection

Rock work and live protection are erosion control works that are designed to protect the stopbanks and/or natural channel banks from erosion and consequential flood overflows, to maintain channel stability and to reduce the erosion and subsequent release of sediment into the lower reaches of the river system.

The condition of the live edge protection in the scheme varies depending on its age and its previous maintenance.

Most of the vegetation protection present in the scheme comprises crack willow (Salix *fragilis*). While this species does have some desirable characteristics, such as a large root mass and some resistance to animal grazing, it is rather brittle, and being predominantly female it tends to seed and spread uncontrolled. Thus it is not an ideal species to use. In general, *S. matusdana x alba* hybrids tend to be more suitable, in particular male hybrids such as Hiwinui or Moutere.

Other more desirable species such as shrub willows, *S. matusdana x alba* hybrids and clones are now used and as the stock of these species increases along the rivers, much of the existing crack willow will be displaced. Having a mix of species and clones reduces the vulnerability of edge protection to a disease or insect infestation – as different species have different resistance to particular diseases or insect. Leaf rust, sawfly, silverleaf and Armillaria are examples of common problems that can strike willows. Only sawfly exists in this scheme at present, however armillaria is present in other schemes in the region. Nonetheless, field staff maintain a watch for signs of disease, particularly as diseases such as leaf rust can evolve.

Trials of various hybrid species of willows, in particular golden willow hybrids (*matsudana x alba vitelina)* are being assessed, and findings from crown research institutes are being obtained to further help identify suitable species to use as bank protection.

In order to create more native edge protection plantings and to reduce the risk of sawfly damage to willows, Environment Bay of Plenty is carrying out field trials of native edge protection plantings.

Whilst early results of these trials are showing potential at present; they take years to establish and evaluate therefore a cautious transition from willows to natives is prudent.

A regular layering programme is already in place and this will intensify as new areas of edge protection age and thus require layering.

1.10.7 **Buffer (or Berm) Zone**

The buffer (or berm) zone has no definitive design standard and the width allowed is a matter of judgement on a site-by-site basis. For consistency a minimum width of vegetation is maintained in most circumstances. The standard selected for the Whakatane River Scheme Middle Reaches Investigation (Titchmarsh, 1992) was for the buffer zone to be the width of the minor threshold of motion meanders as a minimum i.e. for the:

- Whakatane River, 40m
- Waimana River, 30m

It has not been practicable in many instances to establish these widths and for some areas a width of 15m has been used.

Today much of the buffer zone is well established. Regular inspections are carried out followed by maintenance fencing and planting to ensure the buffer zone is maintained.

1.10.8 **Regional River Gravel Management Plan**

The Regional Gravel Management Plan is prepared under Section 65 of the Resource Management Act (RMA). Its objectives are:

- The management of gravel to reduce flooding and river bank erosion risks (Clause 16.1.1 (a))
- The management of gravel to assist the maintenance of identified standards of control and drainage (Clause 16.1.1 (c)).

The Regional Gravel Management Plan requires Environment Bay of Plenty to manage extraction locations and quantities via a resource consent process. The Plan also notes that Environment Bay of Plenty may negotiate with extractors to extract where there is no demand, if required for flood/erosion control purposes. Gravel extractions are also defined in the Whakatane District Plan as a discretionary activity under Rule 3.8.1.3 (5) unless provided by Rule 4.1.3. This means that resource consents are required from both Councils before extractions can take place.

1.10.9 River and Stream Channel Monitoring Programme

In 1993/94 Environment Bay of Plenty commenced its river and stream channel-monitoring programme. Monitoring of channel cross-sectional shape allows identification of quantities of gravel available for extraction. Extraction is either encouraged or limited in order to stabilise the river systems. For example:

- If the bed level is too high or the waterway congested flooding is more likely.
- If the bed is too low, banks are high and have to take the full force of flow during a flood. Protection works are undermined; more gravel is transported downstream to build up elsewhere.

Defining desirable bed levels for each river and stream protects the river assets and public in general.

Extracted gravel is used for commercial purposes.

To encourage stable channels, the following factors need to be promoted:

- Maintaining bed levels within a desirable range
- Maintaining good river alignments
- Keeping roughly in balance with natural supply rates
- Compatibility with existing assets

In the 2002/03 Natural Environment Regional Network River and Stream Channel Monitoring (NERMN) report, the following recommendations are made:

(a) Waimana River

Further extractions should be limited currently in the upper reaches of the river except where major build-ups are surveyed. It may however be necessary to use a selective combination of extraction and channel reshaping to arrest the degrading processes currently occurring particularly to the thalweg invert levels (Environment Bay of Plenty NERMN report, 2003, pg iii).

(b) Whakatane River

Although riverbed levels on the Whakatane River above Pekatahi Bridge are on the rise, the previously set extraction limits of 20,000m^3 per year from existing beaches should be adhered to until desirable bed limits have been reviewed and met (Environment Bay of Plenty NERMN report, 2003, pg iii).

The existing channel capacity for Whakatane and Waimana Rivers is evaluated using current channel monitoring data.

1.10.10 Flood Proofing

Flood proofing a building prevents water damage to a building. Flood proofing measures can be incorporated during the early stages of design or retrofitted to existing buildings. Flood proofing measures include:

- Relocating buildings

- Raising floor or foundation levels
- Surrounding the building with flood proof masonry or concrete walls or bunds (low earth embankments)
- Sealing all building openings below potential flood levels, either temporarily or permanently ("dry" flood proofing)
- "Wet" proofing so that floodwaters are allowed in to counteract the pressure on the outside walls, but with the building materials and internal furnishings designed so that minimal damage is caused.

However, more commonly flood proofing refers to the latter two. Flood proofing is not a failsafe measure; there is still a need to consider whether it is appropriate at all to build at a flood prone site. It should be regarded as a means of protecting individual existing structures.

1.11 River Management and Planning

1.11.1 Design of River Meander Patterns

Many empirical and semi-empirical formulae have been developed to calculate stable meander patterns for rivers. Most are functions of parameters such as bed particle size, bank-full discharge and river slope. The aim of a design meander pattern is to keep the river in a stable alignment and reduce erosion of riverbanks and stopbanks. A stable channel design is one where sediment transport rates equal the supply of sediment to the channel (from upstream catchments). The design aims to keep the channel wide enough to minimise bank erosion but not so wide that incoming sediment cannot get transported downstream.

In 1992 Environment Bay of Plenty prepared a design report proposing river training works to develop a stable channel in the middle reaches of the Whakatane and Waimana Rivers (Titchmarsh, 1992). Below the Pekatahi Bridge the Whakatane River is stopbanked with banks providing either 10 year or 100-year level of protection to the surrounding farmland. The design report identified areas subject to severe berm and bank erosion and gravel deposition, which had modified the river channels into an unstable configuration. Titchmarsh notes:

There has been river training schemes and works…to align the middle reaches *of both these rivers to a stable meander pattern and control erosion since the early scheme designs (1960's) but no comprehensive river training scheme has been able to be fully implemented and maintained due to shortage of funds. This approach has been only partially successful in holding the river. In most cases the riverbank has an exposed gravel layer underlying the silty soil and this quickly erodes causing slumping in the unsupported silt. Severe berm erosion and gravel deposition is continually taking place and existing works have been proved to be inadequate, often requiring maintenance after each fresh…Erosion of the riverbanks leads to aggradation of the rivers giving rise to decreased flood capacity (1992, Section 2).*

The intention of the 1992 design report was to determine the channel alignment, (that is the path that the rivers would be trained to take) the widths of channel, fairway and buffer zone.

In 1994/95 Environment Bay of Plenty adopted a three-year programme of works to stabilise the channel. The programme included clearing, training groynes, layering, trenched willows, planting and fencing to return the rivers to a stable meander pattern in terms of width and alignment (Asset Management Plan, 1997, pg 13). In 2004 Environment Bay of Plenty constructed test groynes at Yates in order to arrest berm erosion. Environment Bay of Plenty is committed to installing and monitoring test groynes built at selected erosion sites along the riverbanks of its major river schemes.

1.11.2 Gravel Management in the Whakatane and Waimana Rivers

Gravel has been extracted from the Whakatane and Waimana Rivers for over 50 years. There are two primary reasons for this:

- River Management: planned gravel removal is necessary for the maintenance of channel flood flow capacity and the integrity of the major flood control schemes.

- Commercial Use: demand for gravel as construction and roading aggregate.

The aim of sound gravel management is to establish a balance between supply and demand for gravel and to mitigate undesirable effects, such as:

- Aggradation of the riverbed, which decreases the ability of the river channel to carry floods. This results in greater erosion pressure on riverbanks, increased flooding of productive land, and the infilling of the beds.

- Degradation (erosion) of the riverbed and the undermining of structures.

The July 1998 floods caused significant changes to gravel volumes in the river systems, and these changes are likely to affect the management of gravel for several years.

Since the 1960s, the Whakatane and Waimana Rivers have been regularly surveyed at a series of cross-sections. As well as providing data for hydraulic modelling, the surveys allow riverbed aggradation and degradation to be estimated.

Riverbed levels in the upper reach of the Whakatane River (above Pekatahi Bridge) were degrading until extraction was limited in the mid 1990s. Since then recovery has been taking place and extraction has been focused on beaches and floodway constrictions created during and following the 1998 floods.

Gravel management in this upper reach of the Whakatane is subject to a diversity of viewpoints. On one hand there is strong pressure for extractions to cease until bed levels recover and bank erosion problems are reduced. On the other hand there is a view that the river should remain entrenched to avoid the severe adverse effects from possible overflows onto the surrounding farmland. It is difficult to exactly balance these opposite objectives.

Gravel extractions in the upper reaches of the Waimana River have also been limited in recent years to allow river levels to recover from degradation. A selective combination of extraction and channel reshaping has been used to arrest the degrading processes.

1.12 Response to Flooding: Statutory Non Structural Measures

Non-structural measures are the means by which people are kept away from floodwaters. Legislation that provides the mandate for local and regional councils to create policy for non-structural measures are:

- Government Policy.
- Regional Plans.
- District Plans.

1.12.1 Government Policy

Legislation that can support non-structural measures include:

- Resource Management Act
- Local Government Official Information and Meetings Act 1987
- Building Act 2004
- Building Regulations
- Civil Defence Emergency Management Act

(a) Resource Management Act

The Resource Management Act (1991) gives regional and district councils the legal mandate to manage natural hazards such as flooding and erosion within its boundaries. For example the RMA requires councils to:

- Control the use of land for the purpose of avoidance or mitigation of natural hazards (Part 4: Section30, 1.a.iv).
- Make available information that relates to natural hazards
- Obtain off consent applicants an assessment of environmental effects related to natural hazards
- Protect conservation values by hazard mitigation

(b) Local Government Official Information and Meetings Act

Land Information Memorandum (LIM's) provide statements of known hazards associated with land parcels.

Under Section 44A of the Local Government Official Information and Meetings Act 1987, people can acquire a LIM in relation to matters affecting any land in the district of the authority. The LIM identifies any special feature of the land concerned that may be subject to, but not limited to, say potential erosion or inundation.

(c) Building Act 2004

Under Section 71 to 74 of the Building Act 2004, a territorial authority shall refuse a building consent if:

- The land is subject to inundation or erosion, or
- The building work shall worsen the inundation or erosion of that or any other property.

Exceptions may be made to these rulings if the authority is satisfied that adequate provision has been made or will be made to:

- Protect the land or building work or that other property concerned from erosion or inundation, or
- Restore any damage the land or that property concerned as a result of the building work.

However under Section 72, if,

- The land on which the work is to take place is subject to inundation or erosion, and
- The work itself will not worsen the inundation or erosion of that or any other property.

The authority can issue a building consent upon condition that the existence of the hazard is made on the title of the land.

Section 71 to 74 helps to prevent potential damages from flood events from increasing. Section 72 shifts the burden of risk from the community more towards the landowner (and in doing so may also act as a deterrent to the building work) and ensures that subsequent owners of the land are aware of the hazard.

People can acquire a Project Information Memoranda (or PIM) on any land parcel. PIM's confirm if building work can proceed subject to satisfying other Acts apart from the Building Act. The PIM report is produced by Whakatane District Council and includes specific information such as potential erosion, subsidence, slippage and flooding. Refer also to Section 5 of the Buildings Regulations.

(d) Building Regulations

When issuing a building consent, Clause E1.3.2[5] of the Building Regulations binds the territorial authority to restricting floor levels:

Surface water resulting from a storm having a 2 percent probability of occurring annually, shall not enter buildings…E1.3.2 shall apply only to Housing, Communal Residential and Commercial Non – residential buildings.

[5] Refer to Schedule 1: The Building Act

This regulation tends to be enforced by specifying minimum floor levels above the 2%AEP flood level. In cases of doubt the local authority concerned normally seeks advice from Environment Bay of Plenty. In the Whakatane Waimana catchment the District Council has set minimum floor levels in urban areas. In rural areas RL2.5m (Moturiki Datum) is the minimum floor level but this is subject to confirmation by the District Council building inspectors who assess each site individually.

Local authorities also sometimes set minimum floor level conditions for consents under the RMA. The buildings need not necessarily be residential. In such instances, wider resource management issues are considered (eg the sustainability of the community) rather than just the effects on the building concerned.

(e) Civil Defence Emergency Management Act

Under the Civil Defence Act 1983 regional councils were required to prepare regional civil defence plans, identifying major natural hazard threats to the region, and defining regional policy to manage threats.

District councils were required to prepare civil defence plans for their districts, giving effect to regional plans. This system has been changed under the new Civil Defence Emergency Management Act 2002. In the future only one plan, a Group CDEM plan, is required for the Groups area. It is expected that this plan will combine the broad policies and coordination issues of regional plans with the practical response measures of district plans to achieve much the same desired results of the previous system.

1.12.2 Regional Plans

(a) The Bay of Plenty Regional Policy Statement (BOPRPS)

The statement document provides an overview of resource management issues, and policies and methods to achieve integrated management across the region. It provides guidance to both regional and district councils as to how to manage the Whakatane Waimana flood hazard.

Section 11 (Natural Hazards) of the BOPRPS is of particular relevance. Amongst the Objectives, Policies and Methods of Section 11.3, is a declaration that Environment Bay of Plenty will continue to manage the flood control schemes of the region. It outlines what and how various councils will work together to achieve the 10 specific Anticipated Environmental Results stated in Section 11.4.

(b) Proposed Bay of Plenty Regional Water and Land Plan

The purpose of this document is to address specifically water and land management issues in the region. It aims to promote soil conservation and sustainable land management. Its methods include education measures, incentives and rules. Amongst the rules relevant to flood issues (indirectly via runoff and erosion) are those on indigenous vegetation clearance, earthworks, stream crossings and wetland modifications.

Flooding and drainage issues are addressed, and recommendations from this Floodplain Management Strategy could possibly be incorporated into later versions of the land plan.

(c) Bay of Plenty Regional Coastal Environment Plan

This plan covers the rules applicable to the coastal marine area of the region, which includes the Whakatane River mouth. The most significant parts of the plan for flood hazard management deal with dredging within this coastal marine area.

1.12.3 District Plans

The District Plan, prepared by Whakatane District Council, consists of objectives, policies, rules and planning maps. Planning maps enable people to find which zoning applies to the property and other standards that will be relevant. Each zone includes controls and performance standards and general rules. There are separate sections concerning landscape and the coastal environment, cultural heritage, natural hazards, work and utilities, and hazardous substances, which apply on a site-specific basis.

Work done at or near stopbanks, floodgates and associated culverts is defined by Whakatane District Council as a controlled activity (refer Rule 4.8.1 (25)). Work proposed around such structures is checked beforehand to ensure that it does not compromise stopbank safety that could otherwise breach and cause flooding. The operation and maintenance of stopbanks (in existence on 1 January 1998) are permitted activities under Rule 4.8.1 (38).

1.13 Current Non–Statutory and Non–Structural Measures

Non statutory and non-structural measures include land use planning methods, voluntary actions and steps floodplain residents, businesses and utility and emergency services can take to prepare for floods. These measures aim to keep people, possessions and development away from flood prone areas. Non structural measures improve the community’s ability to respond to and recover from floods. They enable a community to be more resilient to flooding now and in the future. Such measures include:

- Flood monitoring and flood warning
- Education and emergency preparedness

(a) Flood Monitoring and Flood Warning

Environment Bay of Plenty is responsible for flood monitoring and flood warning in the region including the Whakatane – Waimana catchment.

Environment Bay of Plenty and NIWA operate a series of telemetered rain gauges, river level recorders and river flow recorders. Alarms are set to page Environment Bay of Plenty personnel when a threshold (that is, a certain river height or intensity of rainfall) is reached.

Environment Bay of Plenty maintains a Flood Warning Manual that documents procedures for staff to follow in the event of heavy rainfall or flooding. Figure 1.15 summarises typical responses to be actioned when water level in the Whakatane River reaches certain levels. A similar Figure exists for the Waimana River at Ranger Station (M566, Sheet 4A).

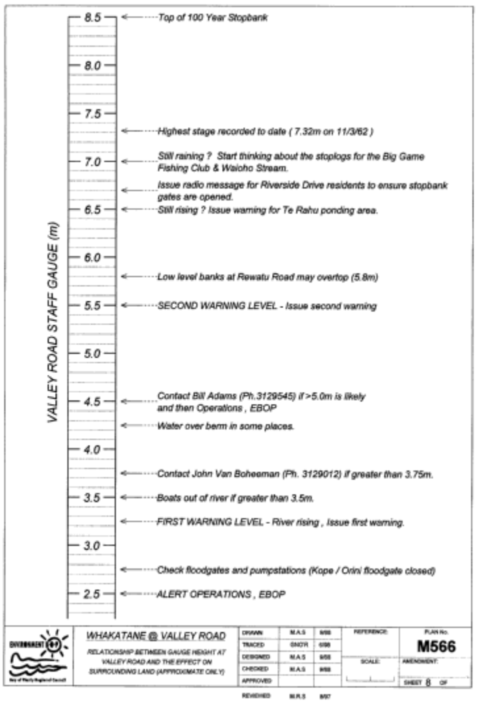

Figure 1.15 Flood warning chart for the Whakatane River based on the Valley Road gauge readings.

In most instances the procedures are initiated after a warning is received from the Meteorological Service (MetService), but they can also be initiated if alarms are triggered from the telemetered rainfall or river level recorders.

The Metrological Office can issue warnings that fall into one of three categories. They are Severe Weather Warning, Severe Weather Watch and a Special Weather Advisory.

(i) MetService will issue a Severe Weather Warning whenever there is an expectation that widespread rainfall greater than 50 mm within 6 hours or 100 mm will occur within 24 hours.

(ii) MetService will issue a Severe Weather Watch whenever there is an expectation that conditions may deteriorate to the thresholds specified for the issue of a Severe Weather Warning:

- After the next 24 hours but within 48-72 hours, or
- If there is a high level of uncertainty within the next 24 hours.

(iii) MetService will issue a Special Weather Advisory whenever a weather event is likely to cause significant disruption to the general public or specific industry groups within the next 48 hours, but the weather is not expected to deteriorate to an extent that would require the issue of a Severe Weather Warning. MetService may also issue a Special Weather Advisory following a severe storm that caused widespread disruption and damage in order to assist with any post-storm operations.

These forecasts are also supplied to the NZ Police and Civil Defence HQ in Wellington.

The Metrological Office issues Severe Weather Warnings to the media who have been asked to pass them on without their own interpretation.

(b) Education and emergency preparedness

A range of measures is currently used, with varying degrees of effectiveness, to raise awareness of hazards and to increase readiness in the event of a flood. These include:

- Land Information Memorandum (LIM's) and Project Information Memoranda (PIM's). Refer section 2.2.4 a) i) above.
- Section 73 of the RMA, which requires notices to be placed on property titles.
- Emergency response information is made available to public via the inside back cover of the telephone directory
- Environment Bay of Plenty and other organisations provide advice in occasional mails drops
- Internet sites such as the Ministry of Civil Defence & Emergency Management checklist in the event of flooding. Refer Figure 1.16.
- Occasional press releases on flood issues issued by Environment Bay of Plenty or territorial authority Refer Figure 1.17

A range of such measures is needed for the information to reach floodplain residents and users. These measures also need to be regularly repeated to maintain effectiveness. Section 35 of the RMA requires councils to keep records and make information available to the public.

Figure 1.16 Flood preparedness Internet site.

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MEDIA RELEASE

Environment Bay of Plenty REGIONAL COUNCIL

Opotiki stopbanks pass the 30-year flood test

For immediate release: Monday 6 October 2003

Opotiki's stopbanks, which help to protect the vulnerable township from flooding, passed a major test with flying colours over the weekend.

While residents slept on Friday night, the nearby Otara River raged in full flood. At one time, the river had risen by four metres in places and was channelling nearly as much water as it did during a major event in1965.

Environment Bay of Plenty's group manager operational services, Clive Tozer, says the town's newly strengthened stopbanks "did a great job" in keeping the town safe.

Over the last two years, Environment Bay of Plenty has upgraded Opotiki's urban system to provide a higher level of flood protection. In some places, stopbanks have been lifted by as much as a metre.

"Without the recent work, they would still have coped - but only just," Mr Tozer says. "The upgrade has given the people of Opotiki a greater degree of comfort at times like this."

The flood was a difficult test and "we are really very pleased with how it worked out. The stopbanks performed to the required standard, the warnings all got out in good time, and the field staff did well with their monitoring and in assisting landowners."

Opotiki township sits at the junction of the Waioeka and Otara Rivers within a 41sq km area of floodplain. Major floods used to regularly devastate the area, with four major events recorded over the last 100 years, including a 1964 flood that covered most of the floodplain and filled nearly all of Opotiki's 650 homes with muddy water. Another flood in 1965, kicked off by similar rainfall to last weekend's event, flooded parts of the residential area.

Since then, the network of stopbanks has offered "a greater degree of security" to the floodplain, Mr Tozer says. However the town will always be vulnerable, particularly when both rivers are in flood. "Luckily that was not the case this time. "

More than 170mm of rain fell on already soaked ground in the upper part of the catchment over 12 hours on Friday night. At its peak, early on Saturday morning, the Otara River clocked a flow of 730 cubic metres a second. It was a 30-year flood event, says Peter Blackwood, the council's manager technical services.

While the urban stopbanks have been upgraded to cope with 100-year flood levels, the district's extensive network of rural stopbanks provides different degrees of flood protection. Last weekend, floodwater overtopped several rural stopbanks with five-year flood protection and one with 20-year. Several farms flooded and roads were blocked by water.

Mr Blackwood says good grass cover on the rural stopbanks meant they did not get damaged by the overtopping.

Environment Bay of Plenty already plans to upgrade parts of the rural system this financial year and the flood will provide important corroborative information for this work, Mr Blackwood says. "We're not trying to block off all escape routes for the water. While we want to protect certain pieces of land, we must still let water escape somewhere. We must release the pressure before it gets to the coast – and the town."

CAPTION: As expected, the floodwater overtopped rural stopbanks with lower flood protection levels.

For further media information please call Peter Blackwood on 0800 368 288 ext 9512 or 07 308 9492 or Ana Cotter, communications officer, on 021 929 349. R/media releases/031006ac.doc

Working with our communities for a better environment

Figure 1.17 Example of an Environment BOP press release

1.14 Recommended Floodplain Management Practices

Based on international observations recommended good practices for floodplain management include:

- a preference towards non-structural measures particularly in those areas where structural solutions have not worked
- focus on land use and regulatory planning as the appropriate method of integrating structural and non-structural measures
- encouraging ongoing community awareness
- emergency management plans as a necessary component for responsible floodplain management

To date several regional, district and unitary authorities have prepared floodplain management strategies based on good practices as outlined in OPUS Consultants document titled "Floodplain Management Planning Guidelines" (OPUS, 2001). Environment Bay of Plenty contributed to these guidelines during the guidelines draft stage.

Since good practice places an emphasis on successful non-structural measures it is only logical to review current measures and supporting legislation.

Given the Whakatane –Waimana catchment's recent experience with flooding in July 1998 and July 2004 there may be lessons to be learnt which may require some non-structural measures and legislation to be updated or amended.

1.15 Conclusions

Review of current Whakatane Waimana floodplain management practices indicates flood protection mechanisms are well developed and have been effective to date. Environment Bay of Plenty are currently dealing with a number of the issues identified in Part 1 and the manner in which these are addressed is described in Part 2.

Key issues identified in Part 1 include the need to:

- confirm whether stakeholders in the rural sub-catchments namely Upper Whakatane and Waimana accept the current level of flood protection provided. Presently no stopbanks are provided in either of these sub-catchments.

- consider the effects of global warming when refurbishing or constructing flood protection assets. Environment Bay of Plenty requires that design of structures allows for intensification of storm flows during the structures life i.e. if a structure has a life of say 50 – 70 years then its design needs to allow for the impact of higher flows, flood levels and storm frequency estimated over that period.

- continue programmed reviews of stopbank capacity. Environment Bay of Plenty carries top ups stopbanks whenever service levels are not being met.

- continue programmed condition assessments of stopbanks and implement remedial works where necessary.

- Identify lessons learnt from July 1998 and July 2004 floods. Review performance of current non-structural measures and make changes where necessary.

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Part 2: Identifying the Flood Problem

2.1 Introduction

Part 2 summarises the results of extensive flood modelling carried out along the Lower and Whakatane Rivers and the Waimana River. Flood modelling compares river levels for various return period floods with current service level requirements. Flood modelling takes into account the effects of global warming and examines what future flood levels might be in the event of 200 year and 300 year flood event. The impact of several potential stopbank breaches is described. Identification of potential breach sites arose out of condition assessments and asset inspections carried out to date. Part 2 describes the actual social and economic impacts on people and property resulting from the July 1998 and July 2004 storm events.

Part 2 includes a financial model of potential flood damages which are compared with actual damage costs. Modelled potential flood damages can be used in Stage 2 to assist in the selection of flood mitigation options. Part 2 concludes with a summary of key issues identified in Parts 1 and 2 and an recommendations.

2.2 Flooding in the Lower Whakatane River

A MIKE 11 model was constructed of the Lower Whakatane sub-catchment in 2004 to evaluate flood levels and define flood hazard maps that result from stopbank overtopping or breaching (Wallace, 2004).

The downstream extent of this sub-catchment was the river mouth. The upstream extent was 3km upstream of the Valley Road recorder. It also included the western floodplain beyond the left bank stopbanks and the Whakatane township to the east of the stopbanks.

Flood levels were modelled in this sub-catchment for three large flood scenarios. They were the:

- 100 year flood event,
- 200 year flood event
- 300 year flood event

The 100 year flood was selected because this is the current design standard for urban stopbanks and floodwalls in this reach. The 200 and 300 year flood events were modelled because they are estimated to become the 100 year flood by years 2070 and 2080 respectively due to global warming (Refer section 1.8.2).

Water levels calculated for the flood scenarios relative to stopbank levels are shown in Figure 2.1. The flood extent due to the 100, 200 and 300 year floods are shown in Appendix 3 flood maps Figures A3.1 – A3.3 respectively.

Subject to confirmation of various assumptions made during modelling initial results indicate:

- Other than at the entrance of the Yacht Club (prior to remedial works being completed – see explanation below) no overtopping of urban stopbanks and floodwalls occur in the 100 year flood event.

- Minor overtopping of urban stopbanks occurs in the 200 year and 300 year flood event.

- The extent of overtopping under a 200 and 300 year flood event are similar because the river is wide, so the extra flow in the river does not cause a large significant increase in river level – and thus the overflows are not significantly different.

It should be noted that the low spot in the stopbank at the Yacht Club is to be to be filled in by Environment Bay of Plenty in 2006/07.

Two streams located within Lower Whakatane (that discharge into the Whakatane River) provide a certain degree of flood protection to neighbouring buildings. The Wairere Stream, located near the river mouth has floodwalls and these provide 100-year ARI protection. The Wainui Te Whara has stopbanks but the protection these provide, in some locations such as at Douglas Street, is less then the statutory 50 year flood level (Titchmarsh, 1983). Whakatane District Council are responsible for ensuring adequate flood protection is provided to residents living close to the stream. Whakatane District Council has set aside a sum of $60,000 in 2006/07 for investigations into the possibility of a constructing a detention dam in the Upper Catchment of Wainui Te Whara Stream. Funds have been included for a flood gauge at the lower end of Gorge Road.

Before any flood mitigation options to reduce the flood hazard are pursued assumptions for modelling must be confirmed. Assumptions made for the Lower Whakatane model include:

- Certainty that the river mouth ‘spit-fuse’ scours during large flood events thus reducing upstream flood levels

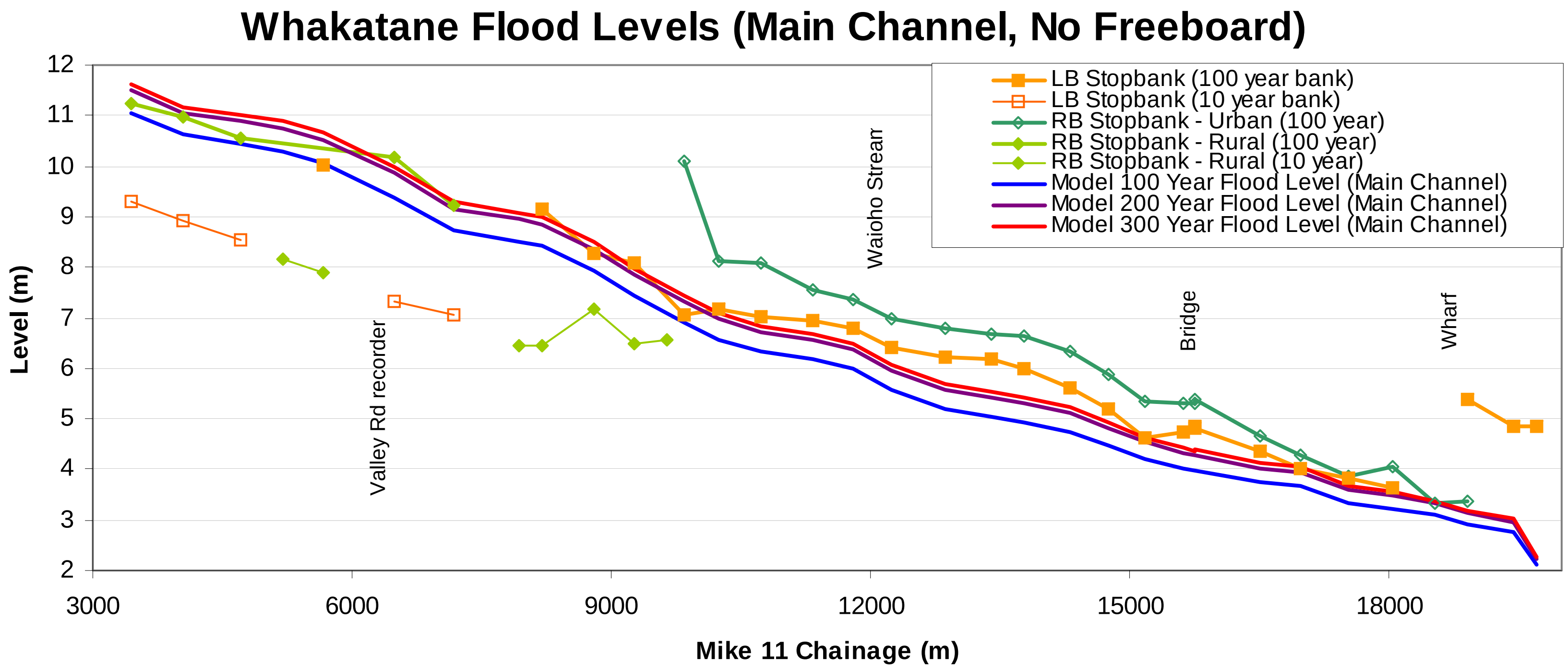

Figure 2.1 Flood levels in the Lower Whakatane River (from Wallace, 2004)

2.3 Flooding in the Upper Whakatane River

A MIKE 11 model was constructed of the Whakatane River upstream of Taneatua to evaluate flood levels and produce flood hazard maps for various storm event magnitudes between 5 and 200 year floods.

This model was not connected to the top end of the Lower Whakatane model owing to difficulties combining the two models as well as that of the Waimana model. The topography of the floodplain near the confluence area where the Upper Whakatane and Waimana feed into the Lower Whakatane is complex, hence the models are best dealt with separately at this stage.

While the model actually extends beyond this, the reach investigated in detail starts at the confluence of the Whakatane and Waimana Rivers at Taneatua, and includes the river and floodplain nearly up to where the formed road ends just South of Waikirikiri Marae.

Environment Bay of Plenty’s involvement with the river extends as far as managing erosion protection along the Waimana river margins and monitoring the movements of rock and gravel. There is little or no flood protection in the form of stopbanking beyond a stopbank on the true right bank directly below the Ohutu Bridge which provides some protection to several houses.

In particular flood levels for the 50, 100 and 200 year flood events are presented below for the following reasons: Firstly the flood levels for the 50-year flood event are what set’s the minimum Building Act floor levels. Secondly the 100-year flood levels are the stopbank levels Environment Bay of Plenty would normally set to protect urban residential buildings. Thirdly the 200 year flood event may become the 100-year flood event by 2070.

The flood extents for the 50, 100 and 200 year storm events are shown in Appendix 3, Figures A3.4 to A3.11. Only Figures A3.8 and A3.9 for the 100 year floods include a freeboard allowance of 500mm. The 100 year flood maps are currently being used to set minimum floor levels in the Upper Whakatane floodplain and the minimum Building Act freeboard allowance is 500mm. The floodmaps do not show the entire flood area due to limitations in the LIDAR ground level data. Nor do they indicate flood levels attributable to side streams, which in some cases exceed the levels shown.

Further, more detailed implications would be available with ground survey of road and floor levels, but comparisons with LIDAR ground level data indicate:

- Road access is disrupted in several places on Ruatoki Valley Road in events greater or larger then the 5 year flood event
- Extensive flooding of the farmland occurs during all flood magnitudes investigated
- The areas of clustered houses are well situated above estimated flood levels
- The Ohutu Bridge deck is higher than the flood level associated with the 200 year flood event

2.4 Flooding in the Waimana River

A MIKE 11 model was constructed of the Waimana sub-catchment in 2004 to evaluate flood levels and define flood hazard maps that result from the Waimana River flooding (Pak, 2005).

The downstream extent of this sub-catchment is located just upstream of the Waimana Gorge recorder site, at cross-section 10A. The upstream extent is about 1km upstream of Piripari marae, at cross-section 33. It includes the Parau and Matatere Streams. The Waimana River floodplain does not have any stopbanks. The flood extent due to the 50, 100 and 200 year storm events are shown in Appendix 3, Figures A3.12 – A3.19

Flood levels were modelled in this catchment for a range of floods ranging from 5 to 200 year flood events. In this report flood scenarios for 50, 100 and 200 year ARI storm events are outlined for similar reasons stated in section 2.3.

Only Figures A3.16 and A3.17 for the 100 year floods include a freeboard allowance of 500mm. The 100 year flood maps are currently being used to set minimum floor levels in the Waimana floodplain and the minimum Building Act freeboard allowance is 500mm.

Subject to confirmation of various assumptions made during modelling initial results indicate:

- Extensive flooding occurs across the Waimana floodplain particularly in the lower half downstream of the Parau Stream in events greater than the 5 year flood.
- Road access through the Waimana Gorge to the Waimana flood plain between Taneatua and Waimana township and is cut off thus isolating the floodplain community
- Road access through Nukuhou to the Waimana floodplain is potentially cut off
- Several buildings in the Waimana flood plain may be at risk from flooding. These include buildings in Addison Road, Ruddick Road, the township of Waimana, along SH2 (between Ruddick Road and Waimana Road) along Lowe Road, along the eastern boundary of Hodge Road and both sides of Matahi Valley Road.

Assumptions for the Waimana model include:

- Confirmation of 'fresh' water levels upstream and downstream of Waimana East and Waimana West Bridges respectively. This water level information will be used to calibrate the model and thus confirm the modelling results.

2.5 Lower Whakatane Stopbank Security

No stopbank is failsafe and some possibility of a breach does exist. Stopbank breaches might occur as a result of:

- Overtopping and subsequent scour of the stopbank's landward slope
- Seepage under or through the stopbank leading to piping or heave failures

- Erosion of the stopbank by the river
- Stopbank slope instability

To date no breach of the Whakatane urban stopbanks has occurred. This is reassuring since the July 2004 floods exceeded the 100 year flood event in the urban reaches. The estimated peak flow in this event was $2820m^3/s$ at the Valley Road recorder. However the rural low level stopbanks did overtop in July 2004. The rural banks provide protection against a 10 year flood event.

Despite no breaching occurring Environment Bay of Plenty continues to carry out regular condition assessment of Whakatane's urban stopbanks.

Maintenance and repairs to flood protection assets are completed based on the outcome of condition assessments, capacity assessments, geotechnical investigations, flood damage and programmed maintenance according to the asset management plan.

In June 2002 Everitt and Arts undertook a condition assessment of the stopbanks wherein several sections of stopbanks were identified as being at risk of breaching. Since that period several vulnerable sites have undergone further investigation and in some cases refurbishment to provide a satisfactory factor of safety against breaching and maintain service levels. In addition a risk assessment was carried out on each of the sites to determine the probability of breach failure under 100, 200 and 300 year flood event.

2.6 Lower Whakatane Stopbank Failure

A summary of the 14 potentially vulnerable sites identified, justification for modelling as a potential breach site and details of remedial works carried out as of June 2005 are outlined in Table 2.1

The location of potential breach sites is shown in Figures 2.2 and 2.3 and the extent of potential flooding in such an event is shown in Appendix 4, Figures A4.1 to A4.10 inclusive.

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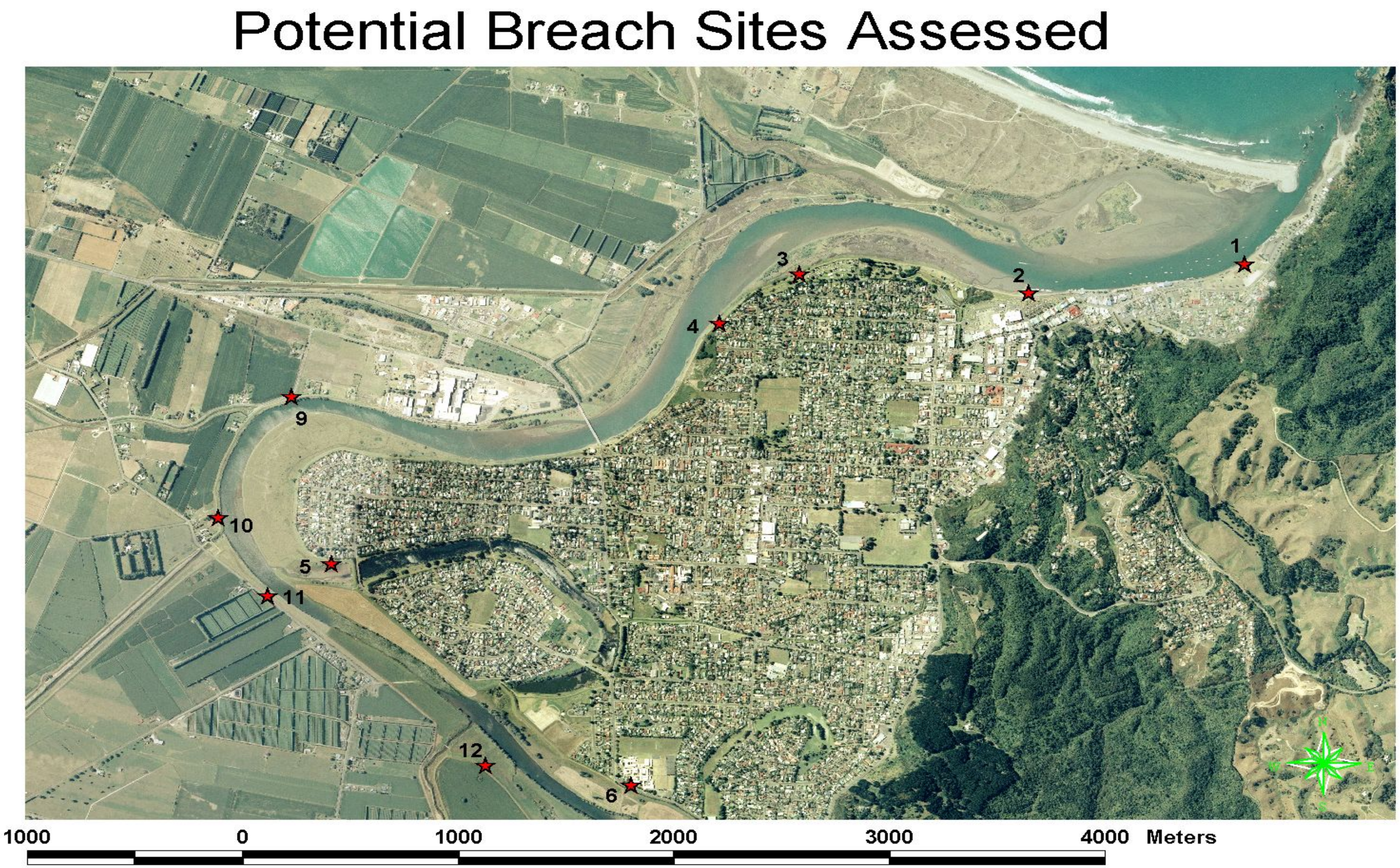


Figure 2.2 Potential urban stopbank breach sites in Lower Whakatane.

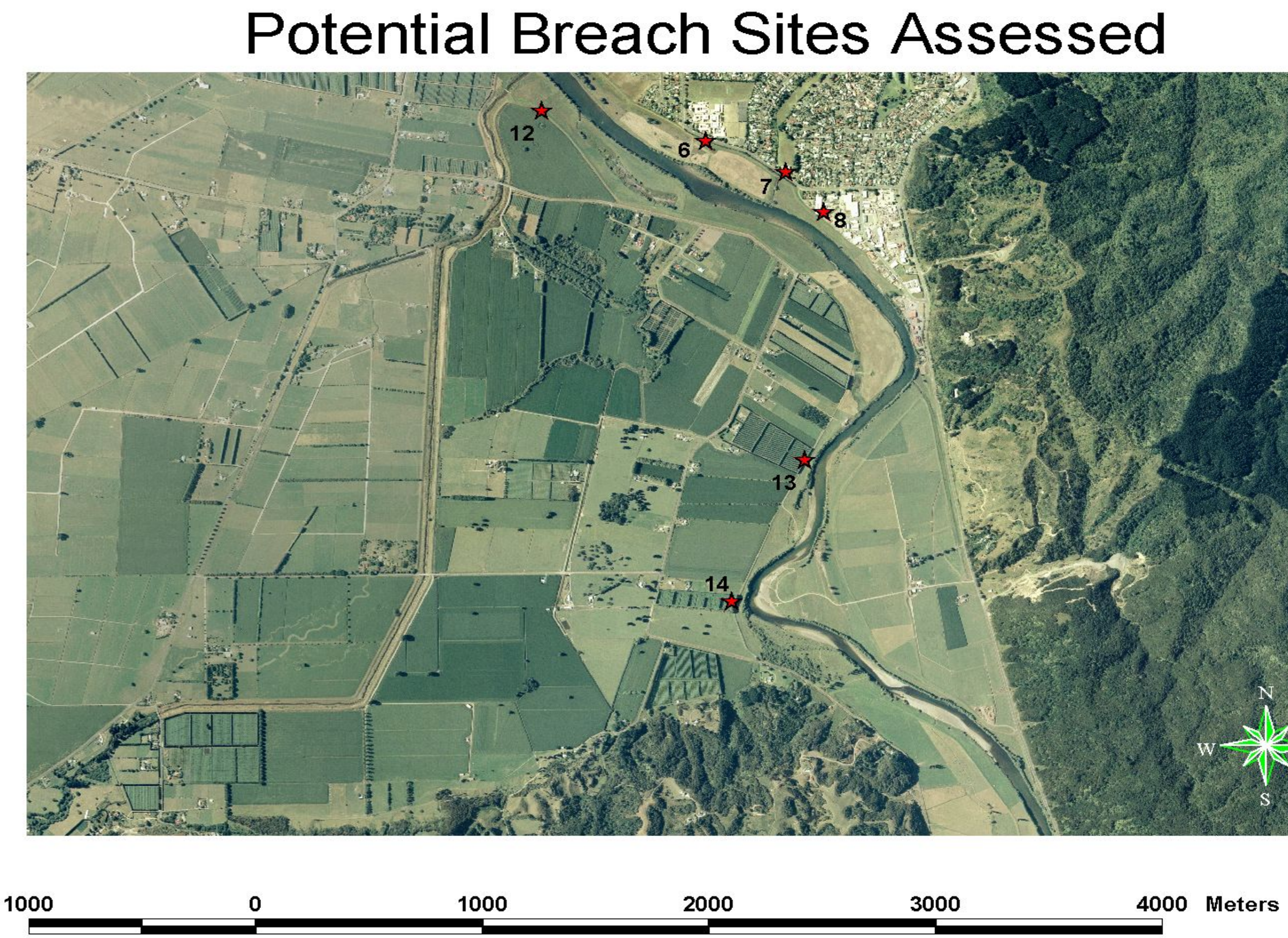


Figure 2.3 Potential urban stopbank breach sites in Lower Whakatane (continued)

Table 2.1 Summary of potential urban stopbank breach sites in Lower Whakatane River

No	Potential Breach Location	Closest Cross-Section /Mike 11 Chainage	Left or Right Bank	Breach Modelled (Yes/No)	Justification	Remedial works completed or anticipated since June 2002 condition assessment.
1	Mataatua Reserve		Right	No	Primary risk from overtopping to be addressed by building a stopbank providing 1%AEP protection with freeboard	Mataatua stopbanks were completed in 2005/06.
2	Yacht Club Marina		Right	No	Low spot along stopbank to be infilled	Work planned by Environment Bay of Plenty for 2006/07.
3	Rose Gardens to end of Eivers Road (including Barry Ave Pump Station)	3AR/16985	Right	Yes	*Considered high risk due to piping potential of stopbank material. Modelled as part of the Eivers Road Breach.	Remedial works completed July 2005. Work comprised installation of a filter and drainage layer in the stopbank behind pump station.
4	End of Eivers Road to Amber Grove (including Tunui Place)		Right	No	*Considered 'moderate to high' risk of piping failure[6]. ^However subsequent hydraulic modelling indicates freeboard is higher then previously thought.	The river berm that eroded in July 2004 has been repaired and additional riprap placed along the river edge. Piping risk needs to be reviewed given the additional riprap protection and higher freeboard
5	Riverside Drive (near Rata Street)	71AR/13410	Right	Yes	*Seepage area has been observed in rainfall events. +Considered to have a relatively low factor of safety against piping.	No works planned to date
6	Trident (Trident High School)	11R/11325	Right	Yes	+Considered one of the two most upstream breaches and possibly longest flowpath through Whakatane township.	No works planned to date

[6] Note the original geotechnical assessment was made at a residential property located to the south of Eivers Road, close to Tunui Place.

No	Potential Breach Location	Closest Cross-Section /Mike 11 Chainage	Left or Right Bank	Breach Modelled (Yes/No)	Justification	Remedial works completed or anticipated since June 2002 condition assessment.
7	Red Conway Park	12R	Right	Yes	*Seepage observed at stopbank toe in 1998 was a greater response then predicted by groundwater model. Considered 'moderate to high' risk of failure due to instability of riverside slope.	Remedial works completed July 2005. Work comprised flattening riverside slope and improving drainage.
8	Te Tahi (near Poto Street)	13R/10235	Right	Yes	+Considered one of the two most upstream breaches and possibly longest flowpath through Whakatane township. However no issues have been identified at this site to date.	No works planned to date
9	Tahere Road (Tahere Road, carter Holt Harvey to Te Rahu Canal)	6A/14305	Left Note: No geotechnical analysis has been undertaken for left bank sites.	Yes	#Seepage observed in 1998. ^The river berm in this area is very narrow and is also on the outside of a bend (increasing velocities and hence erosion risk). Erosion occurred in July 2004.	Seepage resulted from two damaged culverts on the riverside. These have since been repaired and maintenance added to the asset management plan. Riprap placed along riverbank after July 2004 thus reducing severity of berm erosion. Investigate failure modes and update risk accordingly.
10	Fortune (upstream of Fortunes Canal)	7L/13770	Left	Yes	#Seepage observed in 1998.	Major edge erosion repairs were carried out on the river bank extending from Te Rahu Floodgates down to Patuwai Road following the July 2004 floods. Investigate failure modes and update risk accordingly.
11	Selwyn (upstream of Te Rahu Canal)	71AL	Left	Yes	#Seepage observed in 1998	No works planned to date. Investigate failure modes and update risk accordingly.

No	Potential Breach Location	Closest Cross-Section /Mike 11 Chainage	Left or Right Bank	Breach Modelled (Yes/No)	Justification	Remedial works completed or anticipated since June 2002 condition assessment.
12	Carter Holt Harvey Intake to Rewatu Road		Left	No	#Seepage observed in 1998 however the probability of a breach at this site is considered to be low.	No works planned to date. Investigate failure modes and update risk accordingly.
13	Rewatu (upstream of Waioho Canal, Poroporo)	10BL/11800	Left	Yes	Stopbank overflowed in 1964 (Refer section 2.1.2.g).	No works planned to date.
14	Rewatu Road (start of floodplain proper)	17L/8195	Left	Yes	This site is where the river first emerges onto the Lower Whakatane left bank floodplain. It is on the outside of a sharp meander.	No works planned to date. Investigate failure modes and update risk accordingly.

Note:* Refers Riley Consultants Draft Geotechnical Study Report No. 2, October 2002. # Refers Environment Bay of Plenty's draft Whakatane River Stopbanks Condition Evaluation Report, July 2002. + Refers Environment Bay of Plenty assessment. ^ Refers Wallace Hydraulic Modelling report, 2004

For a full analysis of the Whakatane flood hazard, some assessment of the likelihood of stopbank breaches must be made. Environment Bay of Plenty carried out a risk assessment of the likelihood of stopbank breaches for the 14 sites previously identified above as being vulnerable (Wallace, 2005).

Risk assessment for stopbank breach in the event of a 100, 200 and 300-year flood event was carried out taking into account:

- Environment Bay of Plenty's June 2002 condition assessment of the urban Whakatane stopbanks
- Subsequent geotechnical investigations namely Riley Consultants report (2002) at four of the potential breach sites
- Flood levels, velocities and available freeboard from hydraulic modelling done by Wallace (2004)
- Stopbank performance information obtained from the July 2004 floods
- Remedial works carried out on stopbanks and berm areas between June 2002 and July 2005
- The assumption that the spit at the river mouth has burst in an event greater or equal to a 1%AEP flood event.

After calculating breach probabilities of each of the individual 14 sites an overall probability was assessed whereby a *single breach occurred at any one of the 14 sites or a dual breach occurred at two of the three most likely breach sites.* Probability calculations were split between left (rural) and right stopbanks. Based on probability calculations Tunui Place, Riverside Drive and Tahere Road were considered the most likely breach sites.

Further geotechnical investigation of potential failure modes is recommended at the following sites: Eivers to Amber Grove (including Tunui Place), Tahere Road, Fortunes, Selwyn, Carter Holt Harvey Intake and Rewatu 2. Risk will then be re-assessed for once investigations are complete.

Risk assessment results anticipated after remedial works described in Table 2.1 are complete are shown in Table 2.2

Overall Table 2.2 indicates that Environment Bay of Plenty estimates that there is a 17% probability of there being at least one breach somewhere along the Whakatane left (rural, below cross-section 17L) stopbanks and 11% probability of there being a breach somewhere along the right (urban) stopbanks in a 100 year flood event following remedial works. The corresponding chances of breaching in 200 year and 300-year events are also given in Table 2.2.

Table 2.2 Estimated Probability of urban Whakatane stopbanks breaching in large flood events

Flood Scenario	Probability of stopbank breach after remedial works (as of July 2005) are complete (split between left and right stopbanks)	
	Left Bank - Rural	Right Bank - Urban
100 year flood event	17 %	11%
200 year flood event	24 %	17%
300 year flood event	30 %	23%

2.7 The Flood Hazard

The flood hazard is the potential for damage to property or people due to flooding and associated erosion due to say, stopbank and floodwall overtopping or stopbank breaching. Environment Bay of Plenty has a very good database of information regarding the magnitude of historical floods, the most recent notable event being the July 2004 flood. Local councils and utilities record the impact of floods such as the extent of urban flooding and disruption to services.

In July 1998 and July 2004 regional and territorial councils, the community and utility providers got some indication of the risks associated with severe flooding. Descriptions of the impact the July floods (both 1998 and 2004) had on the region are documented below.

2.7.1 Community at Risk

No lives were lost as a direct result of the July 1998 floods. In general the Waimana community suffered the most. Whakatane urban communities needed to deal with surface flooding and a short period of isolation due to flooding. Road closures isolated Whakatane and Opotiki. Road closures included State Highway 2 in the Waimana Gorge, Nukuhou North and Wainui Road.

Fortunately no lives were lost in the Whakatane – Waimana catchment during the July 2004 floods.

Flooding resulted in the evacuation of areas around Mataatua, Awatapu (whole suburb), the area around Trident High School Ruatoki and Waimana. The flooded Mataatua streets included Muriwai Drive and Waiewe St. The flooded areas included: around Trident included Arawa Road, Churchill St, Bridge St and Kirk St (Whakatane District Council Media Briefing 21/7/04).

The worst hit area within the catchment was the suburb of Awatapu. When flood pumps located in the Awatapu Drive recreational reserve failed the natural basin become a reservoir flooding most of the suburb at the same time. Several road closures isolated Whakatane as they did in the July 1998 floods. Road closures resulted from landslide material covering the road. The most notable landslides occurred along State Highway 2 between Whakatane and Te Puke. The region experienced earthquakes at the same time, which triggered some landslides. On some occasions the only access road into Whakatane was from Rotorua.

2.7.2 Built Assets at Risk

Public and private utilities are impacted by large flood events in the Whakatane. In general:

- Flood protection assets including stopbanks, edge protections, buffer land, floodgates and pump stations may be damaged due to high scouring flows and water levels.

- Rural dwellings and farm facilities might be flood damaged at locations where stopbanks breach or overtop.

- Commercial, industrial and private buildings might be flood damaged where stopbanks breach or overtop

(a) Flood Protection Assets

The 1998 and 2004 July floods caused significant damage to Environment Bay of Plenty's infrastructural assets.

The extent of damage outlined in Table 2.3 is described in terms of the nature of the repair work carried out.

Table 2.3 Description of repair works to flood protection assets in 1998 and 2004.

River	July 1998	July 2004*
Waimana	N/A	1.5km of rock placement
	9.8km of vegetation protection replanted	280m of vegetation protection replanted
	1.8km of river channel widened	Channel widening required in Raroa Stream and Waimana fairway
	12km of fence repairs	Nil
Whakatane	1.3km of rock placement	3.6km of rock protection (lining & groynes)
	9.7km of vegetation protection planted	1.23km of vegetation protection planted
	16km of fence repairs	Data not available but some fence repairs anticipated.
	Numerous cleanouts of drains, some channel widening & stopbank realignment, replacement planting and installation of timber groynes.	Various sites desilted, removal of spoil from berms and some channel widening

* Source: Draft Whakatane Waimana Rivers Asset Management Plan, April 2006

(b) Rural Dwellings and Farm Facilities

In July 1998 approximately 40 farms were seriously affected by flooding (deposition of debris and/or loss of land by erosion). During the floods some 1400 cows were transported outside the affected area so that they could continue to be fed and stay in production (Whakatane District Council, 1998).

After the first flood much time and finance was poured into repairing the damage. Unfortunately a lot of work needed to be repeated following the second July 1998 flood. Many hundreds of hectares of pasture needed re-sowing, fences needed repairing, livestock water supplies restored and farm equipment replaced.

During the first flood farmers were given early warning of increased river levels but it appeared the quick rise in rivers meant some farmers were unable to shift stock to higher ground. In the first flood some 78 cows were swept away (Beacon, 7/7/1998).

In the second July 1998 flood all Eastern Bay catchments flooded but the Waimana incurred the most damage compared to other parts of the catchment. This was because the river changed course and dumped debris onto adjacent farmland. Farmers reported that even though the river did not rise, as quickly as in the first flood the resulting land damage was worse.

Shingle, silt and debris settled on the Waimana Flats and reclaimed farmland upstream of the village (Beacon, 14/7/98).

In July 2004 a total of 75 dairy farms were badly affected (Whakatane District Council Release, 22/7/04). Several unfortunate circumstances were evident at the time of the floods. Firstly, since the autumn of 2004 was dry and pasture cover depleted farmers were forced to feed extra supplements during the early winter (May/June) leaving farmers short of supplements at about the time of the flood. Secondly, farmers who took on stock for short term grazing from their flood-affected neighbours reduced their own grass and supplement levels. (Beacon, 14/9/04)

(c) Buildings

In July 1998 flood damage to dwellings from inundations, silt intrusion in or underneath and sewerage flooding around dwellings, occurred in about 60 locations (Whakatane District Council, 1998).

In the first July 1998 flood Whakatane Township appeared not to suffer the same extent of building damage, as did the Waimana urban area where six houses flooded (Beacon, 7/7/98, pg 3).

During the second July 1998 flood some small water seepages and leaks occurred in Whakatane in James Street and Henderson Street. Jim Findlay, from Whakatane District Council reported:

The main issues in town were seepages from the (Whakatane) river and the Awatapu Lagoon, which had been filled with floodwaters from the Wainui Te Whara Stream and had never been higher (Beacon, 14/7/98, pg 3).

In July 2004 floodwaters damaged dwellings in Whakatane especially in the suburb of Awatapu and along Muriwai Drive. Muriwai Drive flooded because floodwall construction (which was in progress at the time) was incomplete. Awatapu was the worst hit of the flooded areas because the District Council sub-catchment drainage pump broke down.

On the 6 August 2004 the Eastern Bay of Plenty Disaster Recovery Office (EBOPRO) reported:

- 297 homes inspected for flood damage. All these houses could be repaired but over a third did not have house contents insurance. Most of these houses were located in Awatapu suburb and Muriwai Drive.

- 3162 people evacuated from their homes in the wider Whakatane District and many of these people were from Awatapu. Just over one third of these people were registered at the Whakatane War Memorial

Data source: (Recovery Report #8, 6/8/04)

2.7.3 Utility Vulnerability

To provide an example of how vulnerable utilities are in the event of severe flooding a brief description of damage incurred in the catchment during the 1998 and 2004 July floods follows.

(a) Roading and Bridges

During the July 1998 floods widespread damage occurred to rural properties and roading throughout the Whakatane District. The worst areas hit were Taneatua, Waimana and Matahi Valley. However properties and roads in Wainui were also adversely affected. Roads owned and managed by Whakatane District Council that suffered damage included Matahi Special Purpose Road, Waimana Roads and Whakatane/Taneatua Road (including Stanley Road) (Whakatane District Council, 1998).

Two thousand cubic metres of fill material placed in a hole created in Waimana Road after the first flood was washed out in the second flood. Although Ruatoki was not too badly affected slips did occur on Stanley Road (Beacon, 14/7/98, pg 3).

In July 2004 flooding and slips affected some 600km of Whakatane District roads including 16 local roads. In Whakatane, Ohope and Wainui area about 150 slips damaged roads, in Waimana and Matai Valley there were about 70 slips (Recovery Report #8, 6/8/04).

State Highway 2 at Waimana Gorge was closed for a period of time.

Three helicopter flights were made into isolated rural communities between Te Whati and Ruatahuna where road access was not available for a couple of weeks. The Okahu/Ngaputahi community of 20 people including six children and 3-4 tourists were delivered food supplies. Basic supplies were also delivered to the Heipipi/Papereru community of about 20 people and to a further 27 people (including 15 children) at Owhakatoro (Ruatoki) (Whakatane District Council release 21/7/04).

(b) Aerodrome

Whakatane Airport was not damaged during any of the two major July floods.

(c) Sewerage Network

In July 1998 the Whakatane township sewer rising main, which discharges approximately 65% of the town’s sewerage to the treatment plant, was damaged at the Whakatane river crossing. In addition septic tank systems were rendered unusable in the rural areas of Taneatua, Waimana and Matahi Valley. As a result sewerage spillage occurred which further contaminated private property when spread by floodwaters. The level control equipment in the Bridge/Hinemoa Sewer pump station required repair. Some electrical controls and step screen at Whakatane Oxidation Ponds required repair (Whakatane District Council, 1998).

No sewerage removal was possible for a number of schools during the July floods. Schools included Allandale School, Trident High School, Kohanga Reo (Arawa Rd), Mananui Kindergarten, Waiariki Polytech (Cutler Crescent), St Josephs (Whakatane) (Whakatane District Council MB 19/7/04)

(d) Stormwater Network

Stormwater flooding occurred in Whakatane and Waimana townships during the July 1998 flood. As a result of stormwater flooding and slips communities were cut off throughout the district. During the storms the Riverside Drive stopbank stormwater pump was damaged and required repair (Whakatane District Council, 1998).

During both July 1998 floods floodgates were vulnerable to jamming open resulting in backflow and flooding in Whakatane town. For example in the first flood Quay St was flooded because of a jammed floodgate (Beacon, 7/7/98, pg 3).

In July 2004 several urban areas in Whakatane flooded when the catchment inflows exceeded the existing stormwater network capacity. The most dramatic flooding occurred in Awatapu. Some damage occurred when flapgated culverts backflowed up road catch pits (Environment Bay of Plenty file note 2320 04 12 by RJB 21/7/04).

On Friday, 16 July 2004 the main Awatapu lagoon flapgates on culvert W31 (2 x 12,200 mm dia pipes) were closed manually in order to prevent rising levels in the Whakatane River backflowing into Awatapu Lagoon. With no alternative outlet available water levels rose in the lagoon and in the early hours of Sunday 18th July water overflowed the internal eastern stopbanks at the end of Edgewater Grove. Floodwaters flowed south along Edgewater Grove and then into Awatapu Drive. Since the Awatapu Drive pump station was not working floodwater began to pond in the Recreational Reserve eventually resulting in the flooding of the suburb as a whole. A major source of floodwater inflow into the lagoon was from Wainui Te Whara Stream and to a lesser extent the flow from Eve Rimmer Park and possibly any feedback along the pump rising main from the river. Floodwaters in Awatapu reduced when a cut was made in the internal stopbanks at the Thompson Drive Recreational reserve on Tuesday, 20 July. Water could then flow from the flooded residential area back into the lagoon. The cut was made after the Whakatane River level began to decrease and the main outlet gates (W31) opened.

There were several reported instances when flapgated culverts backflowed up through roadside grated inlets and popped manholes.

Backflow occurred through two roadside grated inlets on Arawa Rd from culvert W45. This water flowed north towards the roundabout at Bridge St/Awatapu Drive and probably then filled the depression, including the netball courts at Eve Rimmer Park, behind the Polytech. Sandbags were placed across Arawa Rd in order to protect private property from further flooding. Similar observations were made in Pouwhare Street where backflow from a grated sump flooded the corner of Pouwhare and Hikurangi Street. Several stormwater manhole lids also popped along Kakaharoa Drive (upstream of the Information Center). Fortunately discharges in the latter instance were less destructive.

(e) Water Supply

Public water supplies for Taneatua, Ruatoki and Whakatane were disrupted in July 1998. For example Taneatua had no water supply for four days and a temporary supply for 60 days. Whakatane had restricted use for 15 days. The Taneatua water treatment plant transformer and chlorinator booster pump required replacement. Water level indicators and wastewater discharge outfall required replacement at Valley Road water treatment plant. In the rural areas of Taneatua, Waimana and Matahi Valley private water supplies were rendered unusable (Whakatane District Council, 1998).

During the peak of the July 2004 flood water conservation was necessary since demand exceeded supply. (Whakatane District Council MB 19/7/04). Ruatoki and Awakeri needed tanker water when the reticulated supply was cut off.

(f) Electricity

In July 1998 minor damage to power lines occurred. However in July 2004 the damage was far greater. Many power poles were swept away by floods and slips (Ian Robinson, Horizons, 21/9/04).

(g) Gas

Minor erosion to Waimana riverbanks caused damage to a gas pipeline in July 1998. No damage to gas reticulation in the catchment was reported in July 2004.

(h) Telecommunications

No obvious damage to telecommunications network occurred in July 1998. In July 2004 telecommunication was cut off to Waimana (Whakatane District Council MB 19/7/04).

2.7.4 Flood Damage Costs

The Eastern Bay of Plenty Disaster Recovery Office estimated that the July 2004 floods would end up costing the eastern bay region which includes the Whakatane Waimana catchment more than $100M. This estimate included $50M for agricultural losses, $10M for roads and $10M in damage to river scheme assets. It did not include loses that were covered by insurance (Beacon, 11/8/04).

Flood damage costs can be calculated for the following:

- Loss of productive land (temporary loss due to silt coverage and permanent loss due to river bank erosion)
- Damage to infrastructure and utilities
- Damage to urban property

(a) Loss of Productive Land

The number of farms seriously affected by the July 1998 floods by way of debris deposition and/or removal of land by subsidence was 40. Whakatane District Council assessed the severity of flood damage to productive land in terms of reinstatement costs as of August 1998. Results are given in Table 2.4.

Table 2.4 Reinstatement costs of productive land in the catchment that flooded in July 1998 (Source: Whakatane District Council).

Silt Deposits	Area (ha)	Reinstatement Cost per hectare* ($/ha)	Reinstatement Cost ($)
Lost land (to river)	20	N/A	N/A
Severe (Silt > 150mm)	410	1,500	615,000
Moderate (Silt 50 – 150mm)	540	850	459,000
Light (Silt < 50mm)	680	300	204,000
Totals	1,650		1,278,000

*these are August 1998 rates

In addition to the reinstatement costs the loss of income for the period July to December 1998 was estimated to be in the order of $1,000,000 plus $500,000 if only half the farms returned to full productivity by July 1999.

Table 2.5 shows the reinstatement cost for productive land in the Whakatane Waimana catchment following the July 2004. These figures were provided by MAF in September 2004. Costs exclude re-establishing buildings, cowsheds, lost supplements, long-term production losses and continuing costs after the first year of the July 2004 floods. Most of the catchment was affected by excess water with slips and erosion affecting production on unsilted land.

Table 2.5 Reinstatement costs of productive land that flooded in July 2004 (Source: Pat Gillgareth, MAF, September 2004).

Silt Deposits	Area (ha)	Reinstatement Cost per hectare* $/ha)	Reinstatement Cost ($)
Lost land (to river)	40	N/A	N/A
Severe (Silt > 150mm)	500	2,500+	1,250,000
Moderate (Silt 50 – 150mm)	900	1,500	1,350,000
Light (Silt < 50mm)	340	500	170,000
Totals	1,780 ha		$2,770,000

* these are July 2004 rates

MAF's assessment of the catchment areas inundated by floodwaters during July 2004 were:

- Waimana/Nukuhou North 700Ha
- Taneatua 1100Ha

Flooding in Waimana/Nukuhou was lighter then in July 1998 but was more severe in Taneatua.

In September 2004 MAF estimated production losses at 500 – 600,000 kg milk solids. At a rate of $3.80/kg this is equivalent to $1.9 - $2.3M in lost production. Hence the overall damage costs to productive land was estimated in September 2004 to range between $4.67M - $5.07M.

(b) Damage to Infrastructure and Utilities

The cost of flood damage to infrastructure and utilities in the Whakatane and Waimana catchments for July 1998 and July 2004 floods is summarised in Table 2.6. More comprehensive descriptions of damage for each service are provided in Appendix 2. Costs of damage are taken from Environment Bay of Plenty and Whakatane District Council files and correspondence from various utility providers as indicated.

Table 2.6 Estimated repair costs of infrastructure and utilities damaged in July 1998 and July 2004 (Source: Environment Bay of Plenty, Whakatane District Council and others as indicated)

Infrastructure and Utility	Brief Description	1998 Estimated Cost* ($)	2004 Estimated Cost ($)
Roading and Bridges	Repair of road surfaces, slips etc	900, 000	6,538,000[α]
Sewerage	Repair of rising main, sewerage plant equipment, clean up and sterilisation.	561,000	2,147,300[#]
Water Supply	Repair outfall structure, riser main plus additional loading at treatment plant.	210,165	(Included in Sewerage Cost above)
Stormwater	Sandbagging and flood pumping	24,700	(Included in Sewerage Cost above)
Flood Protection	Repair of flood protection assets, flood monitoring & emergency response and contract work.	1,470,500**	4,699,900[##]
Electricity	Straighten two power poles and repair 11kV power line (Source: Ian Robinson, Horizons, 19/2/04) Replace several power poles and lines, which were swept away in floods and slips. Use of generators, some switchgear blown.	4,500	300,000[+]
Gas	Repair of bank erosion on the Waimana River affecting gas network. Environment Bay of Plenty shared repair costs with Natural gas Corporation (Source: Kaye Mathews, NGC, email 20/2/04) The gas assets in these catchments were not damaged during July 2004.	30,000	Nil
Telecommunications	No obvious damage to network in July 1998. [Ψ]In July 2004 washouts undermined telephone poles, washed and water entered telecom cabinets. Landline communications to Waimana and 025 and 027 mobile	Costs not available.	Costs not available.

Infrastructure and Utility	Brief Description	1998 Estimated Cost* ($)	2004 Estimated Cost ($)
	communications near Ohiwa were interrupted. 3km of cable needed replacement and 500 telecom customers experienced disruption to their phone services.		
	Total Estimate of Damage Costs	$2,300,865	$13,952,200

* these are August 1998 costs.

** from Environment Bay of Plenty memo dated 15 January 2002.

From Recovery Report No. 11 (3/9/04) cost also includes repairs to port assets.

From Environment Bay of Plenty (B Crabbe, 2006). Estimate includes response and recovery costs.

\+ From Horizons I Robinson (21/9/04).

α From Whakatane District Council report, Table 1 (R Siebring)

Ψ From Telecom (D May, 21/12/04)

(c) Damage to Urban Property

In July 1998 flood damage to dwellings comprised inundations, silt intrusion in or underneath and sewerage flooding around dwellings in about 60 locations. Clean up activities were carried out by Whakatane District Council employees and contractors at some locations. Restoration of affected buildings on private property have been the responsibility of the owners either by way of private insurance cover or by private means (Whakatane District Council, 1998).

As at 3 September 2004, in the Whakatane District, district inspectors inspected 371 homes for flood and landslip damage. Fortunately no houses were condemned. The inspectors found that 107 of these homes did not have house contents insurance (Eastern BOPRO Report #11, 3/9/04).

In the suburb of Awatapu some people lost everything and because many were uninsured (approximately a third) and generally fell into a lower-socio economic bracket had less of a chance of recovering rapidly. The NZ Herald commented:

"Times are tough for these families. Many tears have been shed, especially by those who have no insurance and no way of getting back on their feet. Some families have lost everything. Many will struggle to recover…The worst-hit families have been those occupying Housing Corporation rental homes. What little they have is ruined. Most are on benefits and still owe money on household items lost in the deluge (NZ Herald, 22/7/04)."

2.7.5 Social Impact

In the event of major flooding much of the focus is on the tangible losses such as loss of assets, property, infrastructure and business. Of less focus are the intangible damages, which include the social and psychological impacts that result from community disruption during and after the major flood. Intangible losses may effect people when:

- Flooded residential areas have resulted in the emergency evacuation of people to safe and dry shelter

- Essential services such as potable water supplies and waste disposal services are cut-off thus increasing health risk
- Personal possessions are lost which may result in emotional trauma.

(a) Emergency Evacuations

At the peak of the July 2004 floods several thousand people were evacuated from their homes and relocated in temporary accommodation. In the Whakatane – Waimana catchment people registered as evacuees at the following centres:

- Whakatane War Memorial 1234
- Wairaka Marae, 30
- House of Hope, 328
- Rangitihi Marae, 74

(Source: Eastern BOPRO, Recovery Report#10, 20/8/04)

By the 3 September 2004 it was estimated that around 610 people were still unable to return home in the Whakatane District (Eastern BOPRO, Recovery Report#11, 3/9/04)

(b) Health Risks

Several communities were cut off from reticulated potable water supplies during the floods. Most of these communities were isolated rural areas like Ruatoki. Although potable water supplies were restored within days (by means of water tankers or reticulated supply) a few communities still needed to boil their water for some time after the floods. No serious illnesses due to the failing potable water supply were reported as a result of the floods.

Repairs made to the sewerage reticulation network after the July 1998 floods appeared to have held up during the July 2004 floods with no major damage being reported to these assets. The most serious sewerage problem encountered in July 2004 was that of removing sewerage from several schools and tertiary institutions. No serious illnesses due to the sewerage removal were reported as a result of the floods.

There were isolated communities in Ruatahuna, which had to have food supplies airlifted in.

(c) Medical Services

Very little was reported at the time of the July 1998 floods or subsequent to it of any medical emergencies that arose as a direct result of the floods. Some children at Waimana were reported sick but were treated adequately.

In July 2004 medical supplies were delivered to people trapped in the Ruatahuna area and three people were airlifted out. The Ambulance service reported increased call-outs, some of which was related to stress as people returned to their homes (Whakatane District Council Release 21/8/04).

(d) Emotional Trauma

The psychological impact of the July 2004 flood was better recorded then the July 1998 floods. After the July 2004 flood there was great demand for support services such as Victim Support, Women's Refuge and Social Workers. Whakatane District Council even arranged to engage a psychologist to assist its ratepayer's work through their loss (Eastern BOPRO, Recovery Report#11, 3/9/04). In late September 2004 Dr Rob Gordon, the clinical psychologist involved in the 2004 Manawatu-Wanganui floods, facilitated a series of workshops on stress in the community.

The responsibility for coordinating counselling requests was passed from the Eastern BOPRO to Victim Support on 3rd September 2004 after the office was disestablished. Victim Support indicated that due to the demand they had to refer people out of the area to connect with counsellors although it was hoped that counsellors might come into the region. Victim Support employed four field workers to work directly with groups and affected areas throughout the wider Eastern Bay of Plenty region. Stresses in the community also manifest itself in an increase in family violence following the floods. The Police indicated that family violence rose in late August 2004 with nine instances reported. There was an increase in self-referrals to Women's Refuge, which put substantial pressure on the service and caused them to seek additional accommodation.

Schools faced considerable challenges to meet the extra social, physical, psychological and educational needs of pupils who were evacuated and/or are in temporary accommodation. The Ministry of Education and Child, Youth and Family therefore prepared a proposal for an emergency Social Worker in Schools (SWIS) in the Eastern Bay of Plenty.

2.7.6 Community Resilience

Recent flood events have impacted and will continue to impact the Whakatane – Waimana community and their ability to pay for future flood protection. The community's ability to pay for flood protection is limited owing to the high level of socio-economic deprivation in the district and anticipated population trends. Offsetting these observations however is the community's positive community spirit that has shown historically that it can rise above natural disasters and will no doubt continue to do so in the future.

(a) Socio-Economic Deprivation

The Index of Deprivation, NZDep01 is an integration of nine variables from the 2001 census, reflecting eight dimensions of deprivation. Variables include income, employment, telephone access, qualifications and home ownership. The following facts help to provide a picture of the community's limited ability to fund future flood protection.

- Of the 16 regions in New Zealand, the regions that have relatively more areas of deprivation include Northland, Gisborne and the Bay of Plenty.
- 40% of the Bay of Plenty population are in the more deprived deciles (8-10) compared with New Zealand as a whole (30%).
- The Eastern Bay of Plenty has higher proportions of its population in the more deprived deciles (8-10) than other parts of the region.

- Whakatane District has 25% of its population in the most deprived decile (10).

(i) Employment

The Eastern Bay of Plenty has a high level of unemployment, particularly in the areas that have been most severely impacted on by the floods. According to the 2001 census 8% of Whakatane District were unemployed compared with 6% for the region and a national average of 5%. Since 2001 unemployment has dropped to 3.9% for the Bay of Plenty and to 3.8% for New Zealand as a whole (September 2006).

(ii) Income

Family incomes in the Eastern Bay of Plenty are low compared to New Zealand as a whole. In Whakatane 32% of families have a combined income below $30,001, which compares to a national average of 27%. When combined with the low levels of insurance in the affected community of Awatapu, these incomes are likely to hinder the ability of the wider catchment to meet the costs of increased rates to fund infrastructure restoration works.

(iii) Qualifications

Whakatane has a high percentage of youth between the ages of zero and 24 years at 39%. This figure compares with the national average of 36%.

61.8% of Whakatane schools are classified as decile 3 or lower when, by definition, only 30% of New Zealand schools have these rankings. Furthermore 24% of people aged 15 years or over in Whakatane District have post-school qualifications, which compares with 27.7% for New Zealand as a whole.

(iv) Telecommunications

In 2001 92% of New Zealand households had access to a telephone and 36% had access to the internet. The Eastern Bay of Plenty, being thinly populated and relatively remote with a largely poor population, had proportionately fewer households with telephone access and or internet access. 86% of households in Whakatane District has a working telephone in their household while 27% had access to the internet.

(v) Industry – Primary Production

The community's resilience was impacted by the July 2004 floods because it reduced the primary industry's productivity and hence financial capacity to help pay for flood recovery and protection.

At the time of the 2001 census primary industry (agriculture, forestry and fishing) accounted for 17.6% of full-time equivalent employment in the Eastern Bay of Plenty. The primary industry's contribution to the local economy (Gross Domestic Product) was an average of nearly 17% over the five years to March 2003.

Each year MAF carries out an economic appraisal of rural regions throughout New Zealand and the Whakatane catchment is assessed as part of the Waikato/Bay of Plenty region (MAF, 2006). In 2005/06 MAF's assessment of dairy farms showed:

- an increase in income (due largely to increased milk solids production) *but* continuing cost rises
- an overall financial loss, a continuation of recent years
- ongoing financial loss in 2006/07 indicating the difficulty for the average farm to operate profitably on a $4.05 payout

Similarly for dry stock farms MAF analysis show:

- steady farm productivity *but* produce prices fell between 15 and 25%
- net trading profit fell by 25%
- continued increases in production costs
- capital purchase have halved

According to Mark McIntosh, AgFirst's Whakatane based agricultural consultant, the current ability of farmers to cover significant capital costs is limited by their constrained cash flows. Although dairy farmers are able to borrow based on their high levels of equity with low payouts the constraint then becomes their ability to service the debt in their cash flows (especially given the high interest rates) (McIntosh, 2006).

Miles Mander, rural banker based at Whakatane's National Bank agrees with McIntosh's view of the rural economy. Miles says that although the value of established farms has increased (due to say purchase of other farms) cash flow has become tighter. Currently dairy farm operational costs are $0.60 per kg but if this is compared with a payout of $4.05 per kg of milk solids then one can see that margins are indeed slim (Mander, 2006).

The National Bank which produces a general nationwide rural report based on various economic factors comments on rural profitability (National Bank, December 2006):

Discretionary expenditure is expected to be constrained at least until March/April 2007 when a better fix on actual revenue is obtained. A cash deficit before capital expenditure was a common outcome in most agricultural sectors for year end June 2006. The positive outlook for unit prices for sheep meat, beef, venison and apples will boost revenue. Revenue for dairy and kiwifruit is forecast to be similar to 2006. However all sectors face increased unit costs. The hard winter will exacerbate absolute expenditure on many pastoral farms in 2006/07 as they try to rebuild conserved feed reserves.

(b) Anticipated Population Trends

The Whakatane–Waimana's catchment ability to pay for flood protection schemes is dependent in part on its rating base and thus population size.

In 2001 the total population was approximately 32,800 (rural and urban) and the medium projected population for the district (rural and urban) from 1996 – 2016 anticipates a rise until 2006, before decreasing to about 1996 levels.

While population increases in the townships of Whakatane and Ohope will continue, changes in the nature of farming and other rural-based activities make predicting rural population growth difficult. It is likely that communities that were reliant on the forestry sector for employment opportunities will continue to contract in the foreseeable future.

(c) Community Spirit

During and following the July 1998 and July 2004 floods various reports revealed a strong and supportive spirit in Whakatane and Waimana, which helped it recover from the immediate community trauma.

- July 1998

  For example in 1998 the Beacon reported the mood in the community after the second flood:

  When the Beacon travelled through the area yesterday amid large areas of sticky oozing mud and silt, there was an air of optimism. Throughout the area there was evidence that everyone was pitching in to help with the clean up which is estimated to take at least a month (Beacon 1998, 14/7/98, pg 1)

  During the second July 1998 flood volunteers and Whakatane District Council staff worked around the clock to:

  - Provide emergency food, which, was flown in to people, trapped at Matahi Marae.
  - Clean up and carry out emergency repairs throughout the district especially at Waimana.
  - Deliver rubbish skips for flood rubbish and debris.
  - Restore Taneatua's water supply by treating it manually.

- July 2004

  On the 20 July 2004 the NZ Herald reported:

  Many people had been traumatised by the floods, made worst by the series of earthquakes which hit the area (NZ Herald, 20/7/04) However despite the tragedy Deputy Whakatane Mayor Brian Birkett told the NZ Herald, "That was the last thing we need," he said. "But there is a real strength of spirit in this community. We will get through this."

During the July 2004 flood volunteers and Environment Bay of Plenty and Whakatane District Council staff worked around the clock to:

- Sandbag and protect the Edgecumbe substation from being inundated with water.
- Pump water off affected farms
- Deliver rubbish skips for flood rubbish and debris
- Clear roads of debris and slip material
- After the July 2004 floods a positive spirit prevailed in the community. Teams of workers called “Task Force Green” travelled through the urban and rural communities of Waimana and Taneatua and assisted them in the clean up. Priority works included desilting, cleaning and refilling water troughs, picking up debris in paddocks and reinstating fences.

In August 2004 many kilometres of fencing were repaired and reinstated, troughs were recommissioned and tons of destroyed haybales were removed from farms. Task Force Green was also responsible for helping remove slip debris, revegetating, fencing off slip faces and work in the urban area by reinstating walkways and playgrounds contaminated by floodwaters. (Eastern BOPRO, Recovery Report 11, 3/9/04).

(d) Community Outlook

Despite the positive spirit of the local community to rise above the ‘floodwaters’ other factors appear to make flood protection difficult to sustain financially in the future. The level of socio-economic deprivation, the vulnerability of the primary industry to help pay for protection works and predictions of future population size collaborate to make funding of flood protection works questionable. These issues have implications for the resilience of the community and its ability to cope with future flood events. Based on current observations:

- there will be limitations on the community in paying for mitigation programmes, works etc
- some residents will be vulnerable to flood damage as a result of underinsurance
- recovery in the event of a future flood may be slow

Ongoing issues with stock created higher then normal stress levels for farmers in the area.

2.8 Estimated Potential Damages

Results of flood modelling can be used to provide estimates of potential damage, provided reasonable information about the value of the floodplain asset or property, and its distribution is available. Potential flood damage costs were assessed catchment wide for a number of *hypothetical scenarios* that included stopbank overtopping and breaching for the locations discussed in sections 2.2 – 2.6 above. Damage rates were based on real data gleaned from the floods that impacted the

Manawatu and Bay of Plenty in 2004. Refer to Appendix 4 for more detail regarding flood damage modelling.

The extent of flooding including water depth and coverage area were assessed using latest topographical data and computer modelling of flood levels. Rates were calculated for urban and rural land uses. Urban land uses included residential and commercial/industrial areas. Rural flood damage rates took into account the effect of seasonal variations.

Flood damage modelling indicates:

- the estimated cost to the rural sector of the July 2004 flood would have been approximately $5.5M. This compares with the MAF estimate for the July 2004 flood event between $4.67M - $5.07M.
- stopbank breaches at locations closest to the town CBD result in the greatest damage costs but the cost reduces for breach sites further upstream. For example a breach at Eivers Rd in a 100 year flood event could cost approximately $58M whereas a stopbank breach at say Fortunes could cost around $1.1M.
- rural damage occurs in all stopbank breach scenarios
- damage costs are higher for true right stopbank breach locations due to the existence of higher density residential and non—residential buildings.
- damage due to stopbank overtopping in a 100 year flood event impacts mainly rural land in Lower Whakatane. Floodable rural land is located between river edge and the 100 year stopbanks (i.e. berm areas).
- in a 300 year flood event it is estimated that the urban stopbanks would overtop causing approximately $39M in damage costs to urban and rural areas
- rural areas in Upper Whakatane and Waimana flood in events greater than 50 year flood event. Clusters of buildings appear above flood levels but some isolated buildings in both areas also flood.
- rural damage costs in Upper Whakatane range for flood events ranging between 50 and 200 years range between $1.2M and $2M.
- damage costs in Waimana range for flood events ranging between 50 and 200 years range between $1M and $2.9M. Most of the damage cost is attributed to rural damages.

2.9 Summary of Key Issues

A summary of the key issues identified in Parts 1 and 2 follow. Also noted are recommendations that arise out of the key issues, which are to be addressed in Stage 2 of the WWFMS.

Key issues arising from Part 1 are:

2.9.1 Land use

Population growth within the Whakatane Waimana River scheme catchment is expected in the urban coastal suburbs of Coastlands and Orini. Urban area stopbanks and minimum floor levels are aimed at protecting these suburbs against flood inundation.

Decreases in population within the scheme catchment are expected in outlying rural areas such as Taneatua. Outlying rural urban areas have flood protection in the form of minimum floor levels but do not have stopbanks.

2.9.2 Hydrology

River flow records are available on Waimana River and Lower Whakatane River (downstream of Valley Road recorder). However only river level data is available for Upper Whakatane River (Ohutu Bridge recorder). It is recommended that the river level data in the Upper Whakatane River be rated to complete the catchments flow monitoring records and confirm flood modelling results.

Global warming and its potential to increase the magnitude and frequency of floods in the catchments is being studied by Environment Bay of Plenty. Results will be used to review the capacity of existing flood protection assets.

The Intergovernmental Panel on Climate Change predicts sea levels will rise between 0.15 – 0.2m by 2050 and 0.43m by 2100. Since sea levels have risen 1.2mm per year since 1900 Environment Bay of Plenty has adopted IPCC sea level rise estimates in its Coastal Environment Plan. Sea level rises are minimal when compared with storm surges. Current Environment Bay of Plenty policy therefore is to use the magnitude of storm surges when evaluating stopbank capacity.

As a result of global warming Environment Bay of Plenty expects the frequency of floods to double which means what is presently considered the 200 year flood event will become equivalent to the 100 year flood by say 2070. This increase in flow equates to a rise in flood levels of around 300mm in the reach of river between Landing Road Bridge and the river mouth. When flood protection assets come up for renewal Environment Bay of Plenty will take into account global warming data available at that time and take this into consideration during the design stage.

Impact of the Interdecadal Pacific Oscillation on Whakatane River scheme is that the river flows will be higher or lower then average. Since the Bay of Plenty is currently in an ‘active’ phase of the IPO the flow is expected to be 14% more than average and this will continue for approximately the next 20 – 30 years. During the subsequent ‘benign’ period river flows will drop approximately 15% below the average flow. Environment Bay of Plenty considers the effect of the IPO when it evaluates catchments run-off flows.

2.9.3 Historical Flooding

Flood protection measures were constructed as part of the Major River Scheme in the period 1965 – 81. Since 1993 major floods have, for the most part, been contained within the urban stopbanks protecting Whakatane township. Environment Bay of Plenty will continue to review flood levels contained within stopbanks and top these up where stopbanks have fallen below current service levels.

Urban areas near the mouth of the Whakatane River namely Whakatane Heads and Muriwai Drive flooded in July 1998 and July 2004 respectively. Environment Bay of Plenty has constructed stopbanks at Mataatua and is due to top up the low area identified in a short section of stopbank at the Yacht Club in 2006/07.

During July 2004 the suburb of Awatapu flooded as a result of several causes including the severity of the event and a malfunction of the main pump station. Whakatane District Council is investigating and will implement the preferred option(s) for reducing the risk of future flooding within Awatapu. Whakatane District Council has set aside a sum of $980,000 in 2006/07 for implementing flood protection works in Awatapu.

2.9.4 Response to Flooding – Structural Works

Stopbanks within the scheme have been subject to several capacity reviews and condition assessments since the scheme works were completed. As a result several stopbank sections have been raised or refurbished where they have been shown to fall below the required level of service. Environment Bay of Plenty will continue to monitor and maintain the scheme assets in accordance with the current asset management plan requirements.

2.9.5 River Management Planning

In 1994/95 Environment Bay of Plenty adopted a 3 year programme of works to stabilise the Whakatane river channel. Stable river channels reduce berm erosion and gravel deposition (aggradation) on the riverbed which would otherwise decrease flood capacity. Environment Bay of Plenty will continue to monitor and maintain a stable river channel. Regular cross-section surveys show where changes in alignment have occurred.

Gravel extraction from the Whakatane and Waimana Rivers has been undertaken for over 50 years. It also reduces berm erosion and riverbed aggradation. If river surveys indicate beds are degrading then gravel extraction ceases or is reduced in those reaches until the riverbeds recover. Environment Bay of Plenty will continue to control the amount of gravel extracted through its gravel analysis and resource consent process.

2.9.6 Response to Flooding – Statutory Non – Structural Measures

Government policy gives local and regional government the mandate to manage natural hazards on behalf of the ratepayers within their areas. Legislation is covered in the RMA (1991). Other legislation used for flood protection purposes is the Building Act and Building Regulations Act. In the Building Act a local or regional authority can refuse building consent if the development proposed is at risk of flooding or it puts other land or building at risk of flooding. The Building Regulations Act binds the territorial authority to setting floor levels. In this case floor levels must be built above 50 year flood levels. Environment Bay of Plenty will continue to provide flood levels such as the 50 year to Whakatane District Council so they can set minimum flood levels within the catchment.

Under the Civil Defence Emergency Management Act 2002 a Group CDEM Plan is required for the Groups area (Whakatane). The Group CDEM Plan is based on the Regional Plan and the local authority implements the practical response. Environment Bay of Plenty will contribute to and be involved in the implementation of the Group CDEM Plan.

Regional Plans include Bay of Plenty Regional Policy Statement (BOPRPS), the proposed Bay of Plenty Regional Water & Land Plan (BOPRW&LP) and the Bay of Plenty Regional Coastal Environment Plan (BOPRCEP). Through these plans Environment Bay of Plenty will continue to manage flood hazard and promote sound water and land management practices

District Plans are prepared by Whakatane District Council. Planning maps enable people to see what zoning applies to property and whether there are any natural hazard risks such as flooding.

2.9.7 Current Non-Structural Measures

Environment Bay of Plenty is responsible for flood monitoring and flood warning for the Whakatane catchment. Rain gauges and river level recorders warn Environment Bay of Plenty personnel when a flood threshold is reached. In addition the MetService provide a Special Weather Advisory to Environment Bay of Plenty if adverse weather (particularly heavy rainfall) is anticipated.

A Flood Warning Manual provides procedures for the Environment Bay of Plenty personnel to follow once flood warnings have been activated. Environment Bay of Plenty will retain responsibility and continue flood monitoring and flood warning for the Whakatane catchment.

2.9.8 Recommended Floodplain Management Practice

International observations recommend that good floodplain management gives preference to non–structural measures. Many regional, territorial and unitary authorities have formulated good floodplain management strategies and these are outlined in OPUS Consultants Floodplain Management Planning Guidelines.

Environment Bay of Plenty and Whakatane District Council will review the efficiencies of its non-structural measures and update these where necessary.

Issues arising from Part 2 are:

2.9.9 Flooding in the Lower Whakatane River

Flood levels were modelled for the 100, 200 and 300 year flood events. Results were compared with the levels of the urban flood floodwalls and stopbanks. Subject to confirmation of various assumptions associated with the Lower Whakatane river model:

- no overtopping occurred in the 100 year flood event (even allowing for ‘take up’ of freeboard) apart from known ‘low spots’ at the Yacht Club and Mataatua Reserve.
- minor overtopping occurred in the 200 and 300 year flood events
- Environment Bay of Plenty will confirm the assumptions associated with the Lower Whakatane River model. Assumptions are certainty that the river mouth ‘spit-fuse’ scours during large flood events
- The Wainui Te Whara stream has some stopbanks but the protection these provide, in some places such as at Douglas Street is below the statutory 50 year flood level. Whakatane District Council is responsible for providing statutory flood protection to residents living close to the stream.

- Whakatane District Council has set aside a sum of $60,000 in 2006/07 for investigating and implementing flood protection works in the Wainui Te Whara Stream.

2.9.10 Flooding in the Upper Whakatane River

The Whakatane River reach upstream of Taneatua was modelled but Environment Bay of Plenty requires further ground survey and floor levels to confirm LIDAR data and subsequent results. Initial river model results show:

- Road access is disrupted in several places on Ruatoki valley road in events greater or equal to 5 year flood events. It is recommended that Whakatane District Council review flood protection provided to Ruatoki Valley road and measures be undertaken to reduce the risk of it being cut-off in future floods.

- Extensive flooding of farmland occurs during all flood events investigated. Upper Whakatane scheme ratepayers need to confirm if the current flood protection service level is acceptable. If not then, then stakeholders would need to pay the local share of the cost to raise the service level.

- Floor levels of house clusters appear above estimated flood levels for the events investigated however some isolated buildings do flood. If requested Environment Bay of Plenty will provide actual or modelled flood levels to Whakatane District Council for the purpose of setting minimum floor levels in the sub-catchment within the model's boundaries.

2.9.11 Flooding in the Waimana River

Flood levels were assessed for a range of floods between 5 and 200 year flood events. These were compared with the minimum floor levels set for houses in the sub-catchment which do not currently have any stopbank protection.

Subject to confirmation of various assumptions associated with the Waimana river model results show:

- Extensive flooding occurs across the Waimana floodplain particularly in the lower half downstream of the Parau Stream. Waimana scheme ratepayers need to confirm if the current flood protection service level is acceptable. If not then, then stakeholders would need to pay the local share of the cost to raise the service level.

- Road access between Taneatua and Waimana is cut off at the Gorge. It is recommended that Transit New Zealand review flood protection provided to these access roads and measures be undertaken to reduce the risk of them being cut-off in future floods.

- Road access through Nukuhou is potentially cut-off. It is recommended that Whakatane District Council review flood protection provided to this access road and measures be undertaken to reduce the risk of it being cut-off in future floods.

- Several buildings in the Waimana floodplain are flooded. These include buildings in Addison Road, Ruddick Road, the township of Waimana, along State Highway 2 (between Ruddick Road and Waimana Road) along Lowe Road, along the eastern boundary of Hodge Road and both sides of Matahi Valley Road Environment Bay of Plenty can provide modelled flood levels to

Whakatane District Council for the purpose of reviewing minimum floor levels in the sub-catchment within the model's boundaries

Environment Bay of Plenty will confirm assumptions associated with the Waimana River model. Assumptions associated with the Waimana River model are confirmation of the 'fresh' water levels upstream and downstream of Waimana East and Waimana West Bridges respectively.

Whakatane District Council will investigate and implement suitable remedial works to reduce flood risk on district council owned roads.

2.9.12 Lower Whakatane - Stopbank Failure

The impact of stopbank breaching on Lower Whakatane River has been modelled at 10 sites considered to be vulnerable based on previous condition assessments, geotechnical investigations, past performance observations and hydraulic modelling results.

Risk analysis have been carried out on 14 Lower Whakatane sites to determine the probability of at least one stopbank site breaching during a 100, 200 and 300 year flood event.

Specific remedial work has been identified and is about to be implemented by Environment Bay of Plenty on the Whakatane River scheme to raise factors of safety against breaching. The remaining task is to raise a short section of stopbank at the Yacht Club. Environment Bay of Plenty plans to complete this work in 2006/07.

Assuming outstanding remedial work is complete then the probability of at least one stopbank breach occurring at any of the 14 sites is:

- For the 100 year flood event, 17% on the left (rural) stopbank and 11% on the right (urban) stopbank
- For the 200 year flood event, 24% on the left (rural) stopbank and 17% on the right (urban) stopbank
- For the 300 year flood event, 30% on the left (rural) stopbank and 23% on the right (urban) stopbank

Scheme ratepayers need to confirm that the current risk of stopbank breaching is acceptable.

Environment Bay of Plenty will carry out geotechnical investigations at several potential breach sites to confirm the failure modes and confirm the level of risk. Sites are Eivers/Amber, Tahere Road, Fortunes, Selwyn, Carter Holt Harvey Intake and Rewatu 2.

2.9.13 The Flood Hazard

(a) Community at Risk

In recent history no lives have been lost in the catchment due to flooding however rural communities such as Waimana in the upper reaches have been isolated owing to road access closures It is recommended that Whakatane District Council review flood protection provided to these access roads and measures be undertaken to reduce the risk of these being cut-off in future floods.

(b) Built Assets at Risk

In recent times large floods such as during July 1998 and July 2004 have caused significant damage to flood protection assets in the catchment. Environment Bay of Plenty will continue to monitor and maintain flood protection assets at the service levels specified in the scheme asset management plan.

Deposition of debris, shingle, silt and removal of land by river erosion disrupted farm production during the large floods of July 1998 and July 2004. In July 1998 rural land in the Waimana incurred the most damage compared with other parts of the catchment. This was due to the river changing course which then dumped debris onto adjacent land. Environment Bay of Plenty will continue to monitor gravel aggradation/degradation processes on the major rivers. This will be done by carrying out regular cross-section surveys, gravel analysis, monitoring of resource consent and study of fluvial processes specific to each river.

(c) Utility Vulnerability

Few medical emergencies arose as a result of the July 1998 and July 2004 floods however ambulance services did report increased call outs some of which related to stress as people returned to their flood damaged homes.

During major floods several roads and bridges have been washed out due to high flood waters and slips. It is recommended that Whakatane District Council review flood protection provided to roads and bridges and measures be undertaken to reduce the risk of future flood damage.

Sewerage networks have been disrupted as a result of broken pipework and high water levels which have made gravity discharge systems inoperable. It is recommended that Whakatane District Council review flood protection provided to sewerage networks and measures be undertaken to reduce the risk of future flood damage

Stormwater has flooded urban areas due to capacity exceedance, broken pipes, drainage pump failure and jamming of floodgates. It is recommended that Whakatane District Council review flood protection provided to stormwater networks and measures be undertaken to reduce the risk of future flood damage

Water supply treatment equipment at the Whakatane and Taneatua plants required replacement thus restricting water supply to those areas. In July 2004 floods the demand from the Valley Rd plant exceeded supply and water conservation was necessary. It is recommended that Whakatane District Council review the security of supply of potable water to catchment users. The review should recommend and implement measures to reduce the risk of short supply during future flooding. Presently Whakatane District Council are investigating the optimum position for the intake to the water treatment plant on the Whakatane River to ensure security of water supply.

Rural water supplies, from private sources were unusable. Owners should be encouraged to have back up sources of potable water in the event that floods cut off their primary supply.

Power lines were damaged and power cut off due to poles being swept away by flood waters. It is recommended that Horizons review flood protection provided to power supply networks and measures be undertaken to reduce the risk of future flood damage

There was minimal disruption to gas supplies apart from in July 1998 when a gas pipeline was damaged. It is recommended that Natural Gas Corporation review flood protection provided to gas supply networks and measures be undertaken to reduce the risk of future flood damage

Telecommunication was cut off to Waimana residents in July 2004. It is recommended that Telecom review flood protection provided to telecommunication networks and measures be undertaken to reduce the risk of future flood damage

(d) Flood Damage Costs.

Significant flood damage costs have been incurred by rural and urban property owners, public and private utilities.

In July 1998 flood damage to buildings comprised inundations, silt intrusion and sewerage around approximately 60 dwellings. Restoration costs were paid for by Whakatane District Council and private owners. In July 2004 the number of homes inspected for flood damage was 371, one third of which had no house contents insurance. It is recommended that building owners especially those inundated in previous floods be strongly encouraged to acquire house contents insurance. Public education regarding insurance could be implemented jointly by Environment Bay of Plenty, Whakatane District Council and insurance companies.

(e) Social Impact

Social disruption occurs during significant flood events as a result of people being evacuated from their homes. For example in July 2004 approximately 1600 people had been evacuated from their homes throughout the Whakatane Waimana catchment during the storm. By December 2004 some 610 people were still unable to return to their homes.

Great demand for support services occurred during the large flood of 2004. Whakatane District Council engaged a psychologist to assist their ratepayers were required. Other services such as Victim Support coordinated counselling service. MCDEM, Environment Bay of Plenty and Whakatane District Council have gained invaluable knowledge about how best to help reduce the social impact during significant flood events. It is recommended that lessons learnt be incorporated into the Group Plan (i.e. emergency management).

(f) Community Resilience

Flood events will continue to impact the Whakatane catchment however the community is limited in its ability to pay for flood protection owing to its high ‘level of socio-economic deprivation’. Environment Bay of Plenty will continue to seek ways of making flood protection affordable during its review of the schemes asset management plan.

The July 2004 flood reduced the primary industry's productivity and hence its ability to help pay for flood protection and recovery. Medium population growth of the catchment is expected to increase in the immediate term to 2006 after which it is expected to reduce to 1996 levels. Population increases are expected in mainly urban areas such as Whakatane. Environment Bay of Plenty will review the existing scheme asset management plan and confirm if other income sources exist and contribute towards the cost.

(g) Estimated Potential Damages

Potential and annualised damages were calculated catchment wide for situation whereby the stopbanks overtopped and breached. Actual rural damages during the July 2004 flood compared well against the modelled damages

Potential damages can be used by Environment Bay of Plenty when it comes to costing mitigation options as part of Stage two of this FMS.

Part 3: Future Management: The Way Forward

The underlying aim of floodplain management planning is to reduce the susceptibility/exposure to flooding to persons and property that exist within the scheme catchment. The aim of this stage one report is to identify and describe existing flood issues within the catchment, review existing flood protection measures and identify potential hazards and elements at risk.

This stage one study has revealed that flood protection service level requirements as set out in the scheme asset management plan are in general being met. The purpose of this floodplain management strategy is to review current practices and plan for the future flood protection needs of the catchment and its stakeholders. Table 3.1 summarises the recommendations made in this stage one report; it nominates the stakeholder responsible, the output required and timeframe.

For stakeholders in Lower Whakatane and protected by the 100 year stopbanks, the main question to be answered is: do scheme ratepayers accept the current level of risk associated with potential stopbank breach? Currently the probability of at least one stopbank breach occurring at any of the 14 potential breach sites for the 100 year flood event is 17% on the left (rural) stopbanks and 11% on the right (urban) stopbanks (this assumes the low point in the Yacht Club stopbanks have been raised).

For stakeholders in Upper Whakatane and Waimana where little, if any, stopbank protection is provided the main question to be answered is: do scheme ratepayers accept the current level of service or do they wish to raise it?

If Whakatane Waimana stakeholders do wish to raise their flood protection service levels then they would also need to be prepared to pay for the local share of costs.

The decision making process will be aided by the outcomes of stages two and three of this floodplain management strategy. Stakeholders will be consulted at each stage of the floodplain management process to obtain their feedback, decisions and approval of options.

In the Stage two report Environment Bay of Plenty will:

- report on the outcome of recommended tasks made in this stage one report
- identify the flood mitigation options that are available to reduce the flood risks identified
- if necessary, provide an economic and environmental evaluation of the options

In Stage 3, Environment Bay of Plenty will confirm the stakeholders' choice of mitigation options, prioritise strategies and set in place a programme to implement the choices made.

Table 3.1 Tasks for Stage 2: Identifying Mitigation Options for Whakatane Waimana Floodplain Management Strategy.

Task No.	Recommendation	Stakeholder Responsible	Output for Stage 2 Report	Completion Date
1	Establish a flow rating for the Upper Whakatane River level recorder (Ohutu Bridge) and confirm modelling report conclusions. (Report reference: 2.9.2)	Environment Bay of Plenty	Develop flow rating & update modelling report.	30 June 2008
2	Raise the low point in the stopbank at Yacht Club, Whakatane River to meet River Scheme service level requirements. (Report reference: 2.9.3)	Environment Bay of Plenty	Raise short section of stopbank.	30 June 2007
3	Investigate and implement flood protection options for Awatapu suburb. (Report reference: 2.9.3)	Whakatane District Coun cil	Flood protection provided to Awatapu	To be confirmed
4	Lessons learnt regarding flood emergency management be incorporated into the MCDEM Group Plan (Report reference 2.9.6)	MCDEM/Envi ronment Bay of Plenty /Whakatane District Coun cil	Updated Group Plan	30 June 2007
5	Review effectiveness of current non structural measures in view of performance during July 1998 and July 2004 flood events (Rep ref 2.9.8)	Environment Bay of Plenty /Whakatane District Coun cil	Joint Input with recommendations for improvements	31 July 2006
6	Flood modelling assumptions for Whakatane and Waimana Rivers are to be confirmed and updated reports published. (Report reference: 2.9.9, 2.9.10, & 2.9.11)	Environment Bay of Plenty	Updated flood modelling reports	30 June 2007
7	Statutory flood protection is to be provided to residents living near Wainui Te Whara Stream. (Report reference: 2.9.9)	Whakatane District Coun cil	Provide flood protection against minimum 50 year flood levels	To be confirmed
8	Acquire further ground survey data and floor levels to confirm LIDAR data in Upper Whakatane sub-catchment. (Report reference: 2.9.10)	Environment Bay of Plenty	Acquire additional survey data	30 June 2007
9	Provide flood protection to access roads to reduce risk of being cut off. Roads include Ruatoki Valley Road, the road between Taneatua and Waimana at the Gorge, the road through Nukuhou, and several roads in the upper Waimana catchment. (Report reference: 2.9.11)	Whakatane District Coun cil and Transit NZ (road between Taneatua and Waimana at the Gorge)	Review & provide flood protection to roads	To be confirmed
10	Geotechnical investigations are necessary at several known potential stopbank breach sites to confirm stability levels. Sites are Eivers/Amber, Tahere Road, Fortunes, Selwyn, Carter Holt Harvey Intake and Rewatu 2. (Report reference: 2.9.12)	Environment Bay of Plenty	Stability Report	30 June 2006

Task No.	Recommendation	Stakeholder Responsible	Output for Stage 2 Report	Completion Date
11	Update stopbank breach risk assessment report based on findings in the geotechnical investigation report. (Report reference: 2.9.12)	Environment Bay of Plenty	Update risk assessment report	31 July 2006
12	Review flood protection provided to infrastructure and implement protection measures where required to reduce risk of failure. Roads and bridges, sewerage and stormwater networks require review. (Report reference: 2.9.13)	Whakatane District Coun cil	Review & implement measures to reduce risk of failure during floods.	To be confirmed
13	Review security of supplying potable water and implement flood protection measures to reduce the risk of short supply in future floods. (Report reference: 2.9.13)	Whakatane District Coun cil	Review &implement measures to reduce risk of short supply of potable water due to flooding.	To be confirmed
14	Owners of private water supplies should have back up supplies of potable water in the event that main water supplies are cut off. (Report reference: 2.9.13)	Owners of private water supplies	Provision of back up water supply	
15	Review flood protection provided to power supply facilities and implement protection measures where required to reduce risk of failure. (Report reference: 2.9.13)	Horizons	Review & implement measures to reduce risk of failure during floods.	To be confirmed
16	Review flood protection provided to natural gas supply facilities and implement protection measures where required to reduce risk of failure. (Report reference: 2.9.13)	NGC	Review & implement measures to reduce risk of failure during floods.	To be confirmed
17	Review flood protection provided to telecommunication network facilities and implement protection measures where required to reduce risk of failure. (Report reference: 2.9.13)	Telecom	Review & implement measures to reduce risk of failure during floods.	To be confirmed
18	Homeowners should be encouraged to obtain home & contents insurance policies that cover flood damage. (Report reference: 2.9.13)	Environment Bay of Plenty /Whakatane District Coun cil to promote	Reduction in the number of home owners without insurance cover.	
19	Publish Stage two report-outlining outcomes of stage one recommendations and mitigation options available.	Environment Bay of Plenty	WWFMS Stage 2 Report	31 August 2006

Appendices

Appendix 1 – Summary of Whakatane Riverbank Capacity Reviews

Appendix 2 – Description of Utility and Infrastructure Damages

Appendix 3 – Whakatane Waimana Flood Maps

Appendix 4 – Potential Stopbank Breach Flood Maps

Appendix 5 –Potential Damages and Annualised Damages

Appendix 1 – Summary of Whakatane Riverbank Capacity Reviews

Table A1.1 Summary of capacity reviews undertaken

Report Date	Location	Model Used & Reviewer
July2005	Whakatane River upstream of Taneatua	MIKE 11 by West
March 2005	Waimana River	Mike 11 by Pak
July 2004	Whakatane River downstream of confluence	Mike 11 by Wallace
March 2003	Kope Orini Canal	MIKE 11 by Bailey & Arts
June 2003	Waioho Stream	MIKE 11 by Pak
June 2003	Te Rahu canal	MIKE 11 by Pak
November 2000	Mouth of Whakatane River (Draft)	HECRAS and Mike 11 by Bailey
1995	Kope-Orini Canal	Mike 11 by Surman
1995	Wairere Stream	Mike 11 by Surman
1995	Whakatane River upstream of Landing Road Bridge	MIKE 11 by Surman
August 1995	Whakatane River downstream of Pekatahi Bridge	MIKE 11 by Surman
1985	Wairere Stream	RIVERS by Stocker
May 1985	Whakatane River downstream of Pekatahi Bridge	RIVERS by Stocker
1985	Whakatane River upstream of Landing Road Bridge	RIVERS by Stocker
December 1963	Whakatane River downstream of Pekatahi Bridge	Soil Conservation "Procedure 20" by BOPCC to design original stopbanks

Appendix 2 – Description of Utility and Infrastructure Damages

Table A2.1 Roading and Bridges

Description Of Damage Repair Work Required	Estimated Cost (Aug - 98) ($)
Matahi Special Purpose Road	400000
Waimana Roads	400000
Whakatane/Taneatua Road (including Stanley Rd)	100000
Total Estimated Cost	$900,000

Table A2.2 Sewerage

Description Of Damage Repair Work Required	Estimated Cost (Aug - 98) ($)
Repair and replacement of some 20m of rising main at the northern end of Whakatane River.	550,000
Repair of damage to pond step screen at Shaw Road, Whakatane	5,000
Clean and sterilise spillages at Salonika, Kirk and Pohutu Streets, Whakatane	5,000
Clean and sterilise spillages at Amokura pump station, Taneatua	1,000
Total Estimated Cost	$561,000

Table A2.3 Water Supply

Description Of Damage Repair Work Required	Estimated Cost (Aug - 98) ($)
Repair wastewater & stormwater outfall structure at Valley Road Water Treatment Plant:	50000
Process extra flood sludge & silt load at Valley Road Water Treatment Plant:	27,565
Replace riser main between pump station and reservoir at Puketi Road, Taneatua	129,500
Replace pipe between well and treatment plant at Ngahina Road,	3,100
Total Estimated Cost	$210,165

Table A2.4 Stormwater

Description Of Damage Repair Work Required	Estimated Cost (Aug - 98) ($)
Sandbagging and emergency pumping required at various Whakatane urban roads including:	
Hikurangi/Pouwhare intersection, James St (western end), Rambler Drive, Henderson St, Arawa Road, Quay St, Kakahoroa Drive and Muriwai Drive	24,700
Total Estimated Cost	$24,700

Appendix 3 – Whakatane Waimana Flood Maps

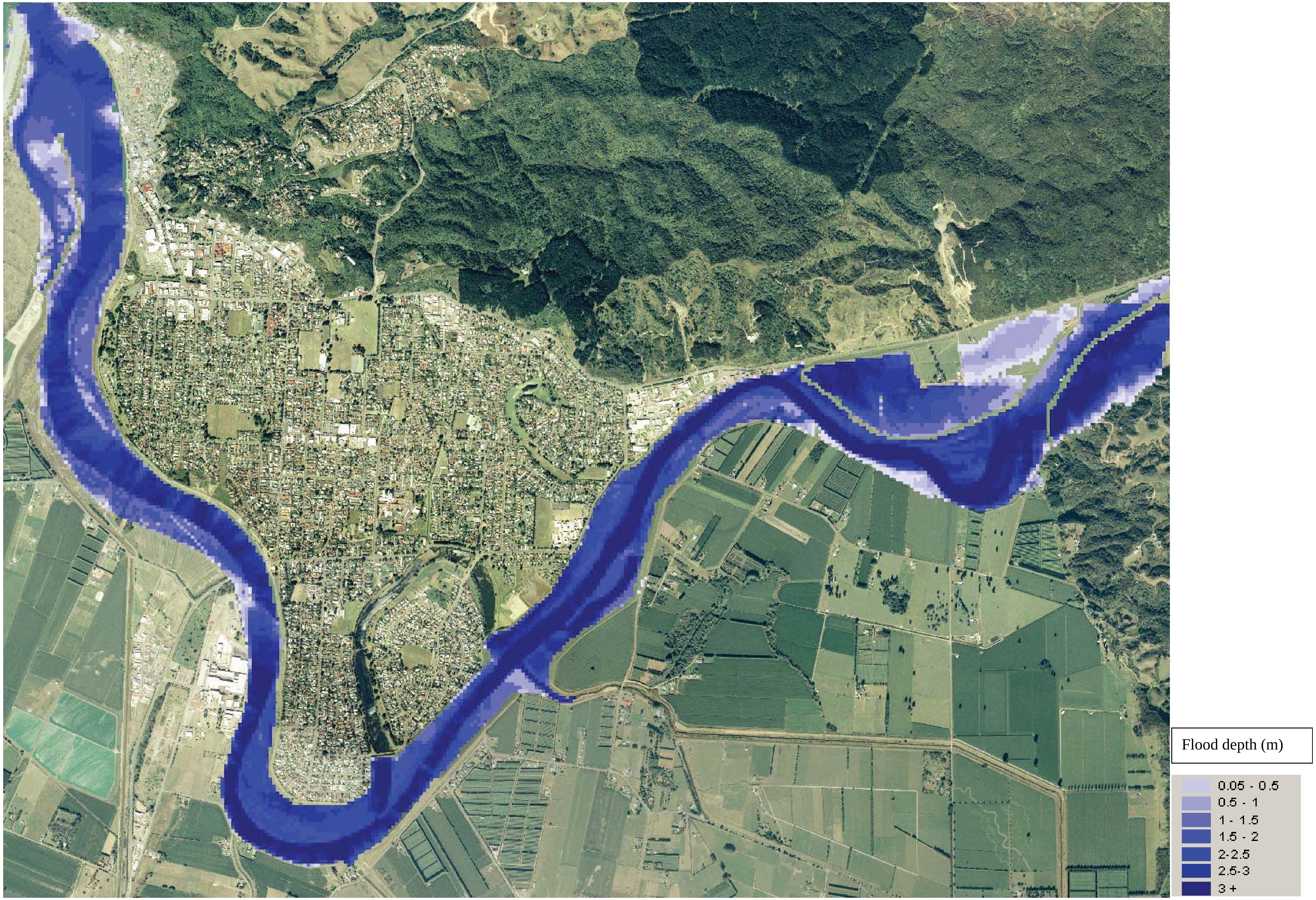


Figure A3.1 Flood Extent in Lower Whakatane River floodplain during (1 in 100 year flood including freeboard)

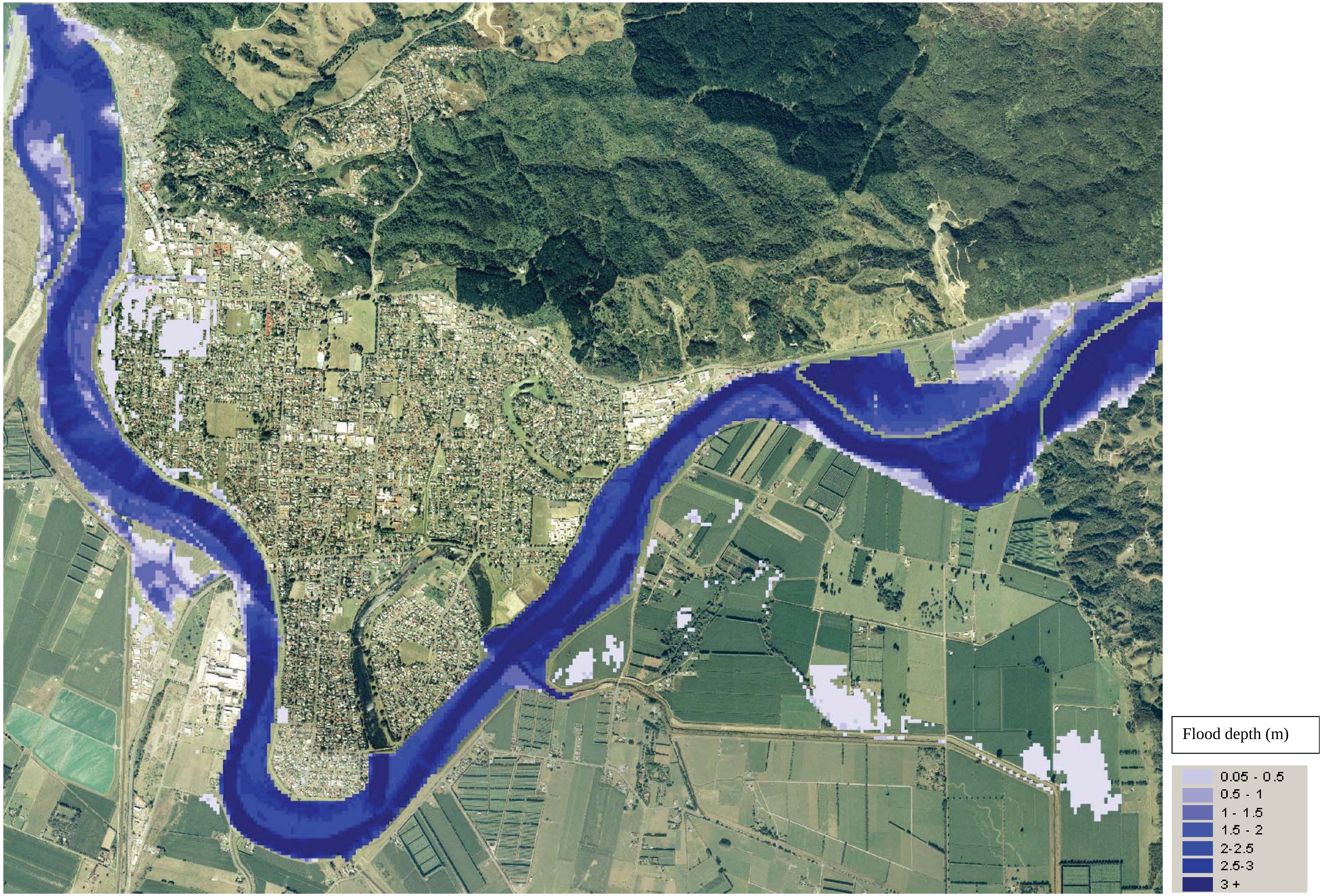


Figure A3.2 Flood extent in Lower Whakatane River floodplain during 1 in 200 year flood (including freeboard)

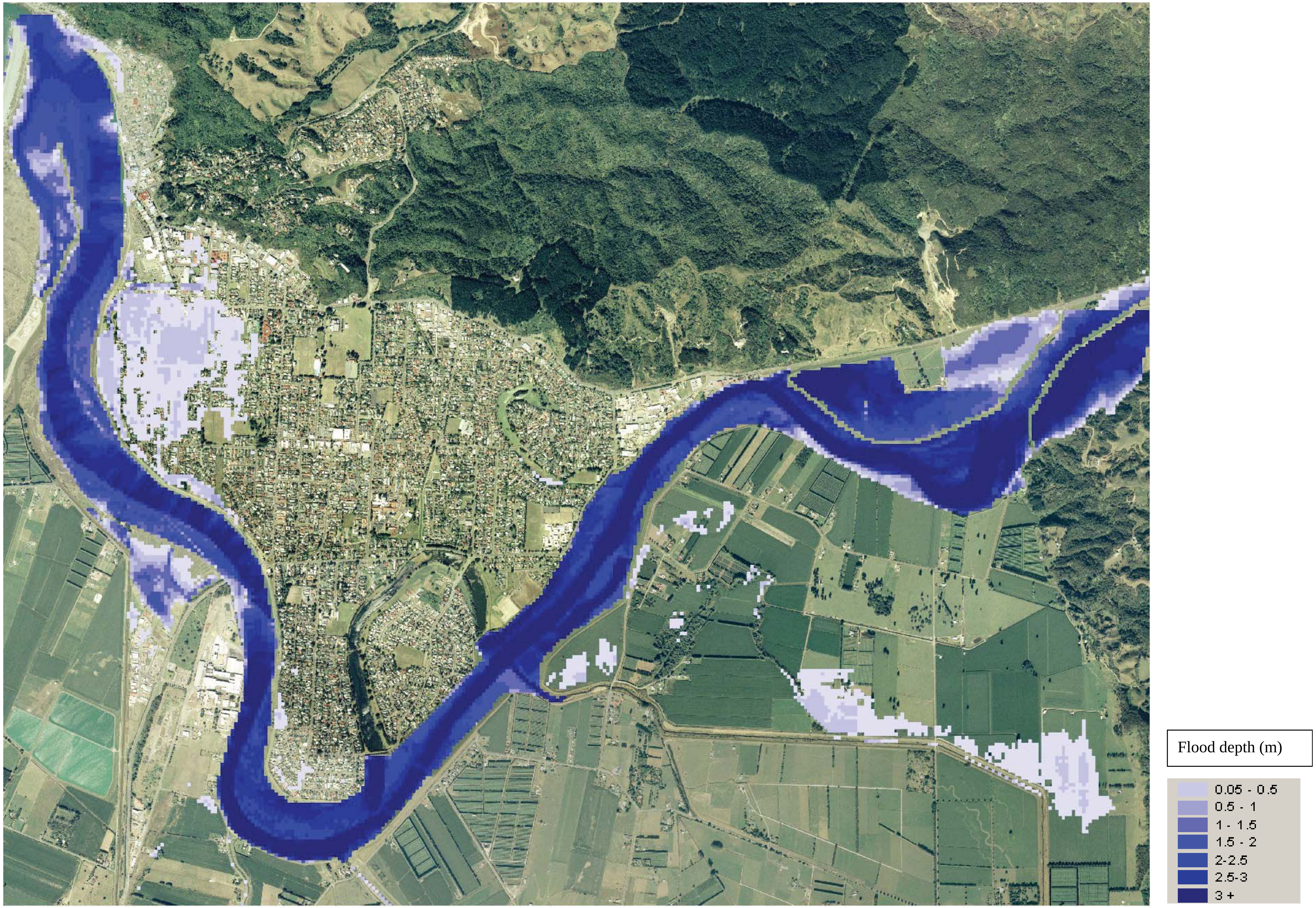


Figure A3.3 Flood extent in Lower Whakatane River floodplain during 1 in 300 year flood (including freeboard)

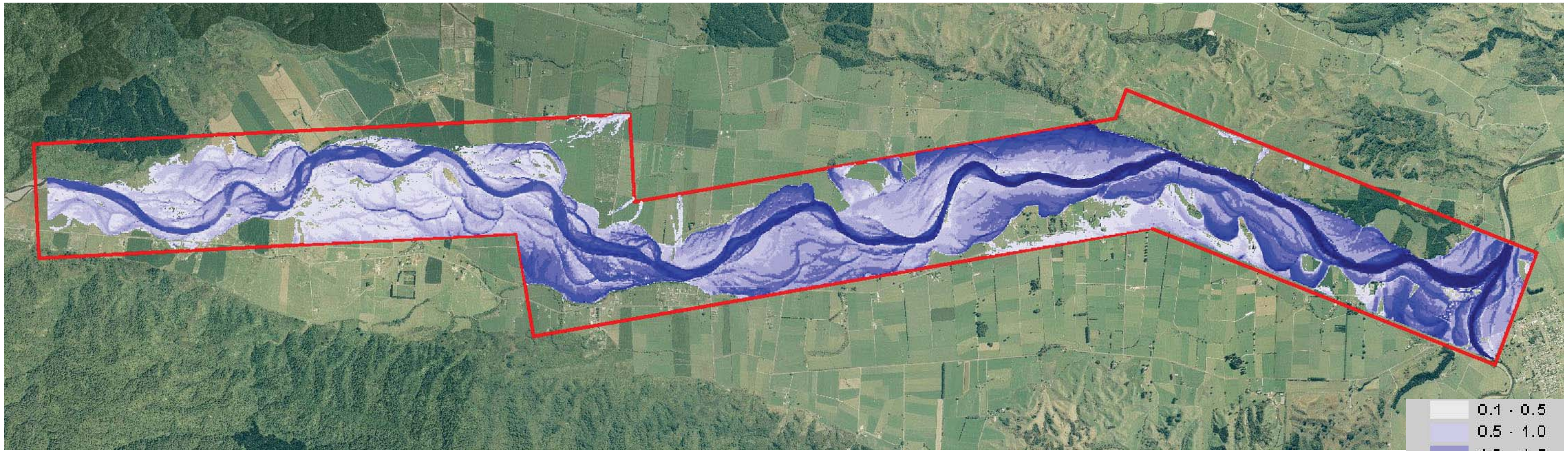


Figure A3.4 *Aerial Photo of flood extent in Upper Whakatane River floodplain during 1 in 50 year flood (excluding freeboard)*

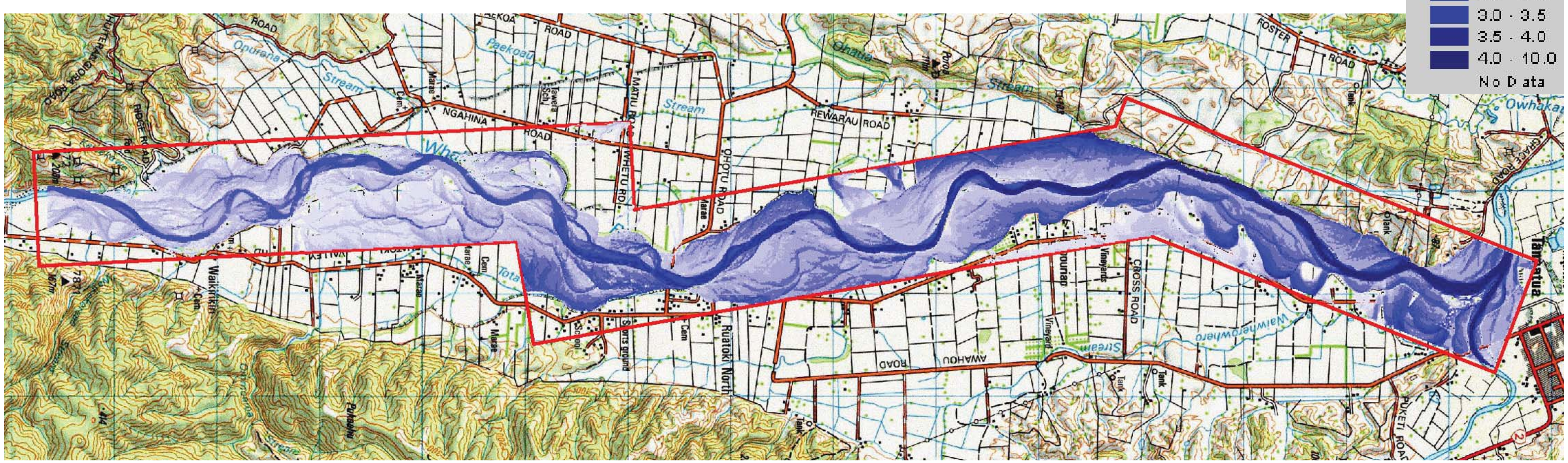


Figure A3.5 *Topography Map of flood extent in Upper Whakatane River floodplain during a 1 in 50 year flood (excluding freeboard)*

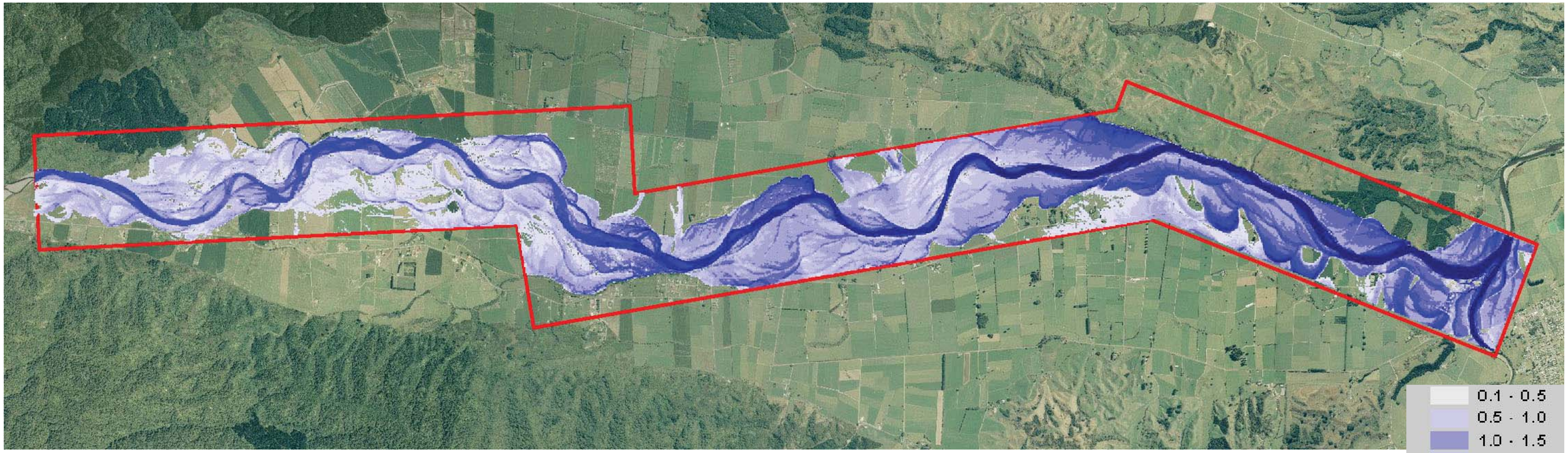


Figure A3.6 *Aerial Photo of the flood extent in Upper Whakatane River floodplain during a 1 in 100 year flood (excluding freeboard)*

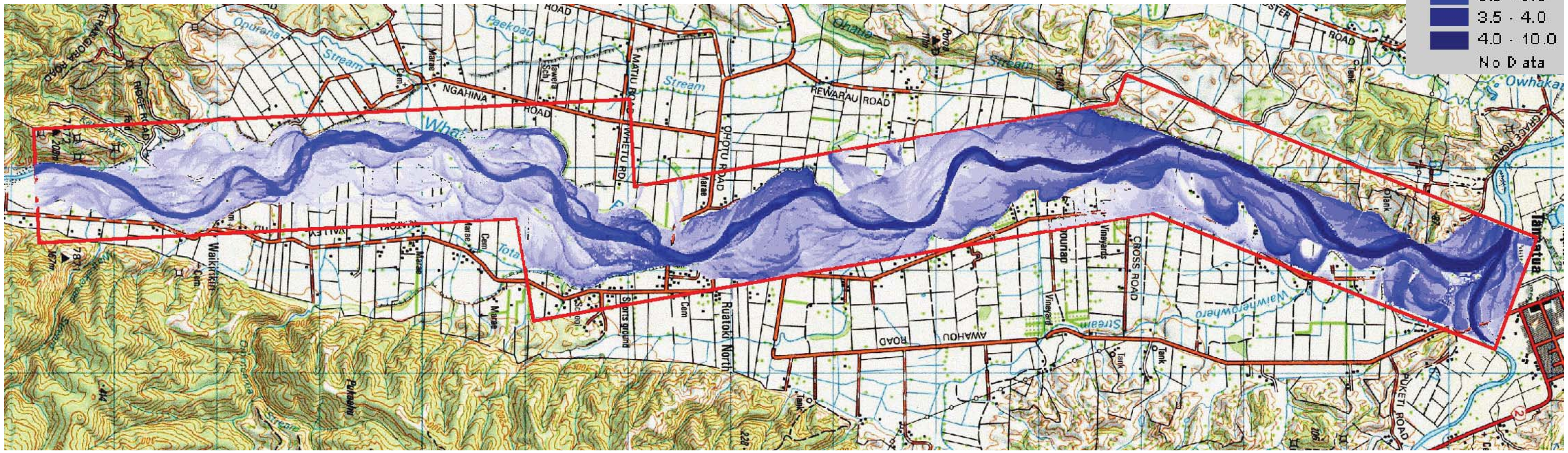


Figure A3.7 *Topography Map of the flood extent in Upper Whakatane River floodplain during a 1 in 100 year flood (excluding freeboard)*

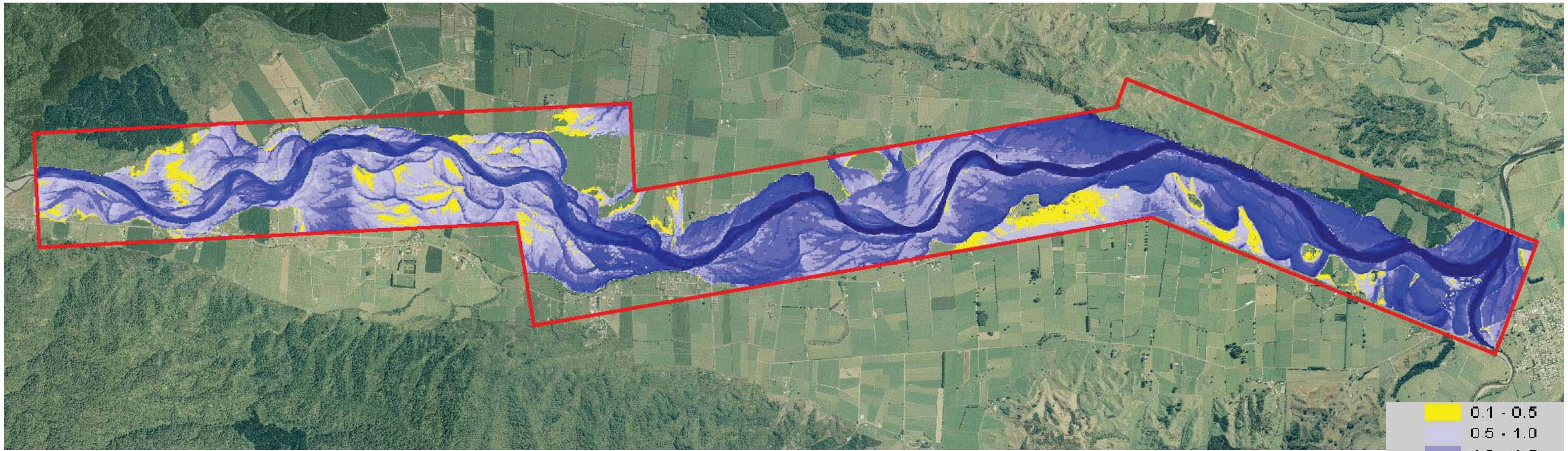


Figure A3.8 Aerial Photo of the flood extent in Upper Whakatane River floodplain during a 1 in 100 year flood (including 500mm freeboard)

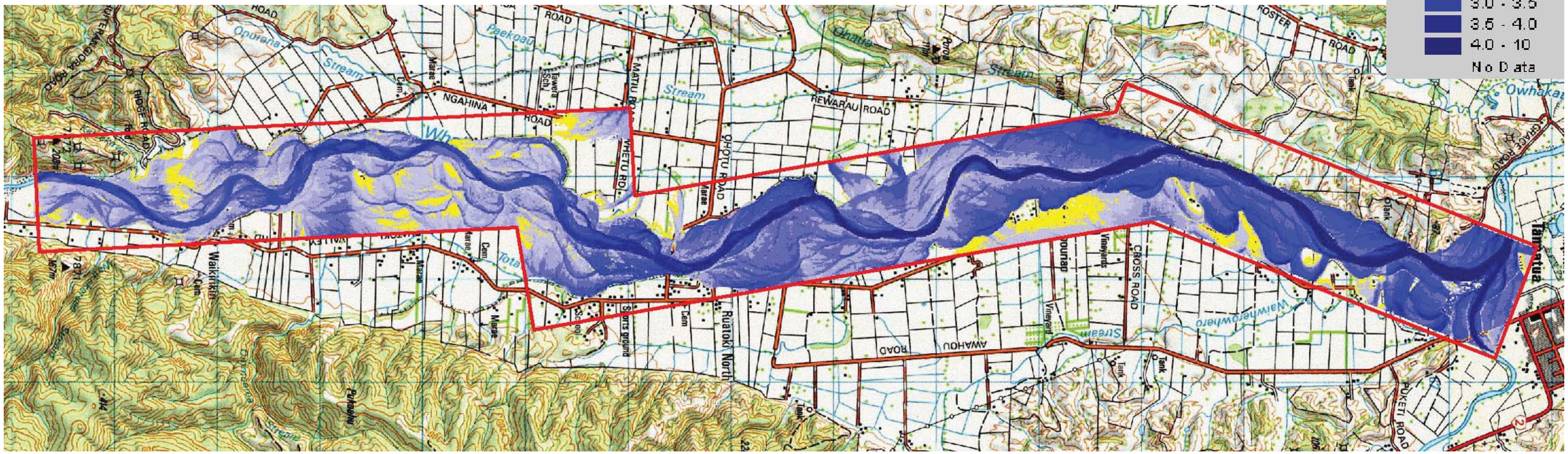


Figure A3.9 Topography Map of the flood extent in Upper Whakatane River floodplain during a 1 in 100 year flood (including 500mm freeboard)

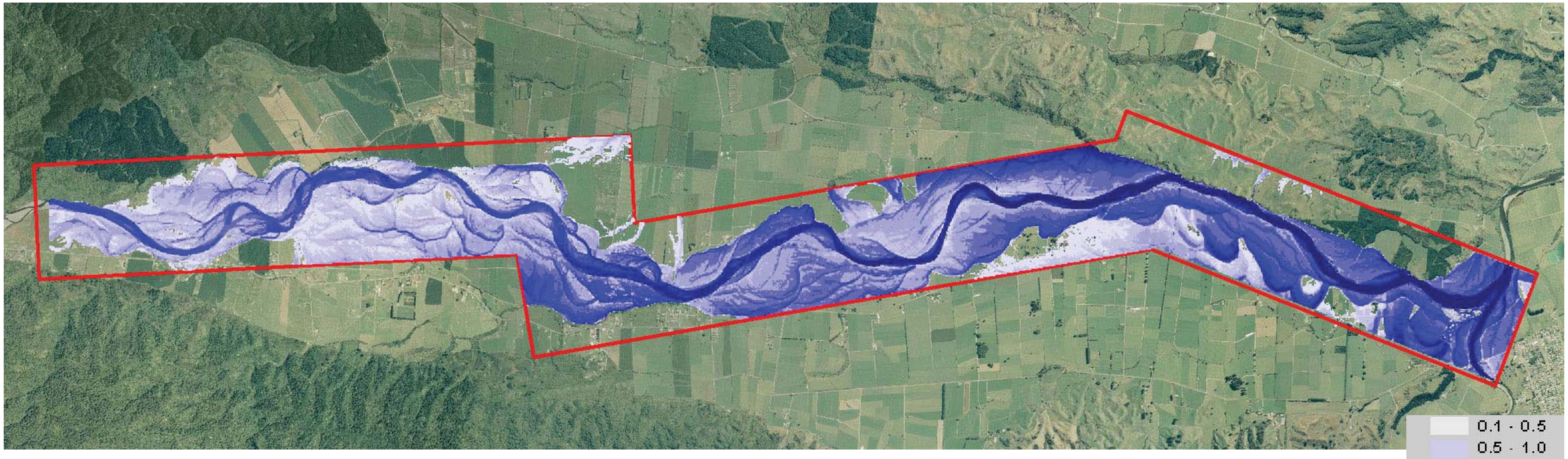


Figure A3.10 Aerial Photo of the flood extent in Upper Whakatane River floodplain during a 1 in 200 year flood (excluding freeboard)

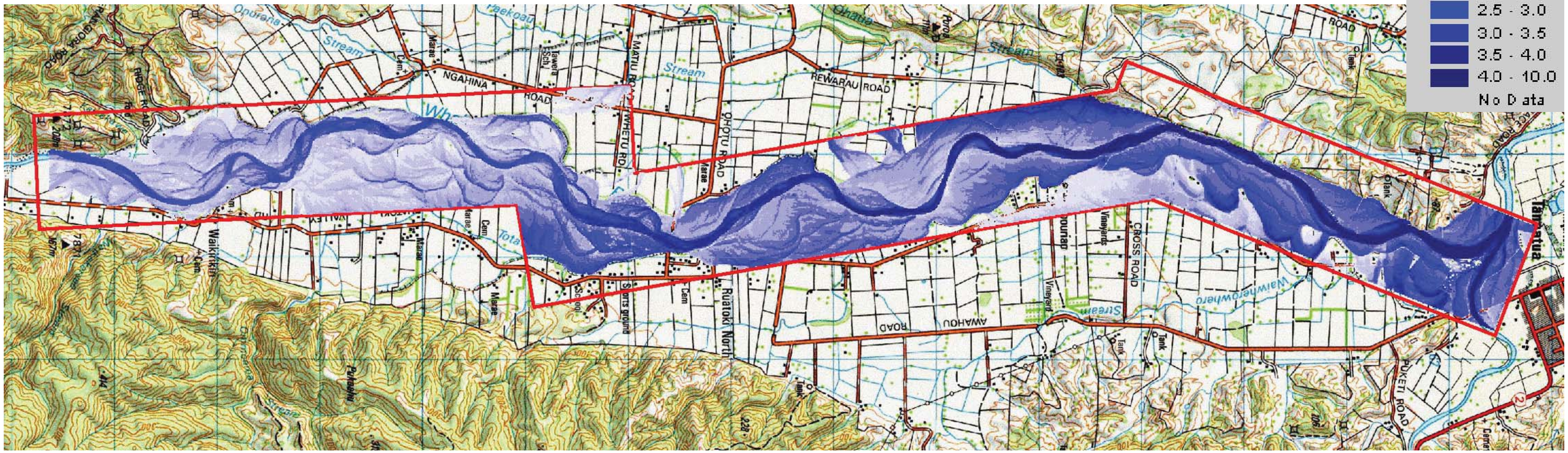
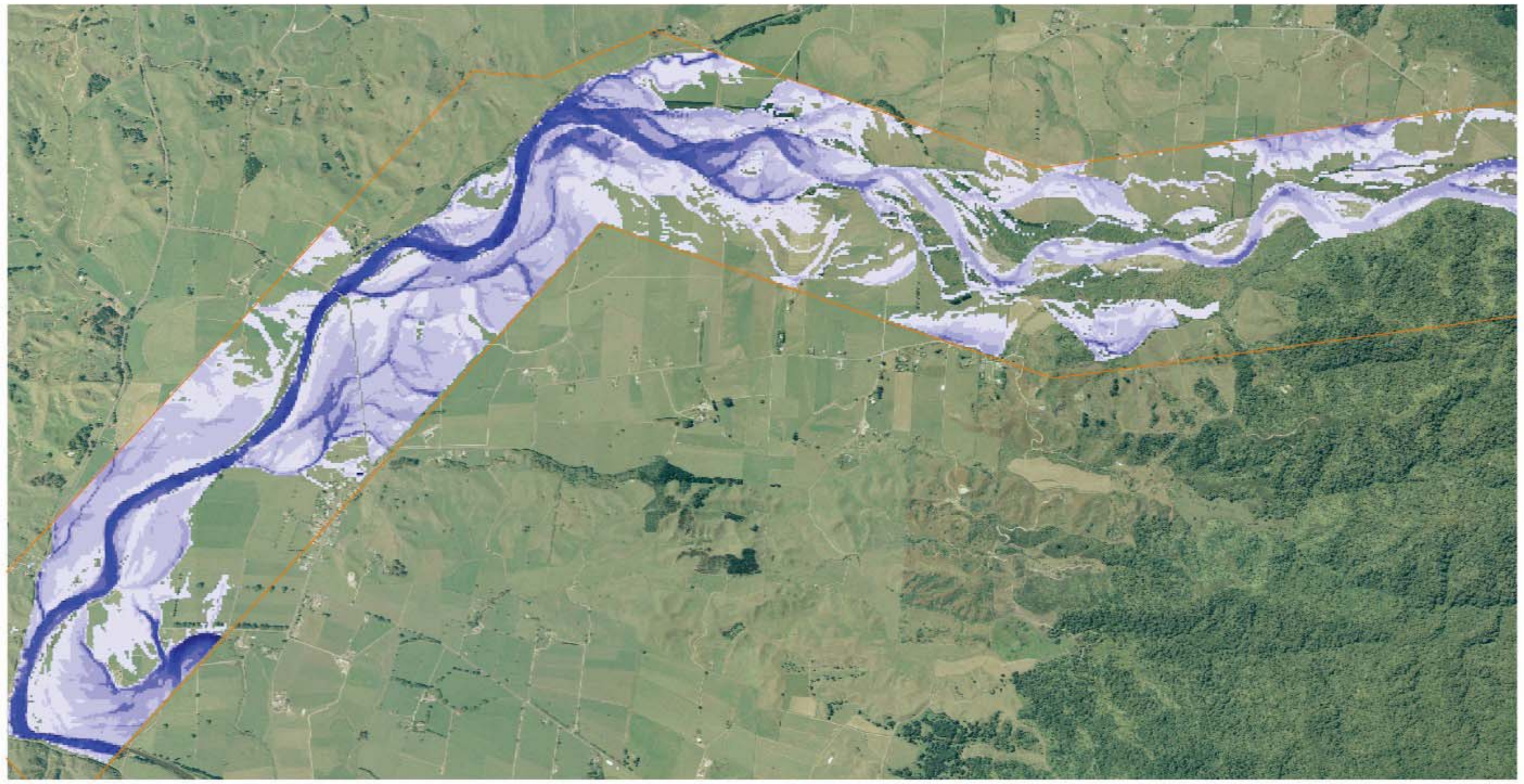
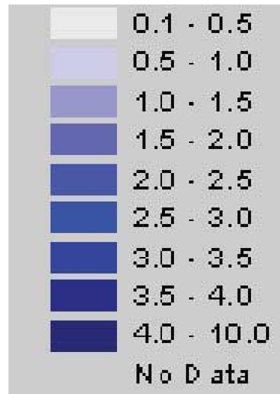


Figure A3.11 Topography Map of the flood extent in Upper Whakatane River floodplain during a 1 in 200 year flood (excluding freeboard)

Figure A3.12 - Aerial Photo of flood extent in Waimana River flood-plain during a 1 in a 50 year flood (excluding freeboard)





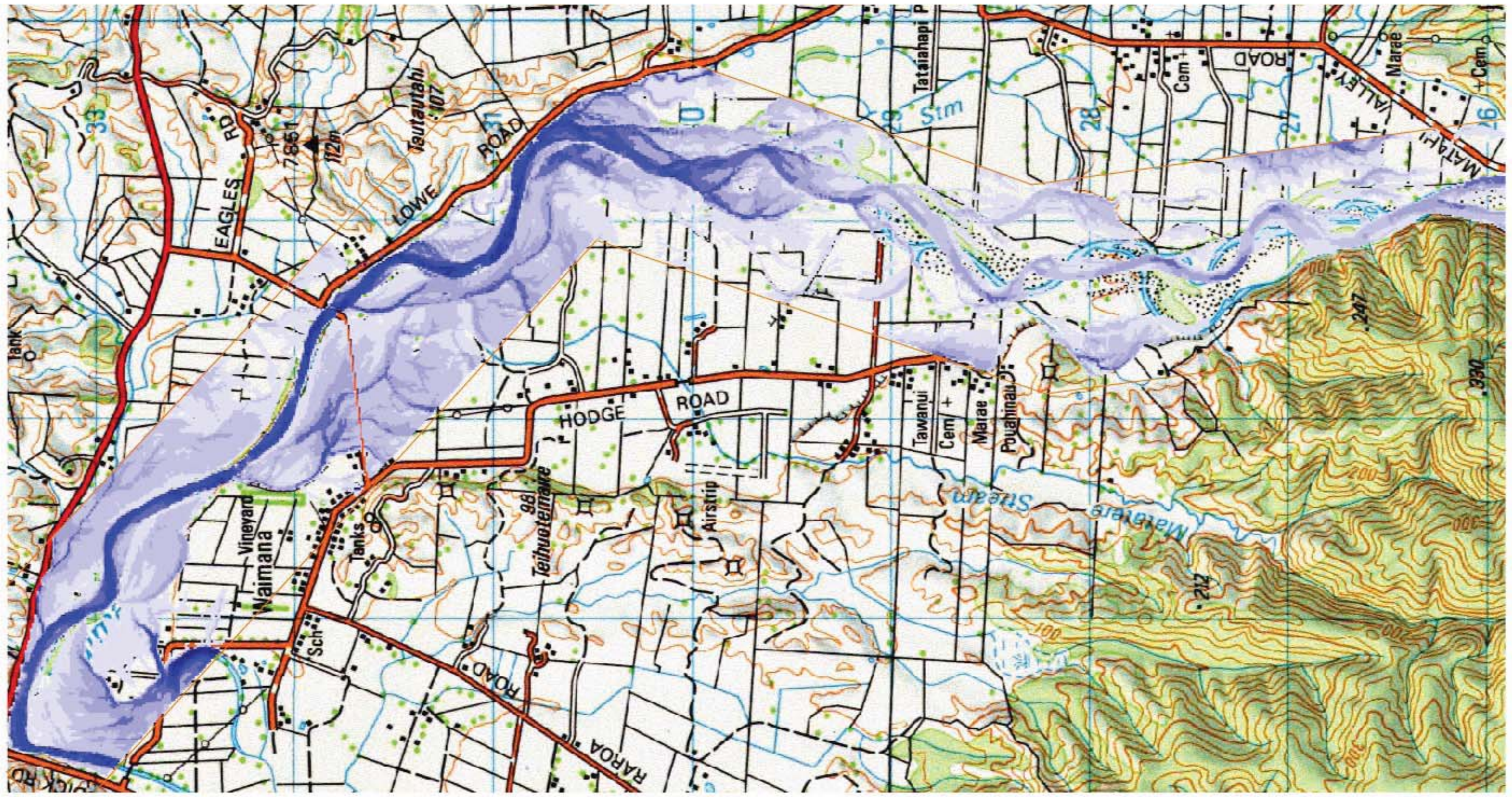
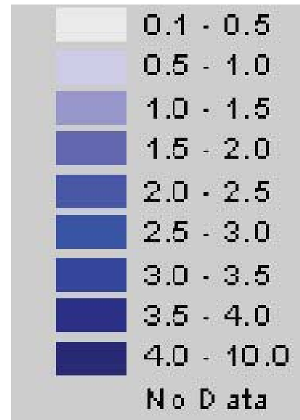


Figure A3.13 - Topgraphy Map of flood extent in Waimana River floodplain during a 1 in a 50 year flood (excluding freeboard)

Figure A3.14 - Aerial Photo of flood extent in Waimana River floodplain during a 1 in a 100 year flood (excluding freeboard)



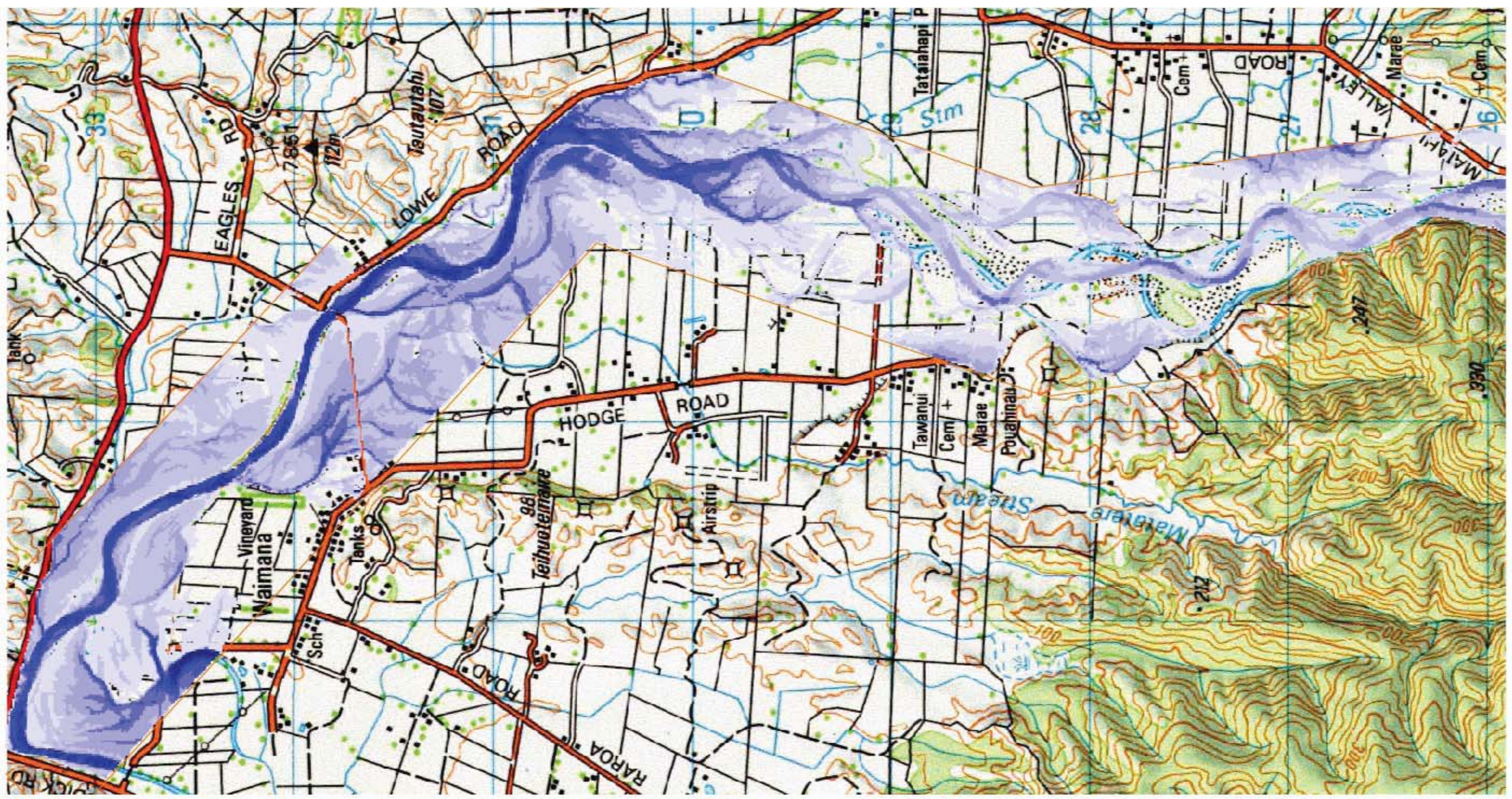


Figure A3.15 - Topography Map of flood extent in Waimana River floodplain during a 1 in a 100 year flood (excluding freeboard)

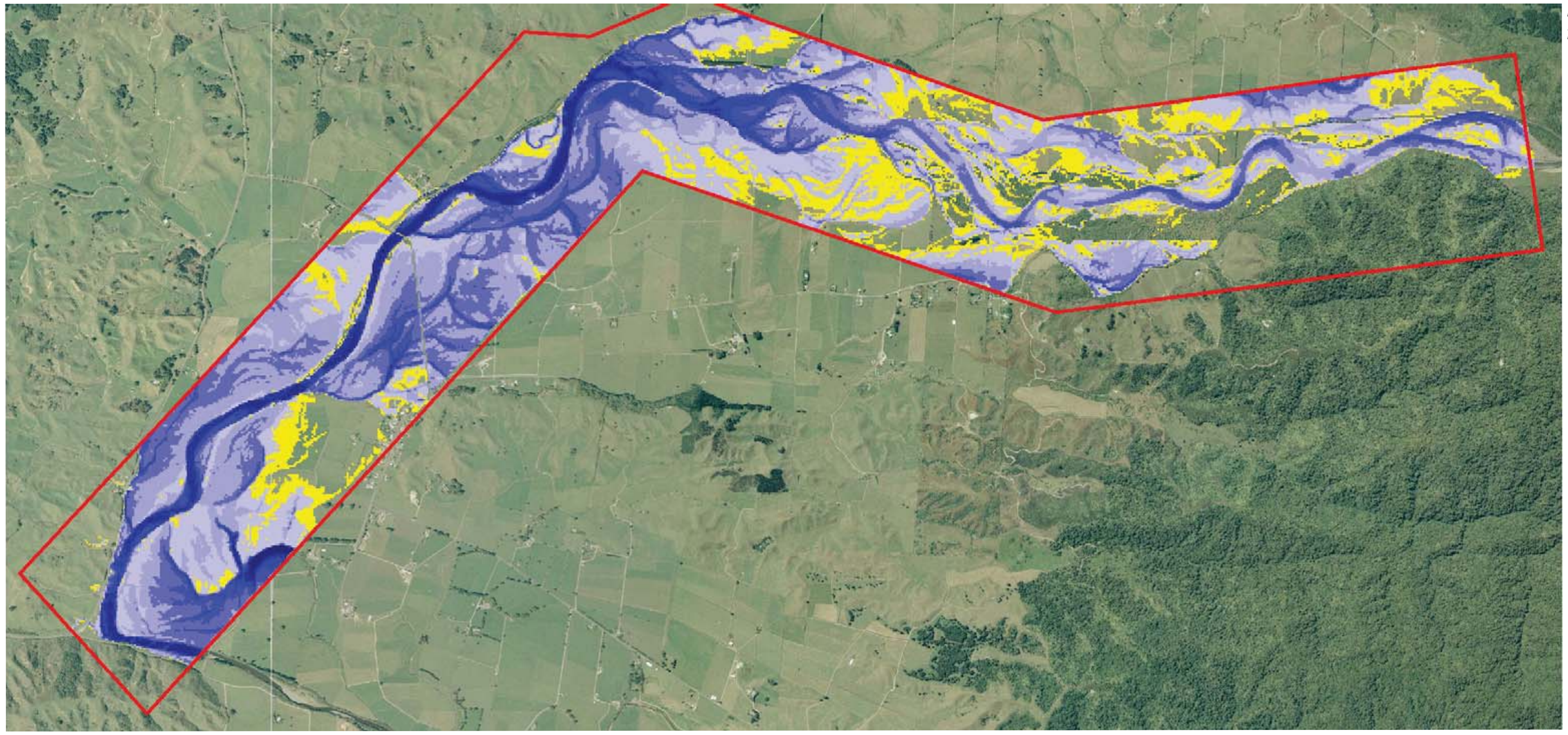


Figure A3.16 - Aerial Photo of the flood extent in the Waimana River floodplain during a 1 in 100 year flood (including 500mm freeboard)

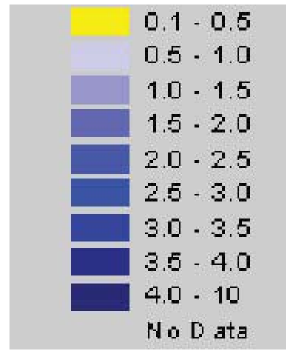
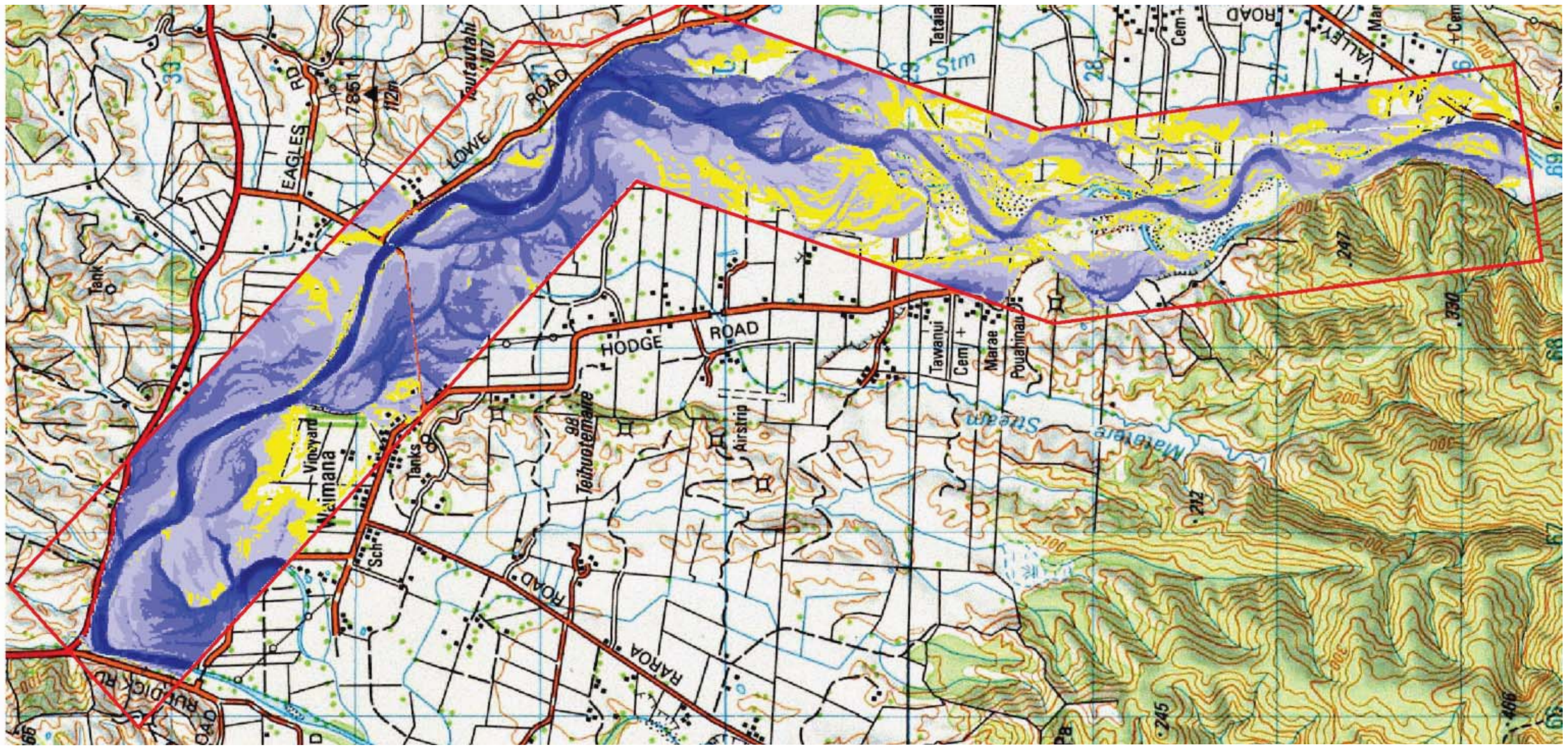


Figure A3.17 - Topography Map of the flood extent in the Waimana River floodplain during a 1 in 100 year flood (including 500mm freeboard)



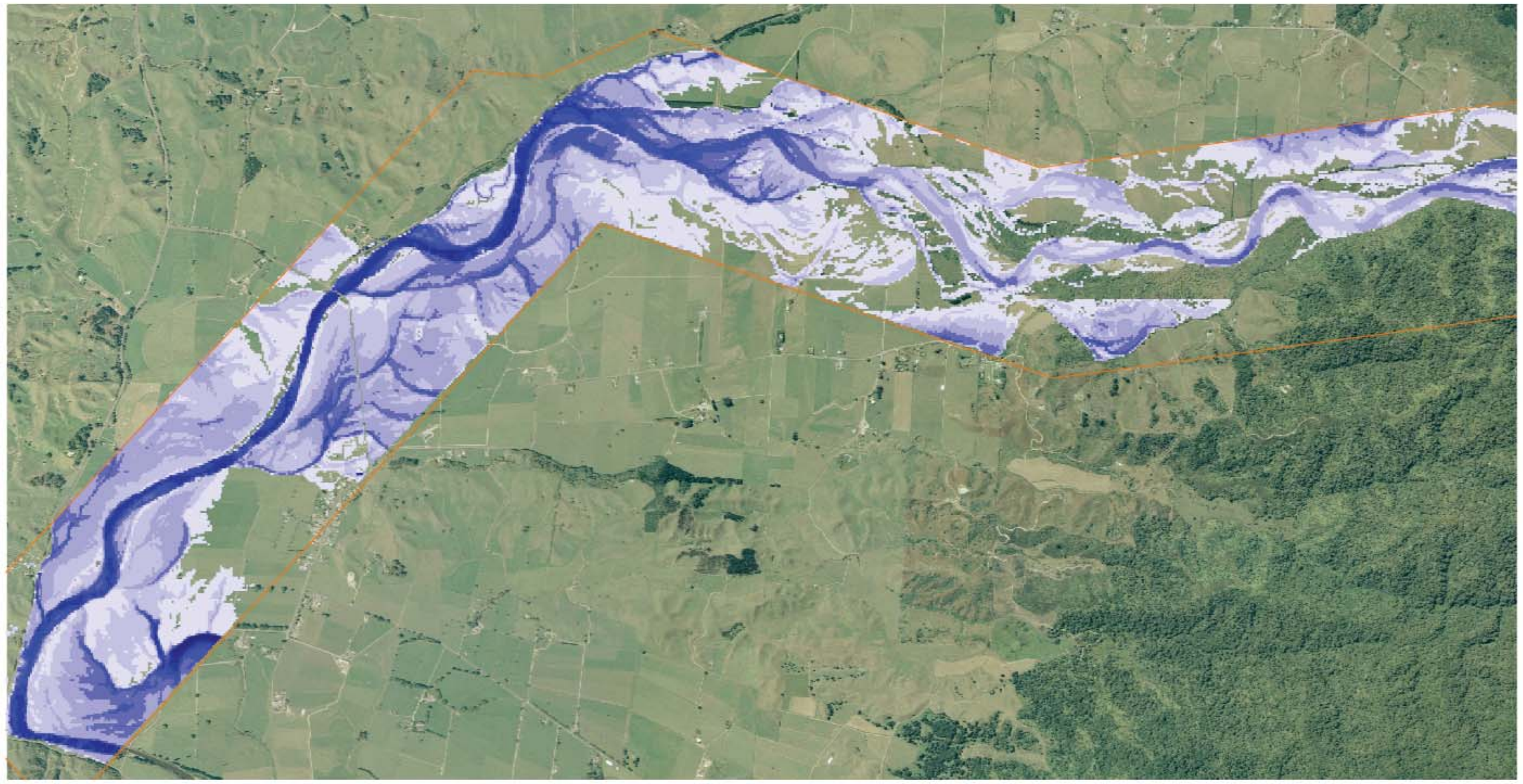
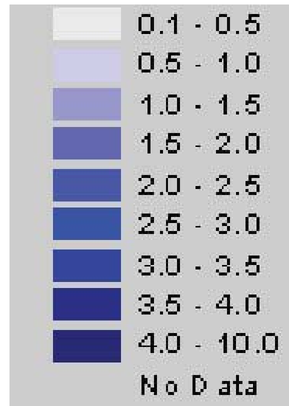


Figure A3.18 - Aerial Map of flood extent in Waimana River floodplain during a 1 in a 200 year flood (excluding freeboard)



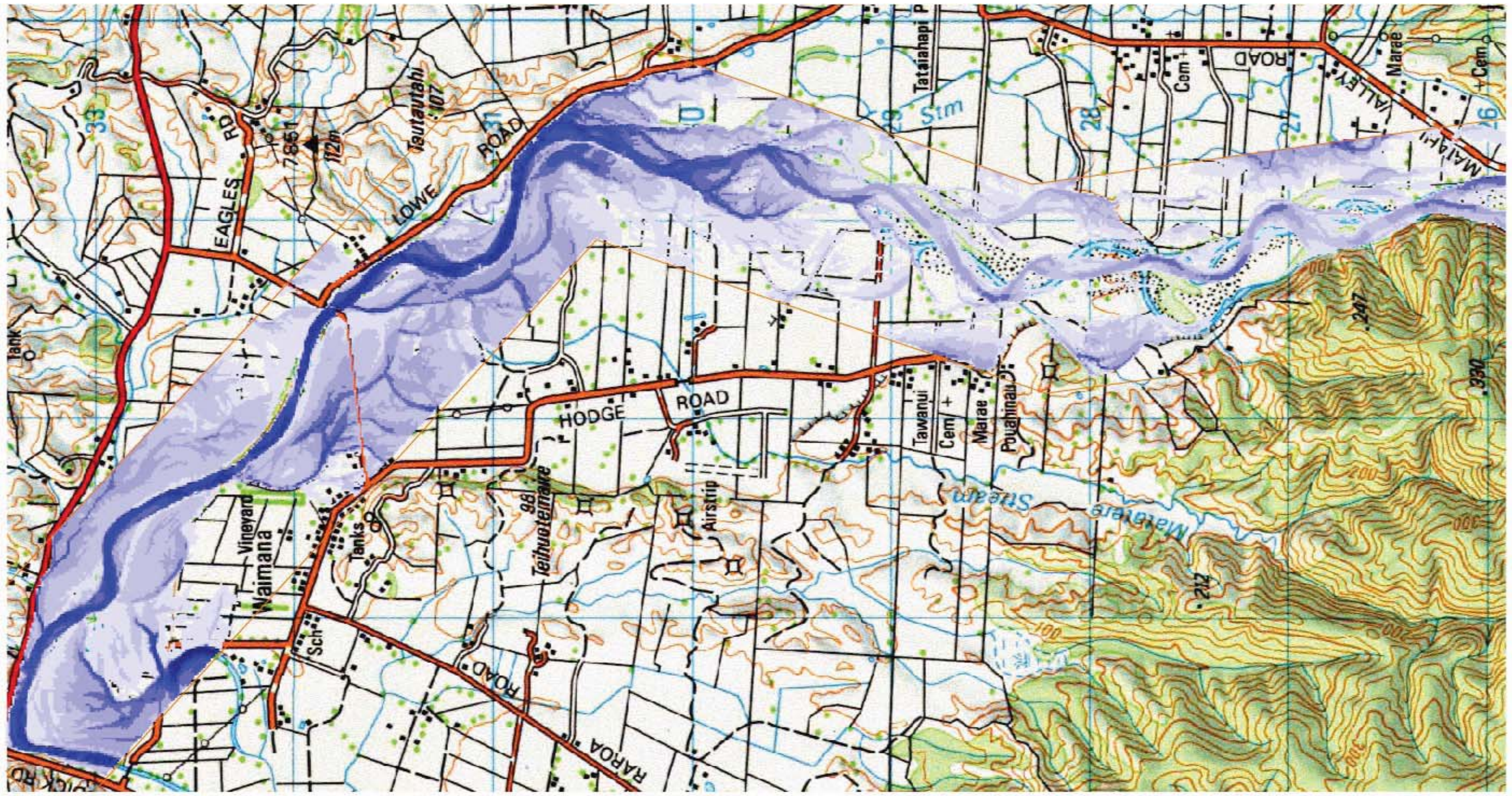


Figure A3.19 - Topography Map of flood extent in Waimana River floodplain during a 1 in a 200 year flood (excluding freeboard)

Appendix 4 – Potential Stopbank Breach Flood Maps

(a) Eivers Road (Breach 3)

A breach has been assumed adjacent to the low area floodplain between the end of Eivers Road and the campground, near the pump station, as indicated by the red line in Figure A4.1 The maximum extent (excluding freeboard) of the flooded area is shaded blue.

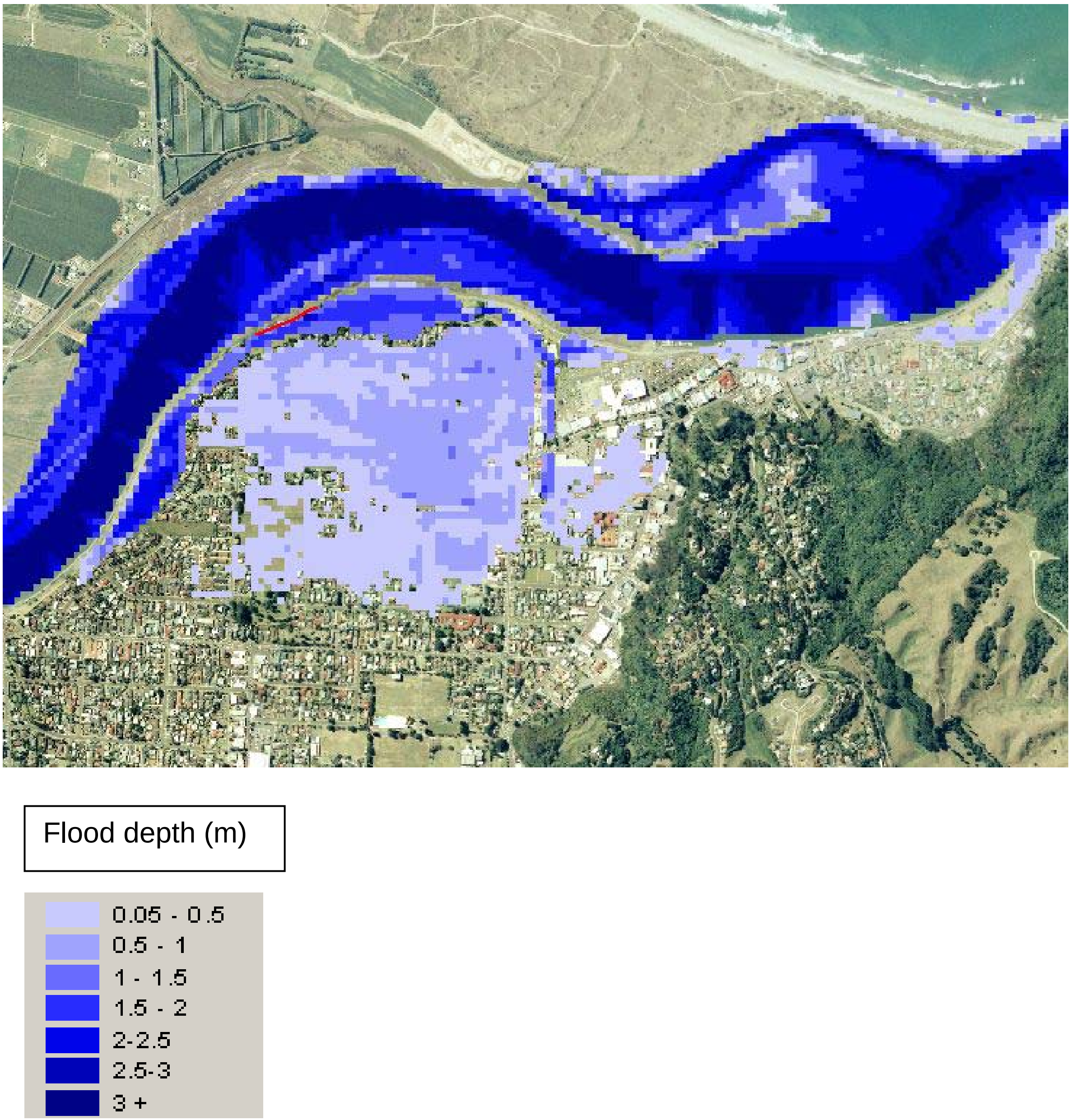


Figure A4.1 Maximum flood extent resulting from a stopbank breach at Eivers Road during a 100 year flood event

(b) Riverside Drive (Breach 5)

The breach location (red line) and maximum extent (excluding freeboard) of the flooded area (blue shading) is shown in Figure A4.2.

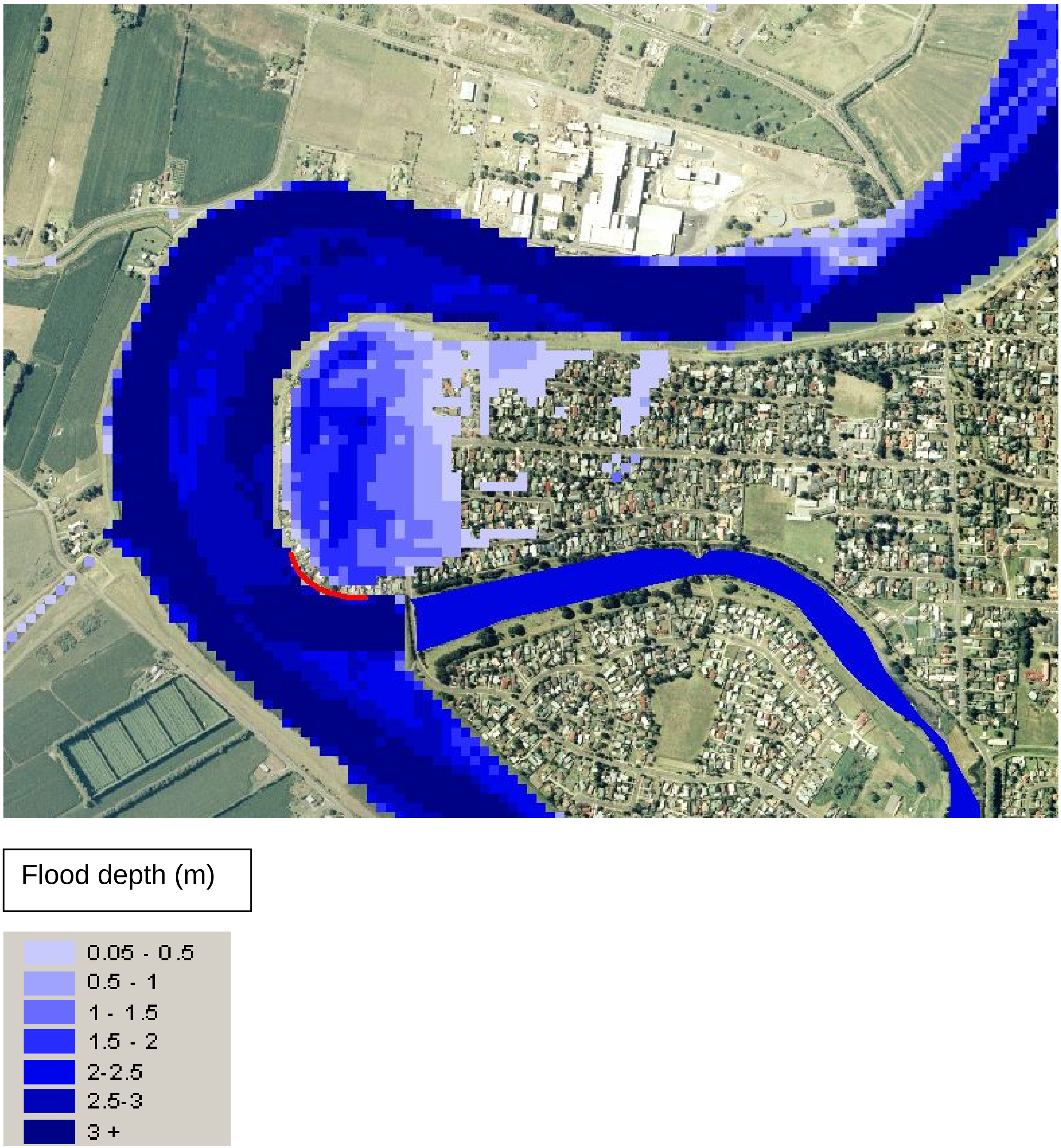


Figure A4.2 Maximum flood extent resulting from a stopbank breach at Riverside Drive during a 100 year flood event

(c) Trident (Breach 6)

The breach location (red line) and maximum extent (excluding freeboard) of the flooded area (blue shading) is shown in Figure A4.3.

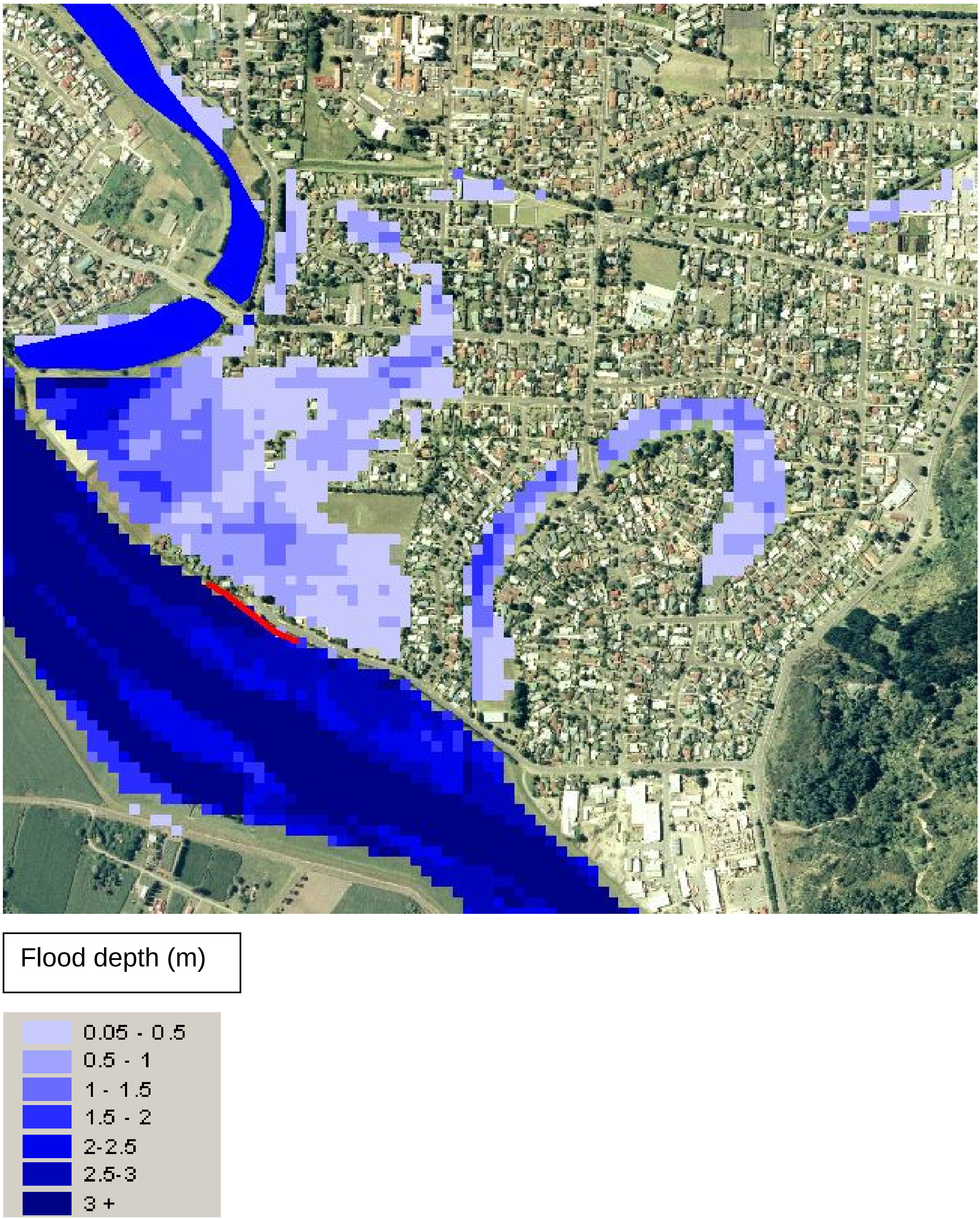


Figure A4.3 Maximum flood extent resulting from a stopbank breach at Trident Road during a 100 year flood event

(d) Red Conway Park (Breach 7)

The breach location (red line) and maximum extent (excluding freeboard) of the flooded area (blue shading) is shown in Figure A4.4.

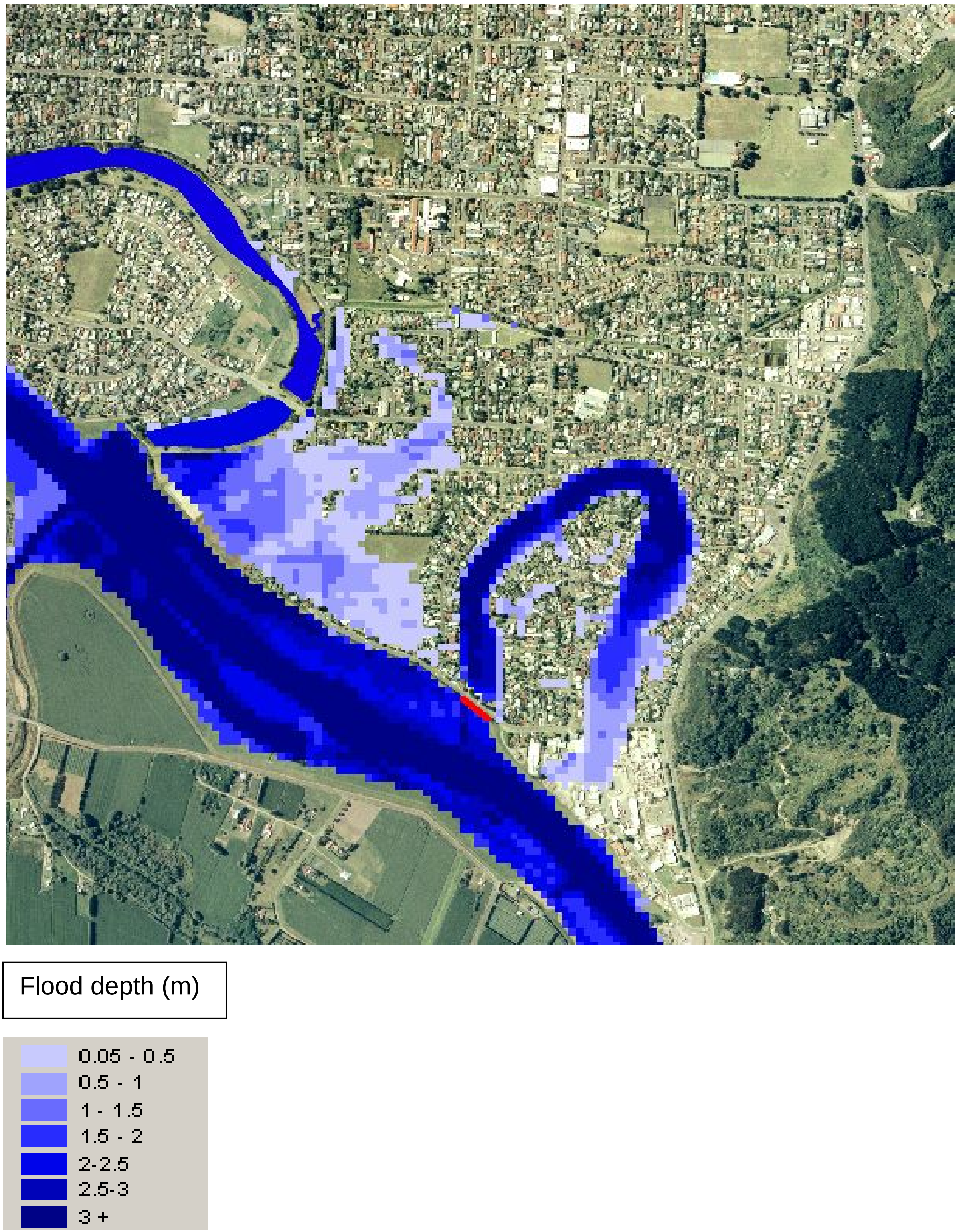
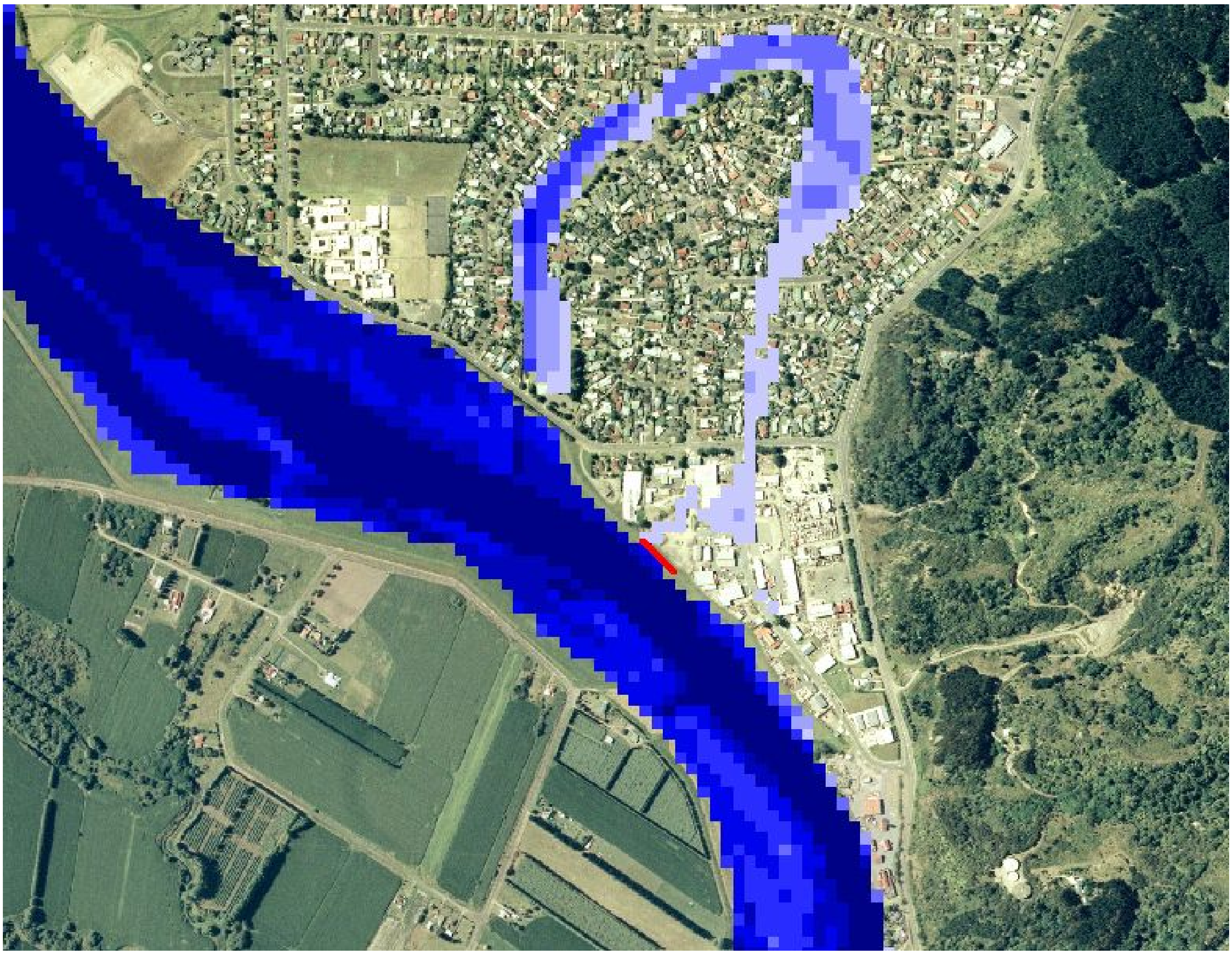


Figure A4.4 Maximum flood extent resulting from a stopbank breach at Red Conway Park during a 100 year flood event.

(e) Te Tahi (Breach 8)

The breach location (red line) and maximum extent (excluding freeboard) of the flooded area (blue shading) is shown in Figure A5.5. This breach has been made narrower than the others, as the floodplain behind the stopbank is generally higher than the 100 year flood level in the river. The flooded area is therefore not very extensive.



Flood depth (m)

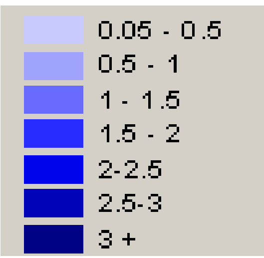


Figure A4.5 Maximum flood extent resulting from a stopbank breach at Te Tahi during a 100 year flood event

(f) Tahere (Breach 9)

The breach location (red line) and maximum extent (excluding freeboard) of the flooded area (blue shading) is shown in Figure A5.6

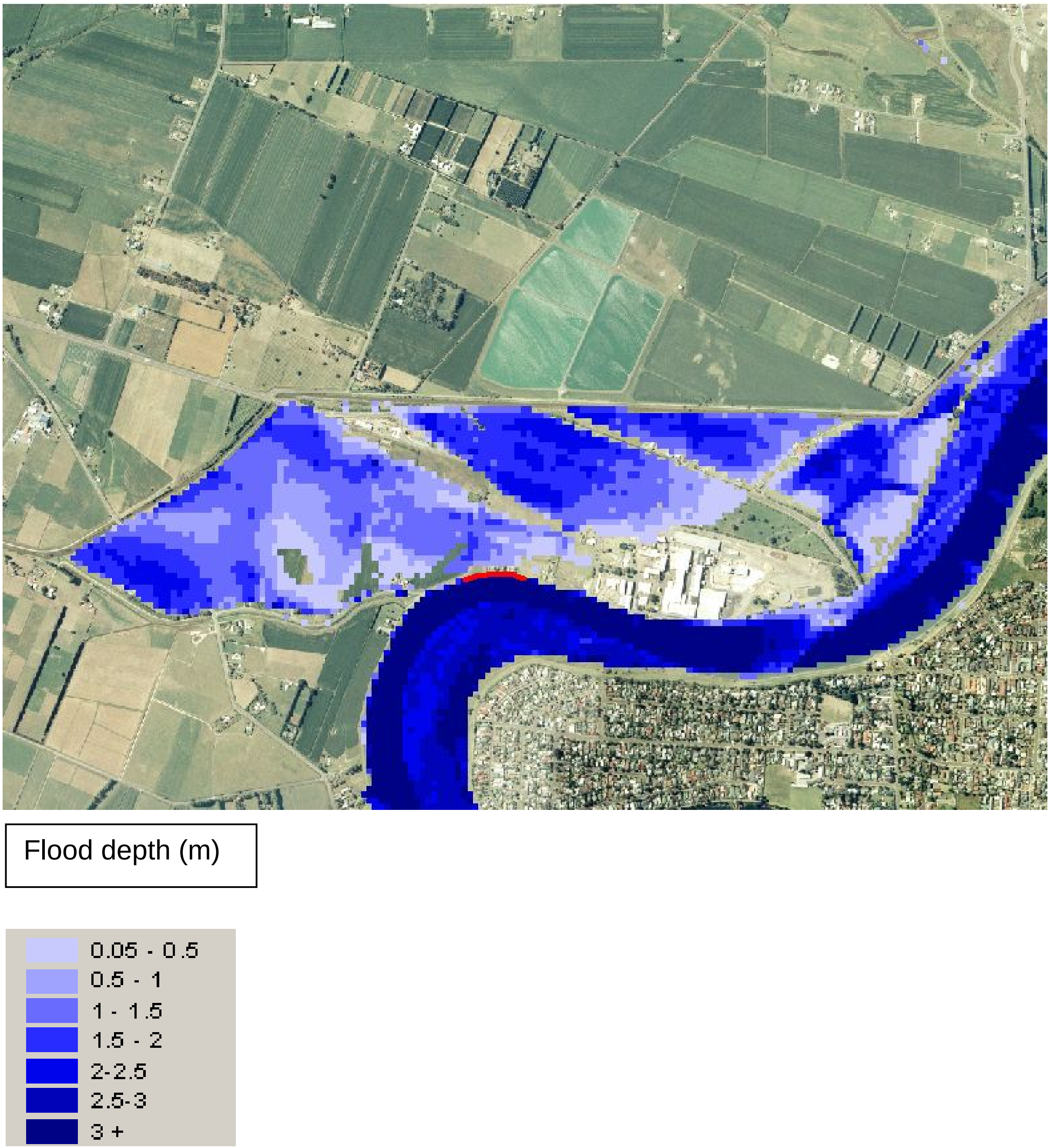
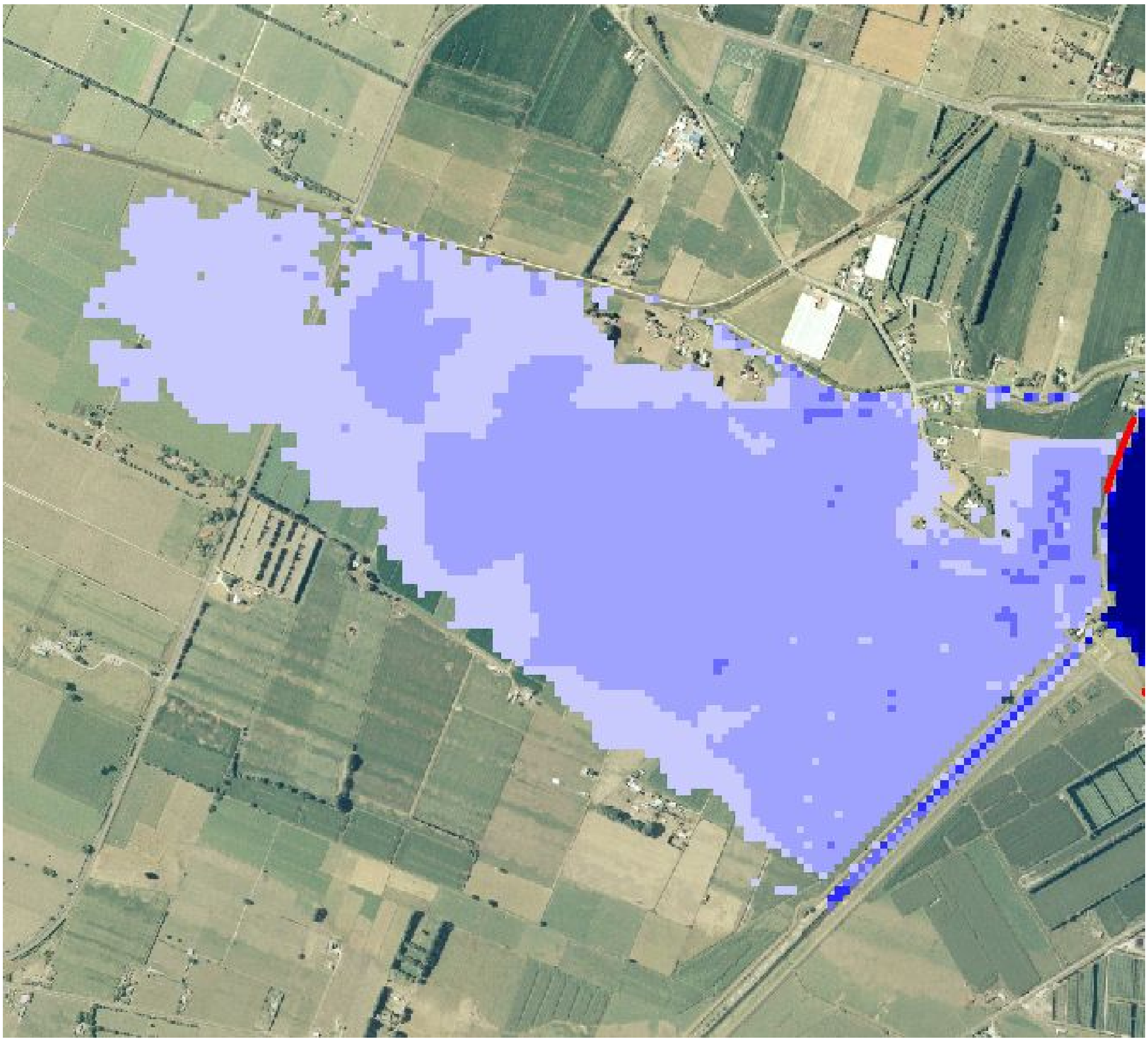


Figure A4.6 Maximum flood extent resulting from a stopbank breach at the Tahere Rd during a 100 year flood event

(g) Fortune (Breach 10)

The breach location (red line) and maximum extent (excluding freeboard) of the flooded area (blue shading) is shown in Figure A4.7.



Flood depth (m)

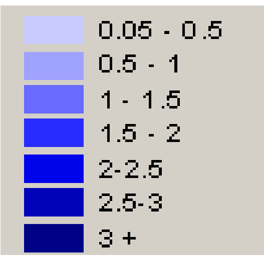
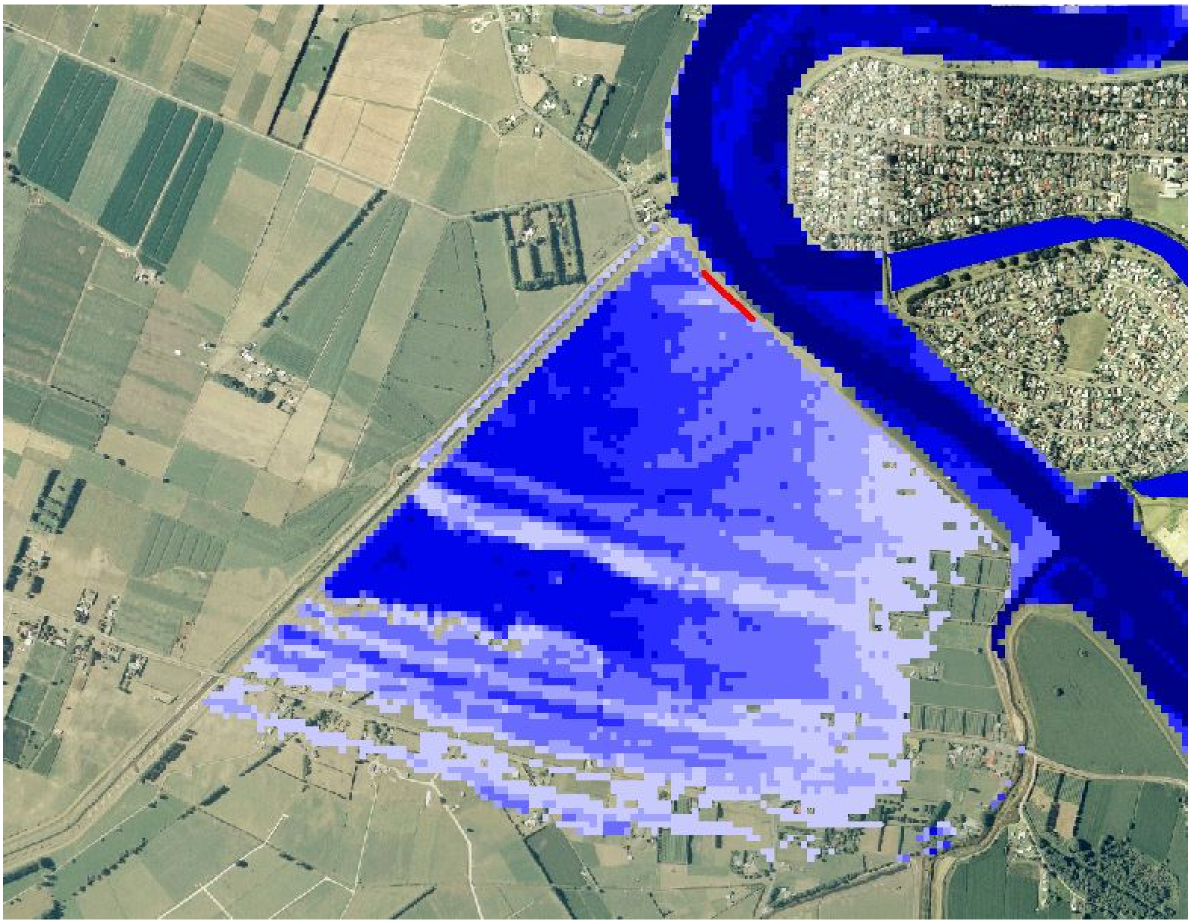


Figure A4.7 Maximum flood extent resulting from a stopbank breach at Fortunes Road during a 100 year flood event

(h) Selwyn (Breach 11)

The breach location (red line) and maximum extent (excluding freeboard) of the flooded area (blue shading) is shown in Figure A4.8.



Flood depth (m)

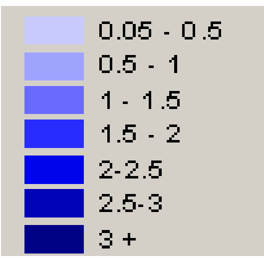


Figure A4.8 Maximum flood extent resulting from a stopbank breach at Selwyn during a 100 year flood event

(i) Rewatu (/Breach 13)

The breach location (red line) and maximum extent (excluding freeboard) of the flooded area (blue shading) is shown in Figure A4.9.

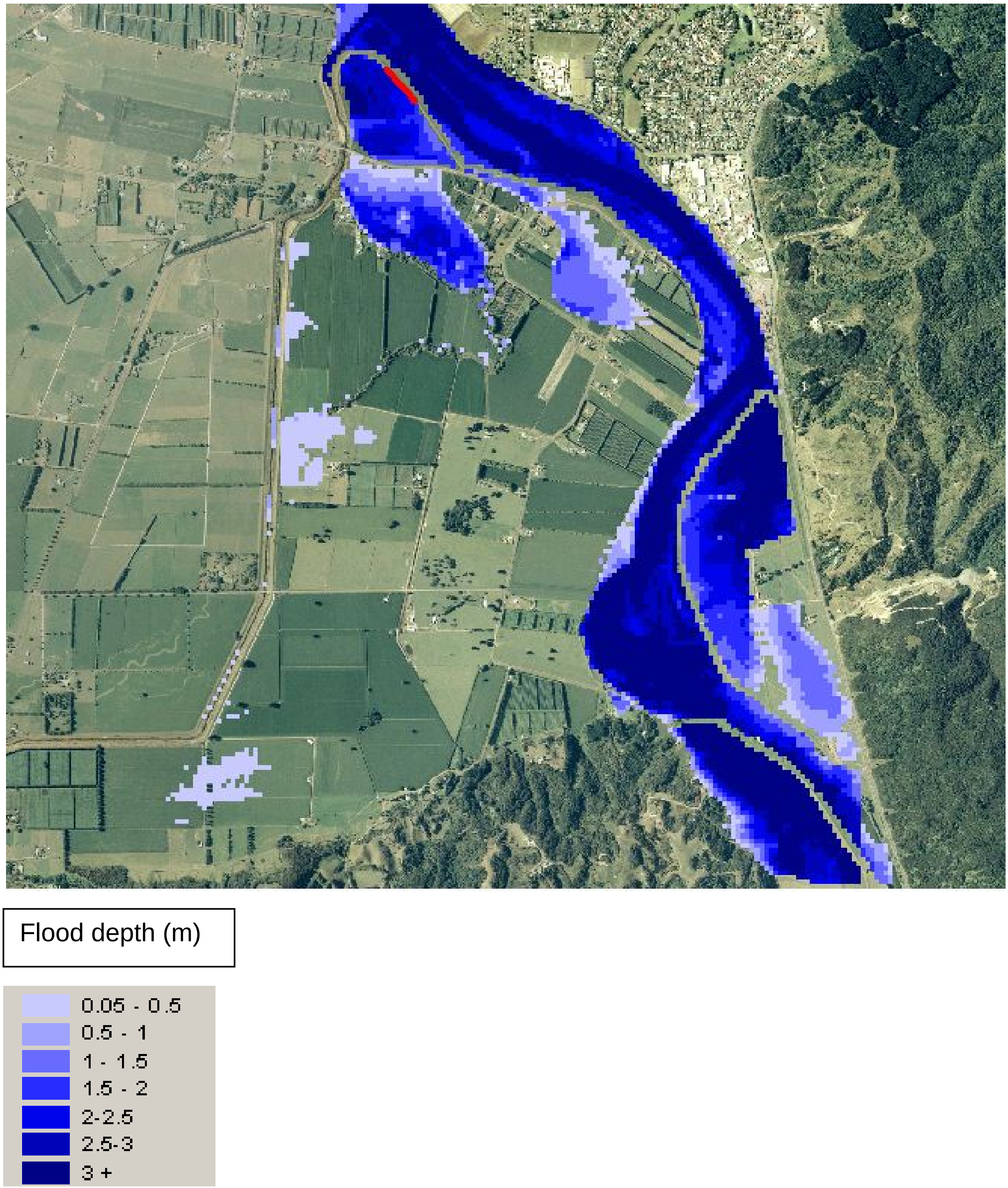


Figure A4.9 Maximum flood extent resulting from a stopbank breach at Rewatu during a 100 year flood event

(j) Rewatu 2 (Breach 14)

The breach location (red line) and maximum extent (excluding freeboard) of the flooded area (blue shading) is shown in Figure A4.10. Note that the overflow path from the breach site to the main ponding area has not been well defined by the model, and the flooded area immediately downstream of the breach is likely to be more extensive than that shown.

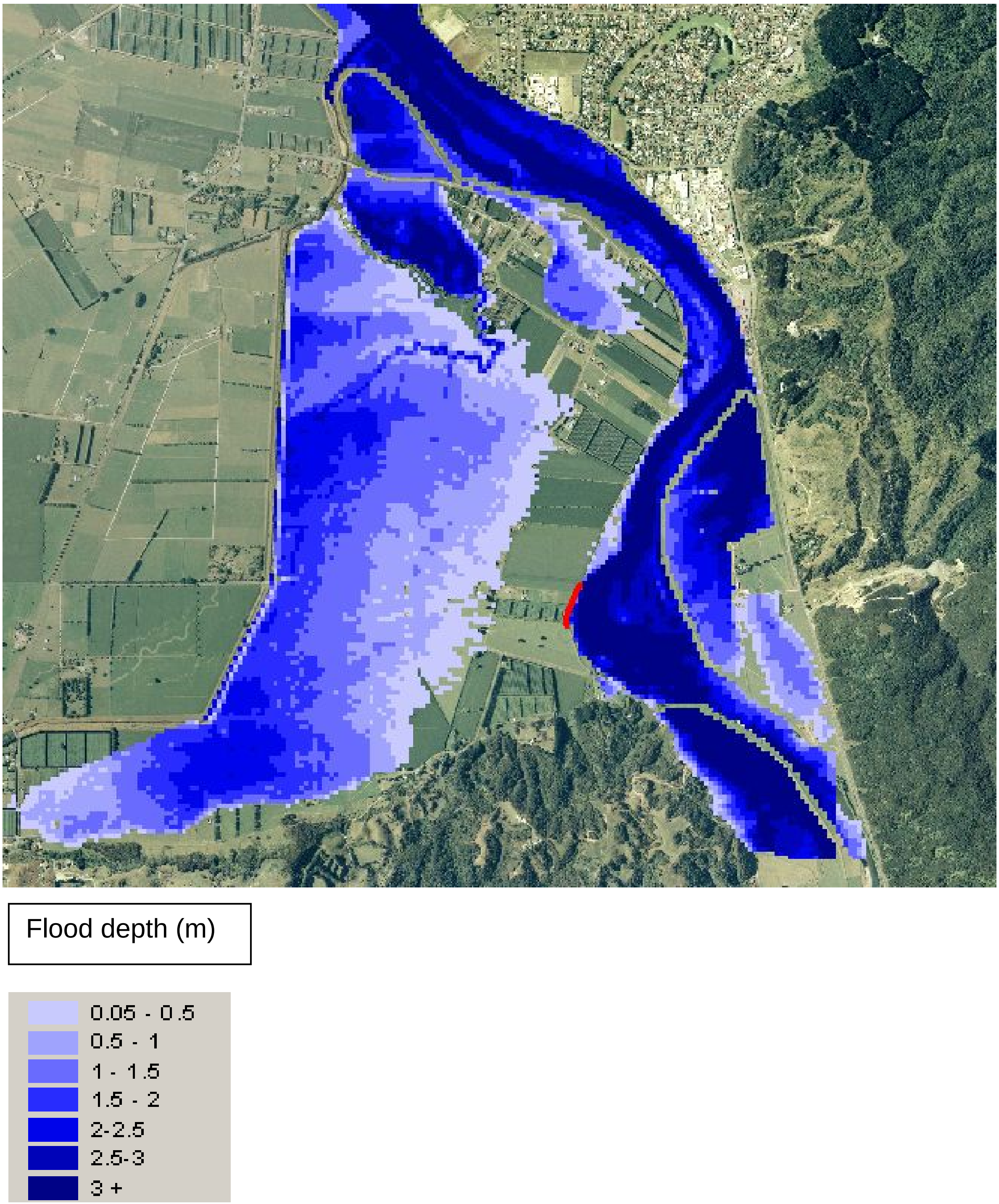


Figure A4.10 Maximum flood extent resulting from a stopbank breach at Rewatu during a 100 year flood event

Appendix 5 –Potential Damages and Annualised Damages

Results of flood modelling can be used to provide estimates of potential damage, provided reasonable information about the value of the floodplain asset or property, and its distribution is available. In a typical exercise:

- A depth-damage curve is produced for a site (an individual property or a group of properties). Although other flood parameters such as floodwater velocity can be used, damages tend to be most sensitive to flood depth.
- The depth for a particular scenario at the site is assessed, with the aid of flood model results.
- The damage, usually in dollar terms is therefore assessed for that site
- The damages are aggregated over the floodplain for the scenario

The results of a desktop flood damage assessment presented below have been derived from real data gathered from the July 2004 Whakatane floods as well as from the February 2004 Manawatu floods.

(a) Urban Damages

In this study loss adjustors GAB Robins (2004) calculated urban damage rates based on the repair/replacement costs for houses damaged in the 2004 floods. GAB Robins also provided damage rating curves for commercial and industrial buildings damaged during the same period (GAB Robins, 2005).

Urban damages comprising residential (both house and contents), commercial and industrial buildings were calculated as a function of flood depth.

Urban damages that could arise as a result of the bank overtopping or breaching scenarios detailed in Appendix 4 and costed in Table A5.3 below.

(b) Rural Damages

AgFirst Consultants (2004) estimated the financial loss and cost for the main productive rural land-uses likely to be affected by a significant flood within the Whakatane Waimana catchment. Land uses are shown in Figure 1.4. Damages were calculated taking into account the season (winter or summer), flood depth, loss of production and reparation costs.

Both July (winter) and February (summer) flood scenarios were considered as losses vary considerably between the two seasons. Damage costs were worked out for flood depths varying between 0 – 3m at 0.5m intervals. Depth of silt also has a significant impact on production, especially in the pastoral land-uses however due to insufficient data it has not been considered in this analysis. For this report an assumed silt depth of between 0 – 0.5cm is deposited. Reparation costs include re-grassing, cropping, grazing, fertiliser and repairs to structures. Costs not included in rural damages were damage to domestic dwellings. These non-urban residential damages were calculated using residential damage rates supplied by GAB Robins.

Average damage rates calculated for the winter and summer seasons are given below in Tables A5.1 and A5.2.

Table A5.1 July (winter) flood assuming 1 – 1.5m of water and 0-5cm silt

Land-use affected	Production loss/ha	Reparation costs/ha	Total Loss & Cost/ha
Dairy	$1,820	$1,205	$3,025
Drystock	$450	$775	$1,225
Maize for silage	$0	$0	$0
Kiwifruit	$2,900	$400	$3,300

Table A5.2 February (summer) flood assuming 1 – 1.5m of water and 0-5cm silt

Land-use affected	Production loss/ha	Reparation costs/ha	Total Loss & Cost/ha
Dairy	$1,333	$866	$2,199
Drystock	$363	$525	$888
Maize	$5,000	$0	$5,000
Kiwifruit	$5,800	$600	6,400

(c) Urban and Rural Damages

Urban and rural damage rates prepared from actual costs incurred during the 2004 floods and results of specific bank breach and overtopping scenarios have been combined to produce damage estimates in the catchment. These damage costs are shown in Table A5.3 and exclude infrastructure such as roading, flood protection etc.

Table A5.3 Potential flood damage estimates for residential, commercial and industrial buildings plus rural costs in the Whakatane Waimana catchment.

Land Use		Stopbank Breach in a 100 year Flood Event										Stopbank Overtopping		Riverbank Overflow					
	Breach Site No.	3	7	5	6	8	9	10	11	13	14								
	Location	Eivers Brch	Red Con Brch	Riverside Brch	Trident Brch	Te Tahi Brch	Mill Brch	Fortune Brch	Selwyn Brch	ReWatu Brch	ReWa2 Brch	Lower Whakatane		Upper Whakatane			Waimana		
		Right bank	Right bank	Right bank	Right bank	Right bank	Left bank	Left bank	Left bank	Left bank	Left bank	100 year flood	300 year flood	50 year flood	100 year flood	200 year flood	50 year flood	100 year flood	200 year flood
Rural - Summer	Dairy	419,211	418,436	420,702	419,010	418,924	439,106	608,147	585,631	431,063	566,990	421,880	459,945	1,114,255	1,212,070	1,255,602	405,593	1,212,070	1,255,602
	Drystock	33,672	33,632	33,672	33,672	33,672	30,368	33,672	33,672	33,672	33,608	33,876	34,388	18,243	22,337	25,667	34	67	112
	Maize/Sillage	0	0	0	0	0	156,672	314,824	390,212	233,664	1,190,624	0	199,668	105,753	126,757	150,239			
	Kiwifruit	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Sub-totals	452,882	452,068	454,374	452,682	452,595	626,145	956,642	1,009,514	698,399	1,791,222	455,756	694,001	1,238,251	1,361,165	1,431,507	405,626	1,212,138	1,255,714
Rural - Winter	Dairy	783,306	780,803	784,996	783,011	782,976	799,396	938,623	1,021,134	797,697	976,879	789,434	860,753	1,657,014	1,873,479	2,025,287	446,479	1,873,479	2,025,287
	Drystock	62,285	62,264	62,285	62,285	62,285	56,562	62,285	62,285	62,285	62,102	62,664	64,109	14,028	18,439	23,863	25	50	93
	Maize/Sillage	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Kiwifruit	0	0	0	0	0	21,287	0	93,508	9,696	52,168	0	0	0	0	0	0	0	0
	Sub-totals	845,590	843,068	847,280	845,296	845,260	877,245	1,000,908	1,176,926	869,678	1,091,149	852,098	924,862	1,671,042	1,891,919	2,049,150	446,504	1,873,530	2,025,380
Urban	Residential	41,537,642	16,515,648	30,792,377	11,269,826	950,397	0	0	0	0	0	0	26,221,031				607,024	879,556	889,888
	Non-Residential	15,860,389	6,181,625	0	4,904,000	684,893	4,745,714	0	0	0	0	0	11,850,476						
	Non - Urban Residential	0	0	0	0	0	2,538,532	131350	2248023	141432	581335	0	0						
	Sub-totals	57,398,031	22,697,273	30,792,377	16,173,826	1,635,290	7,284,246	131,350	2,248,023	141,432	581,335	0	38,071,507	0	0	0	607,024	879,556	889,888
Totals	Summer	57,850,914	23,149,341	31,246,751	16,626,508	2,087,885	7,910,391	1,087,992	3,257,537	839,831	2,372,557	455,756	38,765,508	1,238,251	1,361,165	1,431,507	1,012,650	2,091,694	2,145,602
	Winter	58,243,622	23,540,341	31,639,657	17,019,122	2,480,550	8,161,491	1,132,258	3,424,949	1,011,110	1,672,484	852,098	38,996,369	1,671,042	1,891,919	2,049,150	1,053,528	2,753,086	2,915,268
Average Annualised Damages	Summer	578,509	231,493	312,468	166,265	20,879	79,104	10,880	32,575	8,398	23,726	4,558	129,218	24,765	13,612	7,158	20,253	20,917	10,728
	Winter	582,436	235,403	316,397	170,191	24,806	81,615	11,323	34,249	10,111	16,725	8,521	129,988	33,421	18,919	10,246	21,071	27,531	14,576

Note: Stopbank breach and riverbank overflow scenarios do not include an allowance for freeboard whereas lower Whakatane stopbank overtopping does.

In July 2004 rural damages for the catchment were estimated by MAF to range between \$4.67m – \$5.07m. This range of figures included reinstatement costs to productive land and production losses (Refer section 2.7.4). This range compares with the modelled rural damage costs during winter for all sub-catchments in 100 year flood of \$5.5m.

Stopbank breaches at locations closest to the town's CBD result in the greatest damage costs. For example the greatest flood damage results from a stopbank breach at Eivers Road under a 100 year flood event where total damages are estimated to range between \$57.9m – \$58.2M. Most of the damage, at \$57.2m occurs in urban areas closest to the CBD where residential and non-residential areas (including commercial and industrial) are flooded.

Flood damages due to stopbank breaching reduce at sites located upstream of Eivers Road. For example a stopbank breach at Fortunes would cost between \$1 m and \$1.1 m in damages.

Rural damage occurs in all stopbank breach scenarios.

Flood damages register in rural areas for breaches that occur on true right urban stopbanks (sites 3, 5, 6. 7 and 8) because elsewhere rural land that lies between urban stopbanks and the river floods in the 100 year flood event.

Stopbank breaches on the true left (breach 9, 10, 11, 13, 14) result in mostly rural land flooding and to a lesser extent non-urban residential lots.

Flood damage resulting from a breach of the true left urban stopbanks is less then if a breach were to occur on the true right stopbanks. Should a breach occur on the left stopbank in a 100 year flood event then total damages range between \$1m - \$8.2m whereas stopbank breaches on the true right range between \$2.1m - \$58.2m. The difference is due to the higher density of residential and non-residential buildings located on the true right bank.

Damages modelled for the Lower Whakatane resulting from stopbank overtopping in a 100 year flood event range between \$0.5m - \$0.85m. Damages are almost entirely rural related since urban areas are protected by 100 year stopbanks.

In the 300 year flood event modelled damages for Lower Whakatane rise to approximately \$39m. Damages are similar for the 200 year flood event. Most of the damage, at \$39m occurs in urban areas when the 100 year stopbanks overtop. Residential, non-residential and rural areas are flooded.

In the Upper Whakatane damages modelled for events ranging between 50 and 200 year flood events range between \$1.2m - \$2m. Modelling indicates that most of the costs are attributed to rural damages. Some urban damage does occur in Upper Whakatane but this is limited to isolated buildings. Floodmaps indicate that townships such as Opouriao, Ruatoki and Waikirikiri appear to be located above flood levels for events ranging between 50 and 200 year flood events.

In the Waimana damages modelled for events ranging between 50 and 200 year flood events range between \$1m - \$2.9m. Modelling indicates most of the costs are attributed to rural damages. However residential house also suffer the effects of flood damage.

References

AgFirst Consultants Ltd (2004) *The Affect of Flooding on Various Land-Uses Within the Whakatane River Catchment* by M. McIntosh, December 2004

Balley (2000) Whakatane River Mouth Hydraulic, Whakatane Environment Bay of Plenty, November 2000.

Blackwood (2005) PowerPoint Presentation to Whakatane District Council – "Bay of Plenty Regional Council River & Drainage Schemes: Provision of Global Warming Draft Policy", 25 October 2005

Bay of Plenty Catchment Commission (1985) *Whakatane River Major Scheme, Volume 1* Whakatane: BOPCC

Bay of Plenty Catchment Commission (1987) *The Whakatane River Major Scheme, Pre – Completion Review* Whakatane: BOPCC

Bay of Plenty Regional Council, B R Titchmarsh (1993) *Wainui Te Whara Stream Investigations and Design Report Whakatane*: BOPCC

Cowie, C.A (1957) *Floods in New Zealand 1920 – 1953 with Notes on Earlier Floods* Wellington: The Soil Conservation & Rivers Control Council

Crabbe B.K. (2006) Spreadsheet prepared for MCDEM titled "Cost of Works Completed to 31 December 2005 includes Estimates (Copy for MCDEM)"

Environment Bay of Plenty (1998) *Application to Government for Financial Assistance July 2004 Floods and Earthquake Events* ISSN 1176 – 5550, August 2004 Whakatane: Environment Bay of Plenty

Environment Bay of Plenty, G R Ellery (2000) Meterology and Hydrology of the July 1998 Floods, May 2000, Internal Report 2000/03.

Environment Bay of Plenty (2004) *The July 1998 Floods and Damage to Environment Bay of Plenty's Infrastructural Assets: Request for Assistance under Governments Natural Disaster Recovery Plan* Whakatane: Environment Bay of Plenty

Environment Bay of Plenty, Britton R (2006) Whakatane-Waimana Rivers Asset Management Plan, Operations Publication 2006/03, ISSN 1176-5550, July 2006

Environment Bay of Plenty, R Britton (2004) *Follow Up Memo: Potholes in Riverside Drive* File 2320 04 03 19/8/04, Whakatane: Environment Bay of Plenty

Environment Bay of Plenty, Pascal Balley & Verna Arts (2003) *Kope – Orini Canal System Model (2003 Stopbank Levels)* Whakatane: Environment Bay of Plenty

Environment Bay of Plenty, I Pak (2006) Te Rahu Basin Performance, File 5800 05 and 1950 01, Whakatane: Environment Bay of Plenty

Environment Bay of Plenty, I Pak (2005) *Hydraulic Modelling of Waimana River and Floodplain* Whakatane: Environment Bay of Plenty

Environment Bay of Plenty, P West (2005) *Review of Flood Levels in the Upper Whakatane River upstream of Taneatua* Whakatane: Environment Bay of Plenty, April 2005

Environment Bay of Plenty, I Pak (2003) *Canal Capacity: Waioho Canal* Whakatane: Environment Bay of Plenty

Environment Bay of Plenty, I Pak (2003) *Canal Capacity: Te Rahu Canal* Whakatane: Environment Bay of Plenty

Environment Bay of Plenty, I Pak (2003) *Natural Environmental Regional Monitoring Network River and Stream Channel Monitoring Programme 2002/03*

Environment Bay of Plenty*, B Crabbe (2002) July 1998 Flood Damage Repair Costs*: Environment Bay of Plenty memo, 15 January 2002, File 5600 06

Whakatane: ENVIRONMENT BOP

GAB Robbins (2005) *Whakatane Waimana Floodplain Management Strategy – Commercial*, by H Beedie

GAB Robbins (2004) *Whakatane Waimana Floodplain Management Strategy, Stage 1: Flood Damage Costs for Residential Properties*, by H Beedie

Gibbons, Walter H (1990) *The Rangitaiki 1890 – 1990* Whakatane: Whakatane & District Historical Society (Environment Bay of Plenty library reference: 993.1 Rangitaiki)

Manders (2006) Telephone conversation, Miles Mander/ (National Bank)/Robbin Britton, 13 December 2006

McCallum, Malcolm & Weber, Dr Jeff (1993) *Economic Benefits and Costs of Investing in Management Schemes for the Waimana & Upper Whakatane Rivers* Whakatane: Environment Bay Of Plenty (Environment Bay of Plenty file reference: 5540 – W03)

McIntosh (2006) *Rural Comment for WWFMS*, Email Mark McIntosh (AgFirst) to Robbin Britton, 11 December 2006

NIWA, (1998) Review of Probability Estimates of the Bay of Plenty July 1998 Floods, October 1998.

OPUS International Consultants (2001) *Floodplain Management Planning Guidelines – Current Thinking and Practice in New Zealand,* December 2001*.*

Riley Consultants Ltd (2002); Whakatane River Stopbanks Geotechnical Study, Draft Report No. 2 (RC Ref: 02223 – A), by Tate, D, 14 October 2002. (Environment Bay of Plenty Library Reference: 627.514 WHAKATANE RIVER).

Riley Consultants Ltd, (2002); Whakatane River Stopbanks Remediation Options at Barry Avenue Pump Station and Red Conway Park, (RC Ref: 02223 – C), by D. Tate, 14 November 2002.

Stocker, H (1985) *Whakatane River Major Scheme Review: Evaluation of Lower Whakatane River Flood Protection Works* Whakatane: BOPCC.

Surman, M (1995) *Whakatane River Below Pekatahi Bridge – Model and Hydrology Review* Whakatane Environment Bay of Plenty

Surman, M (2000) 1995 Report on Kope-Orini Canal System Model – Amended 11/1/00, Whakatane Environment Bay of Plenty, January 2000.

Titchmarsh, B R; (1992) *Whakatane River Scheme Middle Reaches Investigation: Report on the Middle Reaches of the Whakatane River Upstream of the Pekatahi and Waimana River from Taneatua to Matahi* Whakatane: BOPRC.

Wallace, P; (2006) *Stopbank Breach Risk* Assessment *Whakatane River:* Wellington, March 2006.

Wallace, P; (2004) *Hydraulic Modelling of Lower Whakatane River:* Wellington, July 2004.

Whakatane District Council; (1998) *July 1998 Floods: Application for Disaster Relief Funding* by B.F. Miles, General Manager, Whakatane: Whakatane District Council.

Whakatane District Council (2003) *Proposed Whakatane District Council Plan* Whakatane: Whakatane District Council, 14 February 2003.

Wellington Regional Council (1976) *Living with the River: Phase One Summary Report* Wellington, November 1996.

Newspaper Articles

Wanganui Chronicle Special Feature (2004) *Storm*, March 2004

Web Pages

http://www.ourregion.co.nz/news.php?articleID=290#hollie

Glossary of Terms

Aggradation – The build up of gravels and other materials deposited by flowing water in the bed of a river over a moderate to long period of time.

Annual Plan – A document produced annually by local authorities to inform stakeholders of its objectives, intended activities and expenditure required for a period of one financial year.

Asset – A physical facility of value which enables services to be provided and has an economic life of greater than 12 months.

Asset Management (AM) – The combination of management, financial, economic, engineering and other practices applied to physical assets with the objective of providing the required level of service in the most cost effective manner.

Average Recurrence Interval (ARI) – The long-term average number of years between the occurrence of a flood as big as (or larger than) the selected event. For example, floods with a discharge as great as (or greater than) the 20yr ARI design flood will occur on average once every 20 years. ARI is another way of expressing the likelihood of occurrence of a flood event. (see also annual exceedance probability).

Berms – Low-lying flat land adjacent to the riverbank. Berms are a natural extension of the main channel, and carry water during floods.

Berm Protection – The land area between the river edge and the stopbanks provides river berm protection. It combines with edge protection to provide security for stopbanks.

Breaching – Breaching occurs when flood waters attack and erode stopbanks and floodwalls, eventually breaking through to flow through previously protected floodplain areas.

Condition Monitoring – Continuous or periodic inspection, assessment, measurement and interpretation of resulting data, to indicate the condition of a specific component so as to determine the need for some preventive or remedial action.

Cumec – A cumec measures water flow. 1 cumec equals 1 cubic metres of water passing a given point every second ($1m^3$/sec).

Design Flood – A hypothetical flood representing a specific likelihood of occurrence (for example the 100 year or 1% probability flood). The design flood may comprise two or more single source dominated floods.

Design Standard (Or Service Level) – The standard of the flood mitigation methods designed to contain a flood of a certain size.

Development – Erecting a building, carrying out excavations, using land or a building, or subdividing land. *Infill* development refers to developing vacant blocks of land that are generally surrounded by developed properties. Greenfield development refers to developing properties in previously underdeveloped areas, e.g. the urban subdivision of an area previously used for rural purposes (see non structural measures).

Effects – See adverse effect or flood hazard effects.

Emergency Management Measures – See non-structural measures.

Flood – A relatively high river flow that overtops the natural or artificial banks in any part of a watercourse (see cumec).

Flood Defences – Physical structures that keep floodwaters in the river corridor. They include stopbanks and flood walls (see structural measures).

Flood Hazard – The potential for damage to property or people due to flooding and associated erosion.

Flood Hazard Effects – The negative impacts of flooding caused by fast flowing or deep ponded flood waters. Fast flowing or ponded flood waters are dangerous for people, becoming more severe where floods affect urban areas. These effects also include damage to the flood protection system. And other structures and building by water and debris, or by erosion.

Floodplain – The low-lying portion of a river valley, adjacent to the river corridor, which is covered with water when the river overflows during floods.

Flood Warning – The process used to warn a community of an impending flood. Warnings to the general public may be provided by methods such as local radio stations and street alarm systems (see emergency management measures).

Freeboard – A factor of safety usually expressed as a height above the adopted flood level thus determining the flood planning level. Freeboard tends to compensate for factors such as wave action, localised hydraulic effects and uncertainties in the design flood levels.

Geomorphology – The landform and landscape of a particular place, shaped by physical processes.

Gravel Extraction – The selective removal of surplus gravel from the riverbed. Extraction has two main purposes: (1) to maintain optimum flood capacity without worsening bank erosion; (2) to correct misalignments and ease flow pressure against eroding banks. Extraction occurs on the beaches in the riverbed and, excluding river crossings, usually does not involve work in flowing water.

Infrastructure – Networks, links and parts of facility systems, e.g. transport infrastructure (roads, rail, parking) of water system infrastructure (pipes, pumps and treatment works).

Land Information Memorandum (Lim)/ Project Information Memorandum (PIM) – They contain a wide range of information about a chosen parcel of land, such as the presence of natural hazards, access easements, services such as stormwater drains, or resource consents issued on the property. Including all publicly available hazard information in a LIM or a PIM is a statutory requirement under section 31 of the Building Act section 44 of the Local Government and Official Information and Meetings Acts, respectively. Guidance may be given for the way this information is interpreted and presented.

Level of Service – The definition of service quality for a particular activity (i.e. roading) or service area (i.e. street lighting) against which the service performance may be measured. Service levels usually relate to quality, quantity, reliability, responsiveness, environmental acceptability and cost.

Meander – The natural wave-line pattern of a river on a floodplain.

Mitigation – For this plan, the act of moderating or reducing the effects of the flood hazard or flood protection works (see flood hazard effects and adverse effects)

Non-Structural Measures – Non-structural measures mainly deal with the residual risk of flooding. These measures keep people away from floodwaters and help the community cope when flooding occurs. *Land-use measures* influence the way land is used and buildings are constructed. They include *regulatory methods* (policies and rules in district plans) and *voluntary actions* (information and advice to help people to make their own decisions). *Emergency management measures* seek to improve the community's preparedness and response to flooding. Non-structural measures are the most cost-effective flood mitigation approach.

Overtopping – The process of floodwaters flowing over the top of stopbanks and floodwalls (see breaching).

Renewal – Works to upgrade refurbish or replace existing facilities with facilities of equivalent capacity or performance capability.

Runoff – The amount of rainfall from a catchment that actually ends up as flowing water in the river or creek stage.

Service – As in *utility service,* is a system and its network infrastructure that supply a community need.

Stopbanks – Banks aligned beside the river to prevent floodwaters flowing into floodplain areas. They are also known as *flood defences.*

Structural Measures – Structural measures are structures or other physical works designed to keep floodwaters away from existing development. Stopbanks and floodwalls are obvious examples of structural works. Channel works include bank edge works and channel management. Rock linings, vegetation buffers and groynes are bank edge works, which protect flood defences like stopbanks and maintain the channel's position. Other active channel management methods include bed and beach re-contouring and gravel extraction. They are used occasionally to reduce the opportunity for the river to erode its banks and damage structural works.