greater WELLINGTON
REGIONAL COUNCIL
Te Pane Matua Taiao

Te Kāuru Upper Ruamāhanga

A floodplain management plan for the Upper Wairarapa Valley

Phase 1 Summary – Volume 1 – Report

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1. Executive Summary

1.1 Scope and Study Area

This Summary Report covers the first phase of investigations and context setting for floodplain management planning for Te Kāuru Upper Ruamāhanga, an area covering much of the Upper Wairarapa Valley.

The catchment above its confluence with the Waiohine covers an area of 1560 square kilometres. This is made up of the eastern Tararua Ranges, the Wairarapa plains and the eastern hills.

The geological and climatic characteristics of the Wairarapa are reflected through its rivers – contrasting between the energised, gravel bed character of the western rivers of the Ruamahanga, Waipoua and Waingawa, and the more sluggish, generally soft sediment bed eastern rivers of the Kopuaranga, Whangaehu and Taueru (Tauweru).

1.2 History and context

The naming of the Ruamahanga River is attributed to a number of stories relating to its translation of 'Rua' meaning two and 'Māhanga' meaning twins or snare trap. Te Kāuru (head waters) is the name given to the area by Māori for the catchment between Pukaha/Mount Bruce and the confluence of the Ruamāhanga River with the Waiohine River. Many of the names given to places and the rivers throughout the catchment come from the story of Haunui-a-nanaia.

The Upper Ruamāhanga catchment is highly valued within the Wellington region. Te Kāuru – the headwaters of the Ruamāhanga catchment – extend from the Tararua Ranges to the Eastern Hills covering an area of 1560 square kilometres. The western puna (springs) and tributaries emerge from the rugged Tararua Ranges. They are well known for their pristine environments and as a result they are much valued for their beauty, mauri, recreational opportunities and spiritual significance. The eastern tributary landform is characterised by undulating hills which is today dominated by agricultural use. However, there remains a strong cultural significance within and around these eastern rivers for Tangata Whenua, and they are popular in some areas for recreational pursuits.

Both the western and eastern tributaries run out onto the fertile Wairarapa plains which have been formed over time through deposition of alluvial material, including greywacke alluvium from the Tararua Ranges and alluvial silts and sands eroded from a mixture of mudstones, sandstones and limestones which form the Eastern Wairarapa Hills.

Through these floodplains run the Waingawa, Waipoua, Kopuaranga, Whangaehau, and Taueru rivers and a number of other smaller tributaries. They all eventually flow into the Ruamahanga River which connects all of these rivers, the mountains and hills on the north, west and east, and, southwards through the valley to Wairarapa Moana, and eventually onto Te Kauae raro/Palliser Bay and the Cook Strait/Raukawa Moana.

These rivers are the lifeblood of the Wairarapa and significant both for Māori and non-Māori. People from a range of cultures share a connection at an individual, family, hapu, community, iwi and organisational level, and each value the rivers in their own, and often different ways.

The land-use of the catchment is dominated by native forest in the upper Tararua Ranges, which transitions into a range of primary production activities -plantation forestry, dry stock grazing, dairying, and cropping - , rural lifestyle development, and urban areas on the floodplain.

Tangata Whenua have had a long-standing connection spanning many generations with the Ruamahanga River and all of its tributaries. Both Ngāti Kahungungu ki Wairarapa and Rangitāne o Wairarapa currently share in the role of Kaitiaki for these catchments.

Non-Māori have been present in the Wairarapa for a shorter period, however over several generations they also have developed strong ties to the land and landforms. Some of the families were present on the first European settler ships, and they have made their mark on the modern social, political and physical landscape through recurrent involvement in the ongoing development changes in the Wairarapa.

Today the Wairarapa has a distinct identity. It has both a legacy of, and a future rich with cultural significance to Māori. With strong agricultural roots – the leading industry in the area – it is also noted for the quality of its landscape and associated recreational opportunities, and its hosting of a number of regional events and concerts. Home to some 40,000 residents, the Wairarapa has produced or become home to more than a representative share of well-known ambassadors ranging from noted scientists and engineers to popular musicians and film directors.

1.3 Hazards

The above snapshot of the Upper Ruamāhanga catchment however, is not complete without consideration of natural hazards. Communities throughout history have had to adapt to a changing natural environment.

For early Māori and later the first European settlers this led to an approach whereby permanent settlements existed but were supported by the establishment of seasonal sites. The timing of these would be driven by a range of factors including flood risk, and their location governed by proximity to important and lucrative resources which were often very close to rivers. These sites would provide easier transport links, improved access to water, food and fertile land.

Today, some of these settlement sites have grown into large towns and their permanency has become well established. The increased size has put them in a position where some parts of the community have spread out into areas of greater hazard. This, combined with changing environmental conditions, leads to growing conflicts between flood hazard and community, and results in increasing risk to both life and property.

1.4 Phase 1 Investigation Outcomes

The investigations summarised in this report were completed during the first phase of the floodplain management planning process. These have created a clear picture of the values of the rivers and the adjacent floodplains, and identified the risks that exist in the relationships between flood hazards, people and communities, values and the way in which the interactions between these are managed.

1.4.1 Key Outcomes

The main outcomes of Phase 1 investigations which will need to be addressed through Phase 2 can be summarised as:

- Flood risk affecting homes, businesses and critical infrastructure in both rural and urban areas of the catchment
- Erosion risk affecting productive land and critical infrastructure situated near the river corridor
- Conflicts between current river management techniques and cultural, environmental and social values
- Relationships between communities, groups and individuals involved with the management of rivers
- The current funding, rating and governance methods used to pay for flood, erosion and river management.

1.4.2 Flood Risk

The updated July 2014 1-in-100 year return period flood models for the Te Kāuru Upper Ruamāhanga Floodplain Management Plan (FMP) have identified some areas of additional flooding greater than that identified in modelling carried out in 1995 which informed the Wairarapa Combined District Plan.

The most significant change from the superseded 1-in-100 year flood model is for northern Masterton, where a large number of new properties (2,043) will be classified as within a flood hazard area. Of these properties, 296 houses are considered to be at risk of damage from flooding within a low hazard area, and 23 homes or habitable structures close to Oxford Street and Mawley Park are considered to be in a high hazard area.

Carterton urban area has not been identified as affected by the modelled 1-in-100 year return period flood risk.

Outside of the urban centres the July 2014 flood model aligns relatively closely with the superseded 1995 modelling, and the current district plan zones. There are relatively few additional landowners who weren't already identified as affected by a flood hazard.

The total flood damages across the project area have been modelled to be $40M (with a range of +/-25%) from a single 1-in-100 year return period flood event. This contributes to an estimated average annual flood damage of $1.7M (with a range of +/- 25%).

Flood risk and associated impacts on primarily economic and social values remain one of the key drivers behind the need for river and flood risk management activities.

1.4.3 Erosion Risk

Tackling erosion risk is a large part of current river management practices. The Phase 1 investigations have identified erosion hazard study areas which primarily affect the western gravel bed rivers – Waingawa, Waipoua and Ruamahanga.

These potential – but currently managed – erosion losses for the western gravel bed rivers are estimated to be approximately $0.6M per year.

Erosion risk and associated economic and social values remain one of the key drivers behind the need for river and erosion management activities.

1.4.4 Conflicts

The need for flood and erosion risk management activities creates an extensive list of issues in relation to the cultural, social and environmental values of rivers. These range from: concerns about who pays (which affects current rating methods and allocations used to fund flood risk management schemes); conflicts between current flood management activities and the values associated with the rivers; conflicts between different values associated with the rivers; and understanding and relationship between groups who care for, manage or protect different aspects of the river systems.

These are of critical importance to this project in relation to holistic river management, and an upcoming resource consent expiration which enables river management activities to be carried out for the primary purpose of tackling flood and erosion risk.

1.4.5 Relationships

Good working relationships between communities, groups and individuals who care for or about rivers are an essential part of river management. Greater Wellington Regional Council (GWRC) and representatives of Ngāti Kahungunu ki Wairarapa and Rangitāne o Wairarapa have concerns about the partnership relationship between GWRC and Tangata Whenua, particularly in respect to the responsibilities of Tangata Whenua as kaitiaki and the incorporation of matauranga Mauri as a part of holistic river management.

GWRC has established good working relationships with landowners who are part of river management schemes, but would like to explore opportunities to broaden the involvement of these groups and those landowners outside of these groups who have an interest in river management.

GWRC would like to facilitate improvements in the relationships between the communities, groups and individuals involved with river management to enable better outcomes and methods of river management.

1.4.6 Rating and Governance

There has been ongoing concern and a call for review of the methods by which current scheme management is funded, and the complexity of the rating scheme for the targeted river rates across these schemes. Current rates are made up of a component drawn from a regional rate, a targeted rate and in some instances, a local rate associated with infrastructure owned and maintained by Masterton or Carterton district councils.

Coupled with a changed understanding of and expectations related to the maintenance and enhancement of values, this is a critical issue strongly linked to the governance structure which will oversee future river management, and in ensuring that the methods used to fund agreed management outcomes are fair.

2. This Report

This report is written in two sections. The **first section** is a narrative about the rivers and the floodplains, their issues and values. It forms the context within which the floodplain management plan needs to be developed. The **second section** collates the executive summaries of the technical investigations completed to establish the context. It is more technical in nature, but provides an overview of what is contained in the supporting documentation.

3. Introduction

Greater Wellington Regional Council has worked with Tangata Whenua, communities and territorial authorities to develop a number of successful floodplain management plans within the region. Over many years the process of designing a floodplain management plan has developed and been influenced by a broad spectrum of people. Flood risk affects many people worldwide and both local and international best practices have formed the approach to floodplain management planning used today.

The greatest strength of the floodplain management planning approach is that it recognises the uniqueness of each catchment and community. As a result it designs a very specific locally-led solution to address the flood risks which face those communities, while explaining it in a way which can be understood and be familiar to an international audience.

Greater Wellington Regional Council's approach to Floodplain Management Planning is documented in their Floodplain Management Planning Guidelines (WGN#1230541). This aligns with international best practices in floodplain management planning and builds upon the New Zealand Standard, NZS 9401:2008 Managing Flood Risk: A process standard.

The guidelines identify a three phase process for development of a floodplain management plan. These three phases are:

- Phase 1 – Establish the Context
- Phase 2 – Identify, Assess and Select Management Options
- Phase 3 – Achieve Sustainable Solutions.

3.1 Phase 1

3.1.1 Purpose – Establish the context

It is difficult to make good decisions about how to address flood risks without having a detailed understanding of the broader picture. A snapshot in time of the catchment, it also explores its history, the decisions which led to the present situation and where those decisions may lead in the future if no changes occur. Perhaps most importantly of all, it tries to understand the people who live on or use the floodplain, and their values.

Phase 1 of the FMP process involves capturing information on the current state of the river environment including the hazards it presents to the surrounding community. This phase will typically involve:

- Hydrological/hydraulic analysis
- Hazard assessment
- Geomorphic assessment
- Terrestrial and aquatic ecology studies
- Bird nesting/habitat assessments
- Assessment of recreational and amenity values
- Understanding cultural and historical values.

This phase also involves establishing contact with stakeholders and providing an outline of the timeframes and deliverables for the project.

3.1.2 Deliverables

Scoping work completed in October 2012 identified a set of deliverables required to complete Phase 1 of this floodplain management plan. These deliverables fall into five categories listed below.

1) River and Catchment Description

- Climate
- Weather Pattern Response
- Structural Geology
- Catchment Geology
- Geomorphology
- Vegetation
- Soils and Erosion
- Flood Issues
- Policy Issues
- Technical and Operational Issues
- Territorial Authority Issues.

2) Flood Hazard

- Hydrology
- Hydraulics.

3) Values of the Floodplain

- Environmental
- Social
- Cultural
- Recreational
- Historic
- Landscape
- Ecological.

4) Elements at Risk

- People and communities
- The economy, infrastructure and activities that have economic value
- Social impacts.

5) Draft FMP Objectives

- Outline of Tasks and Programme for Phase 2
- Record of Community Engagement, including a summary of the process and key outcomes.

Section 1 – The river, floodplains, issues and values

4. The Wairarapa Valley

The Wairarapa Valley is situated in the Wellington Region at the southern end of Te Ika a Maui, the north island of New Zealand. It has a temperate climate with distinct seasonal variations. It is known for having relatively stable weather patterns, commonly experiencing long hot relatively dry summers, and mild winters.

The catchment above its confluence with the Waiohine covers an area of 1560 square kilometres. This is made up of the western Tararua Ranges – formed of greywacke rock of varying ages; the Wairarapa plains – formed from deposited alluvial gravels and silts; and the eastern hills – formed from deposited marine sediments. The geology of the area is dominated by the underlying active boundary between the Pacific and Australian plates which have created extensive faulting throughout the valley, predominantly on a north-east/south-east alignment. The largest recorded fault movement occurred in the magnitude 8.3, 1855 Wairarapa earthquake causing a 13 metre horizontal movement and significant changes to the plains and river systems.

Rainfall patterns in the catchment are dominated by the Tararua Ranges. These create a relatively dry plains area (800mm average annual rainfall) with a significant increase in rainfall in the mountains (6000mm average annual rainfall).

These geological and climatic characteristics of the Wairarapa are reflected through the rivers – contrasting between the energised, gravel bed western rivers and the sluggish, generally soft sediment bed eastern rivers.

Humans have had an influence on floodplain and channel form characteristics in the Wairarapa since early settlement, and it is suggested that the impact of Western civilisation came at a time when the indigenous vegetation was already in a state of flux. Considerable areas of land were cleared through burning in the first few centuries of Māori settlement and the extent of cleared land increased after the arrival of Europeans.

Early observers estimated that around 200,000 acres of the Wairarapa was grassland, 80,000 acres of forest, 25,000 acres of fern and scrub, and 20,000 acres of swamp. The large areas of natural grassland and the close proximity to Wellington made the Wairarapa an attractive area for farming, and this saw the first sheep station in New Zealand being started in 1844. At the time the land along the Ruamahanga River was covered with dense bush and detailed surveys of the Waingawa River from 1900 show native scrub coverage of the banks and islands.

Farming continued to develop and the introduction of further exotic species – deer, pigs, and possums – continued a trend of deforestation, exposing further areas of the ranges to natural erosive forces. This would over time be seen to have impacts on raising the levels of river beds across the plains. European settlers introduced the use of willows as an early bank erosion and flood

protection tool to address some of these impacts. With further population increase more detailed and varied methods were developed to protect both farmland and homes. These included – among other techniques – the use of stopbanks, river diversions, improved willow works, reforestation, and exotic pest control.

It is through both the natural and human modified environment that the Ruamahanga, Waipoua, Waingawa, Whangaehu, Kopuaranga and Taueru (Tauweru) rivers and their tributaries flow.

4.1 The Ruamahanga River

4.1.1 River and Catchment Description

The Ruamahanga is the river into which all other rivers in the Wairarapa valley eventually flow. It connects Tararua to Wairarapa Moana, eventually flowing from there into Raukawa Moana/Palliser Bay.

Its name is attributed to a number of stories relating to its translation of 'Rua' meaning two and 'Māhanga' meaning twins, forks or snare trap. One story is that the translation of two-forks refers to the east/west alternating confluences along its length as it travels from north to south. Another is that its name was given by Haunui-a-Nanaia who caught two birds in a snare trap on the banks of the river. There are further stories behind the name, and this is reflected by its definition being recorded as obscure by Te Ara: An Encyclopedia of New Zealand.

The Ruamahanga flows from its source in the Tararua Ranges down through steep mountainous terrain and native forests, running through rock-lined gorges and boulder garden rapids before leaving the foothills close to Pukaha/Mount Bruce. From there, it flows through a number of steep-sided gorges where historic river terracing can be seen through the fringes of patchy native and exotic vegetation, before opening out into the pastoral Wairarapa plains. Here it turns to a more southerly direction flowing downstream through confluences with all of the other rivers which flow through the Wairarapa valley.

In its reaches downstream of Pukaha/Mt Bruce, it is technically characterised by geomorphologists as having a semi-braided form, changing to a managed single thread in the lower extents (approximately at Te Ore Ore). In more familiar terminology this 'semi-braided' form can be seen when the river mostly maintains a single channel with occasional areas where it 'braids' by breaking out into two or more channels. There may also be evidence of old dry channels or still back water at some locations. These river forms are driven by the river hydrology and geology.

The Ruamahanga River is gifted sediment by each of its tributary rivers, each of these drawing it from a different location. However, in general the floodplains are formed from deposited alluvial parent materials from two different sources. The rivers from the Tararua Ranges contribute the harder greywacke alluvium, while the rivers sourced from the eastern Wairarapa hills

contribute softer alluvial silts and sands eroded from mudstones, sandstones and limestones.

Starting from its source beneath Tararua, the Ruamahanga River starts the transportation of the greywacke alluvium. During high flows it has the energy to move and break up the larger boulder type material that can be seen near Pukaha/Mt Bruce – greater than half a metre or more in size – carrying this downstream until it deposits it again as its energy wanes.

Part of this process of deposition of the soil types that make up the Wairarapa plains has been dependent on the rate of flooding, deposition, the source of material, time since deposition, natural drainage and seismic events. Many landowners, both rural and urban, will be familiar with the frustrations of uncovering these old deposition patterns when they deal with sizeable river gravels when digging on their property. The pattern and process of deposition results in a variable natural fertility and erodability, which in turn is reflected in the mosaic of land-use across the catchment.

4.1.2 The Flood Hazard

The Ruamahanga River is well known to the Wairarapa community for its flood flows. Its hydrology shows the possible variability in water flow and therefore the energy which leads to its flood events and drives its channel form.

The day-to-day flow near Pukaha/Mt Bruce generally is recorded under 8m^3/s, but during flood events this has been recorded as being as large as 467m^3/s and is modelled as having a 1-in-100 year/1% Annual Exceedance Probability (AEP) flow of 506m^3/s. Further downstream at Gladstone the day-to-day flow is under 30m^3/s with flood peaks recorded at 1255m^3/s, and a 1-in-100 year/1%AEP modelled flow of 1388m^3/s.

The flood maps for the 1-in-50 year/2%AEP and 1-in-100 year/1%AEP flood events are shown in Volume 2. The relatively entrenched upper reaches of the Ruamahanga River contains much of the flood water, confining it to old river terraces, and its passage is controlled in several locations by prominent rocky outcrops. As it turns to the south at its confluence with the Kopuaranga River it opens into a broader floodplain, and the modelled flood events show a greater extent of the adjacent land under water. This trend of a broadening floodplain continues to its confluence with the Waiohine River.

The flooding of the Ruamahanga River also strongly influences the flooding in each of its tributaries. If flood events occur in the Ruamahanga River at the same time as any of the tributary rivers much higher flood levels are experienced.

4.1.3 Values of the floodplain

As with all rivers the Ruamahanga has a diverse range of values attributed to it, and as generations come and go the emphasis on these values shift in response to the culture of the people who value them. Many of today's values extend back to pre-European settlement – these are commonly referred to as cultural values in development of floodplain management plans, and these Māori values frequently align with non-Māori values.

The Ruamahanga River has many significant wāhi tapu and archaeological sites associated with its waters and banks which include urupa, pa, kainga, and also middens. Tangata Whenua now record and identify these places in a manner that recognises them as wider areas of interrelated settlement rather than as distinctly individual sites. Several of the archaeological sites are recorded with the (New Zealand Archaeological Association) NZAA and some urupa also have a registered title.

Key recreational values identified for the Ruamahanga River include hill walking; wilderness fishing in the Tararuas; jet boating below the confluence with the Waingawa river; kayaking in the upper reaches and the reach upstream of the confluence of the Waipoua; and fishing of varying experiences and quality along its length. The River is well known for its numerous quality swimming holes and gravel beaches suitable for summertime picnics.

The Ruamahanga River is an important ecological corridor including nesting sites for birds, habitat and migratory route for both native and exotic fish species – both groups are affected by the quality and quantity of riparian margins.

The Ruamahanga River is becoming nationally important for threatened bird life. In recent years it has been recorded as bucking the trends of decline in black billed gull species, and recorded as a location of populations of black fronted dotterel, pied stilts, black shags and NZ pipit. The current river managers have worked over the past decade to improve their management techniques to lessen harm to the habitats of these species, and some of the techniques have been recognised for their positive impacts on the bird populations.

Within the project extent, 26 different species of fish have been identified, and at some point each of these would have lived in or passed through the Ruamahanga River. Of these 26 species, 20 are native and six are exotic. Of the 20 native species, over half are considered to be ‘at risk’, meaning that their populations nationwide are considered to be declining. The associated restoration of the Wairarapa eel (tuna) fishery is of particular significance to Māori.

4.1.4 Elements at risk

Land-use in the catchment primarily includes highly valued, healthy native forest in the upper catchment protected within the Forest Parks of the Tararua Ranges. This transitions to a range of primary production activities – dairying, dry stock grazing, cropping and plantation forestry – and rural lifestyle development across the plains, and finally into the more densely populated urban area of Masterton on the western floodplain.

The river is currently managed to provide flood and erosion protection benefits to adjacent rural landowners across three scheme areas known as the Mt Bruce Scheme, the Te Ore Ore Scheme, and the Gladstone Scheme. In total, almost $0.5M dollars is spent annually on flood and erosion protection works across these schemes each year, and a total of $6.6M dollars of flood and erosion protection assets have been built along the length of the schemes.

These assets, and annual maintenance investment protects against a currently calculated potential damage value of $0.4M average annual damages (AAD) from erosion and contributes to the protection against the $5.5M AAD calculated potential flooding damages across the project area.

There are several sites of particular concern in relation to erosion risk. These include the banks of the river adjacent to Hidden Lake – a site recognised for its regional significance; the areas around Henley Lakes and eastern Masterton – both of which are protected by substantial erosion protection works; the Masterton wastewater treatment plant – which has recently been relocated to a less vulnerable location further from the river than its previous site; a number of Rathkeale College buildings and facilities; the Masterton cemetery; a former Masterton landfill site; and several stock bridges and structures related to farming activities along the length of the river.

In relation to flood risk there have been no significant additions to the areas identified in comparison with the flooding extents modelled for the Ruamahanga River. Much of the area identified in the updated flood model closely resembles those areas already included within the Wairarapa Combined District Plan controls. The flood risk from the Ruamahanga River does have a compounding impact on the Waipoua River flood extents, and coincidental timing of floods in both the Ruamahanga and Waipoua Rivers will result in elevated water levels within the Waipoua River caused by a backing-up effect.

4.2 The Waingawa River

4.2.1 River and catchment description

The Waingawa River was named by Haunui-a-Nanaia. He named it Waiawangawanga which means troubled or uncertain waters, as it was windy with lots of bends and appeared to go in all sorts of different directions. Waiawangawanga has been shortened in more recent times to Waingawa.

The shifting and wandering nature of the Waingawa River remains one of its distinctive and valued features and those who are most familiar with this river respect and admire its energy and wild nature.

It flows from its source within the Tararua Ranges through a combination of managed and unmanaged areas of native forest, which include some fringes of mixed exotic forestry, before running through a foothills area fringed by lifestyle blocks and RAP sites (recognised areas of protection) before entering the Wairarapa plains where it is joined by the Atiwhakatu River.

Within the Tararuas it is confined by steep banks and rock-lined gorges. As it enters the foothills, the energy of this river and the Atiwhakatu River shows itself where it has cut a narrow terraced floodplain from the hillsides. This is occupied by numerous sharp bends and meanders. Downstream of the confluence with the Atiwhakatu River the Waingawa river takes on a semi-braided form, flowing through a deeply cut terrace within which the river has confined itself. Evidence can be seen outside of this channel of a number of other river terraces which have been occupied in other times, some of these going far beyond Upper Plain Road and Norfolk Road.

4.2.2 The Flood Hazard

The Waingawa River, is well respected as a highly energised river. Fortunately for much of the surrounding community, the river is entrenched within a fairly tight, naturally-confined floodplain. This means that much of the flooding – even in a large flood event – is contained by the naturally-formed historic river terraces from where it enters the Wairarapa Plains until it joins the Ruamahanga River near Te Whiti. Within these confining terraces it is possible to clearly see recent river activity on the ground and more clearly in aerial photography, where overflow paths have left their mark both from deposition and scour.

The day-to-day flows exiting the foothills are typically below 10m³/s, however it is termed a ‘flashy’ river by hydraulic engineers meaning its flow can very quickly rise and fall in response to rainfall within its catchment. It has been recorded as having flows as high as 498m³/s, and has been modelled as having a 1-in-100 year/1%AEP flow of 683m³/s at this location.

While the flood risk from the Waingawa River is limited by its entrenched form, the erosion risk both modelled and observed is of much greater concern. The energy of the river regularly reshapes its main channel and after each flood event the bed of the river is scattered with the remains of trees and vegetation eroded from the banks.

4.2.3 Values of the Floodplain

The Waingawa River was identified as having low modification due to human influence in its upper catchment, and high scenic value. This is reinforced by much of this area being protected. Further down, the modification due to human influence on the river increases, both in terms of subdivision and lifestyle blocks along the banks and from in channel river management activities, but it retains a medium to high scenic value score.

Key recreational values within the Waingawa River floodplain include kayaking and wilderness fishing in the upper catchment, with much reduced amounts of these occurring downstream of the foothills (although kayakers are frequently seen in this area close to good vehicle access points where they can get out of the river). Jet boating was also noted as a recreational activity in the lower reaches.

The Waingawa River is an important ecological corridor. Of particular note is the Atiwhakatu River tributary which is noted as a significant spawning area, and is therefore also a popular seasonal fishing location. The Waingawa River and its tributary the Atiwhakatu River contribute to the diversity of fish species present in the study area, and is important for both native and exotic species.

The Waingawa River is the second of the important nesting sites for banded dotterels, and a number of other valued species have been recorded along the river including black shag, pied stilt, black billed gull, and NZ pipit.

The ecological value is reflected in its cultural values which are linked to wetland areas which formed in cut off channels and old backwaters, becoming areas valued for mahinga kai. It is important to note that the mahinga kai value of the Waingawa River carries across to both Parkvale Stream and Booths Creek. Relationships between these streams, the Waingawa River, the Mangatarere River and the Waiohine River, illustrate the intricacies and complex interconnectedness present within catchments.

4.2.4 Elements at Risk

The Waingawa catchment includes high value, healthy native forest in its upper areas, some of which is protected within the Tararua Forest Park . There have been long-running planting initiatives to stabilise the slopes of the upper catchment.

On the narrow floodplain within the foothills the land-use changes to lifestyle properties and small holdings with some primary production activities. This continues out onto the floodplains above and below State Highway 2 (SH2)with a smaller band of industrial processing and production activities adjacent to Masterton.

The Waingawa River contains a number of locations where critical or high value infrastructure sits within the active river corridor. These include the water supply intake, treatment plant and, water supply pipeline to Masterton and the associated treatment plant. In addition, the Masterton-Wellington railway line and SH2 cross the river near to Masterton. The Hood Aerodrome runway has been threatened by erosion risk on a number of occasions.

The river is currently managed by GWRC to provide flood and erosion protection benefits to affected adjacent rural and industrial landowners. Measurements of the land lost to erosion between 1941 and 2012 indicate that approximately 210 hectares of land which would not be classified as river channel has been lost to erosion.

GWRC actively manages the risk to the water supply intake and the water supply pipeline as it runs alongside the river, and has in place a gravel management policy to protect the railway and state highway bridges. The bank edge at the end of the Hood Aerodrome runway has been reinstated several times and rock work has been put in place to lessen future risk in this area. The scheme managers also work with infrastructure owners to protect key services including both local and regional utilities infrastructure which crosses the Waingawa River at a number of locations.

The scheme for the Waingawa River currently spends approximately $179,000 annually to maintain and add to the existing $1.4M of flood protection assets which manage the flood and erosion risks along the river corridor.

4.3 The Waipoua River

4.3.1 River and catchment description

The naming of the Waipoua river is attributed to Haunui-a-nanaia testing its depth with a stick prior to crossing. ‘Wai’ meaning water, and ‘poua’ meaning to plunge a stick in.

The Waipoua River has a catchment area of 149 square kilometres. The headwaters originate from the Blue Range of the Tararuas flowing down through steep-sided gorges, fringed by native forest. A large part of the catchment is within the lower foothills of the range. The river has three major tributaries: the Kiriwhakapapa Stream, the Mikimiki Stream, and the Wakamoekau Stream. These streams join the river as it flows across the Wairarapa plain, before passing through the Masterton urban area to its confluence with the Ruamahanga River at Te Ore Ore.

The main river channel from its headwaters to its confluence with the Ruamahanga River is 30 km in length. The current Waipoua River Management Scheme covers an 18 km length from the Mikimiki Bridge to its confluence. The river channel is characterised as a steep gravel phase river with a relatively stable and narrow single thread channel. The Mikimiki reach and Masterton township reach have been straightened, steepened and shortened.

The Waipoua floodplain soils are formed from greywacke alluvial parent materials from the Tararua Ranges.

4.3.2 The Flood Hazard

The Waipoua is a river of multiple characters. It is considered by some to be ephemeral, drying up completely in places, and under normal conditions the

flow at the Mikimiki recorder drops to below 2m³/s. The river channel itself is fairly entrenched, but of relatively small capacity. This does mean it is able to contain smaller floods completely without spilling water out on the floodplain.

However, in larger flood events, it can be devastating with flows recorded as high as 356m³/s in 1998, and a modelled flood flow of 468m³/s for a 1-in-100 year return period flood event. Unfortunately earlier storms which flooded through Masterton occurred before the installation of the gauging stations to measure flood flows, and as such they have not been quantified.

The erosion risk posed by the Waipoua River flows is smaller than for the other gravel bed rivers, but has potential to cause localised significant impact which in some locations threatens stopbanks. This is of particular concern because of resultant increased flood risk.

4.3.3 Values of the Floodplain

The siting of Kaikokirikiri Pa close to both the Waipoua and Ruamahanga Rivers provides an indication of some of the cultural values associated with the area. In Tawera to Te Whiti, Potangaroa and Rimene refer to Kaikokirikiri as the main pa of the Masterton area, and also note that the Waipoua used to flow at the foot of the pa.

The proximity of the pa so close to the Waipoua River implies that the wider surrounding environment would have been regularly frequented and used for a range of cultural practices.

Masterton urban area is undoubtedly the most significant focus of values within the project area. It was an area of settlement prior to European arrival which included numerous associated locations, these now recorded as sites of cultural value. The modern form of Masterton was not founded until 1854 when the Small Farms Association, led by Joseph Masters, established the town. Its development was further encouraged in the 1940s when the Waipoua River was controversially diverted and straightened onto its current course, and stopbanks constructed along the length of the river's urban boundary to protect the town. Today, it has a population of almost 20,000 making it the largest urban centre in the Wairarapa. Many of these residents, home and business owners sit on the floodplain behind the stopbanks.

The Waipoua River does not retain the same colonies of birds as the Waingawa or Ruamahanga rivers, and its fish populations are susceptible to the drying up of the river bed. Coupled with algal blooms this creates difficult conditions for the survival of both native and exotic species.

However, due to its proximity to Masterton and the ease of access to the lower reaches, the Waipoua River is perhaps the most popular of the Wairarapa rivers for recreational pursuits ranging from walking and dog walking to kayaking to fishing. In higher flow periods the reach through Masterton is noted for the quality of its standing waves by kayakers who would like to see these characteristics improved and formalised.

The upper reaches of the river also have a higher density of population with a proportionally greater number of lifestyle blocks in between the primary agriculture activities.

4.3.4 Elements at Risk

Land-use in the catchment is a mix of native forest in the upper catchment within the Tararua Ranges, transitioning to a range of primary production activities (dairying, dry stock grazing, cropping and plantation forestry), to rural lifestyle development, and the urban areas of Masterton on the floodplain.

Of all the rivers in the Wairarapa, the Waipoua has the potential to affect the most people, both from the impacts of its low flow conditions and from the potentially devastating impacts of its flooding.

The Waipoua river has been modelled as flooding northern Masterton in a large flood event, affecting approximately 2000 properties, and potentially flooding into 300 homes. The depth of this flooding within Masterton means that much of the flooding in this area would be considered low hazard, however there are some areas on the northern bank close to Oxford Street which fall into the high hazard category.

In addition the stopbanks protecting homes in the vicinity of the Paierau Road bridge and the confluence of the Serpentine Stream with the Waipoua River have been modelled and are known to overtop during flood events. Coupled with the vulnerability of those stopbanks to erosion risk due to their closeness to the river channel means that this area is of particular concern.

Fortunately there are minimal other areas which are affected to the same extent. However, a small number of additional locations including parts of the Massey University Riverside property, Mikimiki bridge, and the Mahunga golf course do fall within or are close to an identified hazard.

4.4 Kopuaranga River

4.4.1 River and catchment description

The naming of the Kopuaranga River translates as ‘fish in a deep or dark pool’ – characteristics it is still known and popular for.

The Kopuaranga River has a catchment area of 166 square kilometres. The headwaters originate in the northern Wairarapa hill country to the east of Mount Bruce. The river has a number of small tributaries, and the main channel flows at first on a northeast course from its source in Mount Bruce to Haswell, where it crosses a relatively wide valley before turning south. The river then flows south within a narrow valley, following the line of the West Wairarapa fault. In its lower reaches the river turns away from the fault line and follows an old course of the Ruamahanga River, joining the Ruamahanga River east of Opaki.

The main river channel from its headwaters to its confluence with the Ruamahanga River is 58 km in length. In its upper reaches across the Hastwells valley, the river channel is characterised as an entrenched channel. The river

then flows within a narrow faulted formed valley in a tightly meandering channel. On its lower reaches, the river channel becomes wider and straighter with sections of tighter meandering channels.

The Kopuaranga River floodplain contains a mix of soils formed from sandstone, limestone and siltstone, and it has long been associated with cultivation and farming.

4.4.2 The Flood Hazard

The Kopuaranga River is one of the three smaller eastern rivers, flowing in a relatively incised channel from the Eastern hills. Its day-to-day flow regularly drops below $2m^3/s$, and it is monitored for its low flow conditions in relation to the number of water extraction points along the channel. Its highest recorded peak flow is $201m^3/s$, and it has been modelled to have a 1-in-100 year return period flow of $229m^3/s$.

Common to the other smaller eastern rivers the Kopuaranga River is prone to overtopping the banks of its incised (deeply cut) channel and spilling out onto the floodplain even in relatively small flood events. This combined with a channel choked with willows led to extensive flooding in 2004 and 2005 which led to the formation of a management scheme.

There is minimal erosion risk posed by the Kopuaranga River, however there are concerns regarding silts washed from the banks and into the stream from its upper reaches.In its lower reaches it sits within a remnant overflow path of the Ruamahanga River.

4.4.3 Values of the Floodplain

The floodplains of the Kopuaranga River are relatively sparsely populated, but this population density is slowly increasing under the influence of subdivision into lifestyle blocks.

In the upper catchment the Kopuaranga River retains a small amount of its original character, but it is extensively modified in the areas around Mauriceville.

Land-use in the catchment is predominantly primary production activities – dairying, dry stock grazing, cropping and plantation forestry – with a few scattered areas of native forest throughout the catchment. This is reflected in the classification along its length as having a medium level of modification, with pockets of remnant or reintroduced native vegetation. Its scenic value has been recorded as low to medium along its length. Change in this land-use is occurring within this catchment from pastoral to rural lifestyle development, particularly along the middle reaches.

These land-use changes have had particular impact on informal access arrangements related to recreation opportunities and the guardianship of cultural sites, some of which are not formally protected or identified.

Recreation values associated with the Kopuaranga River reflect its name and it is popular for fishing and game bird hunting, and in some areas this has led to

enhancement of natural wetlands and ponds improving the ecological value of the river.

Only two cultural value sites have been identified along the Kopuaranga, these being Kopuaranga settlement, and Kohekutu Pa. However the river used to form part of a northwards travel corridor and it has value for mahinga kai, related to both the river and the surrounding forested areas.

4.4.4 Elements at Risk

The Kopuaranga River relatively small incised channel means that even small flood events overtop its banks and flood across the plains affecting farms, homes and a number of rural roads.

There is relatively low threat from the erosion risk, and only a small number of rural access structures, farm tracks and buildings have been included in the erosion hazard study area.

Historical planting of willows along the channels exacerbated the flooding problems, and in 2007 a scheme was established to manage the impacts of flooding related to willows choking the channel.

This river management scheme covers 27 km in length from the bridge just downstream of the Clark Memorial Domain, Mauriceville, to its confluence with the Ruamahanga River opposite Rathkeale College.

4.5 The Whangaehu River

4.5.1 River and catchment description

The meaning of the name Whangaehu river is a little more obscure than the other rivers in the project area. There are a number of other rivers named Whangaehu across New Zealand, and its literal translation is of Whanga as bay/estuary/stretch of water and hū as bird call/loud sound or also perhaps to bubble/boil. Historical maps on display at Aratoi indicate that much of the middle reaches of the Whangaehu may have been marshland prior to the changes caused both by the 1855 earthquake and drainage activities associated with farming. This former marshland character may be linked to the origin of the name.

The Whangaehu River has a catchment area of 145 square kilometres. Its puna/springs rise in the steep hill country near Ihuraua and it flows through a comparatively narrow winding channel for 32 kilometres to the Ruamahanga River. Where it reaches the Alfredton fault, it changes course direction to flow south, and follows the line of this fault through this steep sided catchment until it reaches the Te Ore Ore plains east of Masterton. On the plains its course has changed many times, and in some locations multiple dry channels wind their way across the valley floor which can be seen clearly both on the ground and in aerial photography.

The geology of the catchment changes between sandstones, limestones and siltstones, and the limited energy of the river means that the channel forms through this area are relatively stable.

4.5.2 The Flood Hazard

The small channel capacity of the main channel of the Whangaehu is frequently exceeded during heavy rainfall or storm events. When the river overtops its banks the floodwaters flow across the floodplain and into secondary or historic channels spread across the large flat area of the floodplain.

Gauging of the flows which overtop the river banks is very difficult due to the number of secondary flow routes and the flat extensive floodplain which carries much of the flood flows.The only river level recorder is installed at Waihi. The modelled flows for the river are 74m³/s for a 1-in-100 year flood event and the largest recorded flow at Waihi is 80m³/s.

4.5.3 Values of the Floodplain

Formalised access to the Whangaehu River is limited, however, a number of informal access agreements have been established between fishing and hunting recreation groups/individuals and landowners.

No cultural sites of significance have been recorded on the public database produced for this project, however a number exist along the river and in the adjacent hills. Readers wanting further information about the significance of this area should discuss this directly with Ngāti Kahungungu ki Wairarapa and Rangitāne o Wairarapa.

The landscape modification of the catchment has been categorised as medium due to the extensive impacts of farming. The scenic values are generally considered medium to high for the upper catchment, but low to medium once the river enters the plains.

Land-use in the catchment is predominantly primary production activities (dairying, dry stock grazing, cropping and plantation forestry) with a few scattered areas of native forest throughout the catchment. There is little evidence of lifestyle type development in the upper catchment. However a number of subdivided lifestyle-sized lots have been created on the Te Ore Ore plains closer to Masterton.

4.5.4 Elements at Risk

The Whangaehu River historically has caused issues with extensive flooding across the plains area, which has been exacerbated by blockages in the confined channel. The 1970s river management techniques of straightening the river led to significant erosion issues which were addressed through intensive willow planting. Unfortunately, these willows eventually choked the flood channel and spread to other areas of the river, leading to issues with sedimentation causing further channel constrictions.

A river management scheme was set up to manage these issues in 1995 covering from the confluence with the Ruamahanga River to a point 9 km upstream. This scheme solely works to control willow regrowth, and has a small section near the Ruamahanga River where willow planting is carried out

to manage erosion impacts from the straightened channel at that location. Approximately $7,000 per year is spent on these management tools.

Flooding across the floodplain cuts off a number of communities when the east-west roads from Masterton are flooded. In many places the bridges are high enough above the floodplains to remain dry, but the roads on either side of them are covered with water deep enough to cause severe hazard for motor vehicles.

Erosion risk is relatively small due to the low energy of this river, and its limited ability to modify the surrounding geology. Only a small number of bridges, sections of rural roads, and several farm outbuildings are included within the erosion hazard study area. The river is however susceptible to silting from its banks and the hills in the catchment.

4.6 Taueru River

4.6.1 River and Catchment Description

The translation of Taueru means 'hanging in clusters' which may refer to the many wāhi tapu sites used to prepare bodies for burial in trees, before burying the cleaned and prepared bones at adjacent burial sites.

The Taueru River (alternatively called 'Tauweru') has a total catchment area of 498 square kilometres and the main channel has a total length of 69 kilometres. The river has a number of small tributaries, and comparably, for the size of the catchment, has a relatively small and narrow river channel.

The main river channel in the lower reaches has a relatively low gradient with a meandering pattern. The Taueru River catchment contains a mix of soils formed from sandstone, limestone and siltstone in the eastern Wairarapa hill country.

Land-use in the catchment is predominantly primary production activities (dairying, dry stock grazing, cropping and plantation forestry) with a few scattered areas of native forest throughout the catchment.

4.6.2 The Flood Hazard

The Taueru River is another of the three smaller capacity eastern rivers, however, its large catchment size has led to some significant flood flows. Flooding frequently overtops the banks of the river to flow across the floodplain, and to a lesser extent through secondary channels. Its day-to-day flow frequently drops below $2m^3/s$. Its highest recorded flow at Te Weraiti was $488m^3/s$, and it has a modelled 1-in-100 year flow of $638m^3/s$.

It is challenging to fully quantify the flood flows for the Taueru river due to the volume of water flowing across the floodplain outside of the channel, and this is reflected in minor discrepancies between gauged and measured flows.

4.6.3 Values of the Floodplain

The floodplain of the Taueru River is relatively sparsely populated, however development is spread evenly along the length of the river and generally confined by the topography of the narrow valley.

The Taueru River is particularly significant to Māori due to its historic significance as a travel route towards the north east and the coastal areas along the eastern side of New Zealand. This led to the formation of a number of settlements and associated values. There are several of these cultural value sites identified along the river including locations of pa, urupa and mahinga kai. The Taueru River was a particularly abundant source of freshwater crayfish, and this is reflected in names along the valley. Further down the river it was associated more with eels, and today this location still remains a valued fishery.

Farming activity which dominates the modern land-use along its length have had a substantial impact on the landform. However, pockets of good quality remnant native vegetation remain in some less accessible steep-sided gully areas – including isolated locations where remnant totara and kahikatea can be found. Much of the floodplain and banks are grazed Outside the managed scheme areas of introduced vegetation in the form of clumps of willow and poplars dominate the channel form. This diverse mix of character has meant that the reaches have generally been classified as having a medium level of modification. However, at a site-by-site level an area may be considered to be highly modified, and not far from that location another area might be considered to have very low level of modification.

The remnant pockets of native vegetation and the river form make it important in some locations for recreational pursuits, which include game bird hunting, fishing and kayaking.

The lower reaches of the Taueru include a number of RAP sites, including Te Kopi Road and Peters Bush.

4.6.4 Elements at Risk

The key risks within the Taueru River catchment relate to flooding of productive land, access routes to residential property, and the flood risk for rural homes. A river management scheme was established in 1994 in the lower reaches of the river to address some of these issues.

The existing Lower Taueru River Scheme extends for a length of 17.7 kilometres from the confluence with the Ruamahanga River – just north of the Gladstone Road Bridge – up to near the end of Te Kopi Road. This scheme was established primarily for the management of channel blockages caused by the willows which had been historically planted along the length of the river.

The scheme manages the willow growth with an annual maintenance budget of approximately $5000. Most of these funds are spent on spraying willow regrowth, and a small portion on removal of trees when required. The budget maintains no assets on the scheme, and its intent is purely to maintain the flood capacity of the channel and reduce the likelihood of blockage.

There has been some landowner concern in the lower reaches of the scheme area to address erosion issues occurring as a consequence of historic channel straightening, and there is an interest expressed by some upstream landowners who can see the benefits of a scheme which manages willow growth and the associated blockages.

The erosion risk posed by the Taueru River is very limited, and only a small number of bridges and structures sit within the erosion hazard study area. The river however is susceptible to heavy silting from sediments washed from its banks and hills in the catchment.

Section 2 – Investigation Report Summaries

5. Phase 1 Investigation Summaries

To meet the requirements of GWRC's floodplain management planning guidelines and the Phase 1 deliverable objectives, , Phase 1 was split into 13 distinct work packages:

1. Community Engagement
2. Climatology and Hydrology
3. Floodplain Hydraulics
4. Geomorphology
5. Flood and Erosion Damage Assessments
6. Current Flood Risk Management
7. Ecological Values
8. Landscape Values
9. Recreation Values
10. Cultural Values
11. Heritage
12. Land-use
13. Planning.

A summary of the full report findings for each of these investigation packages is included in this section.

5.1 Community Engagement

Community engagement captures both communication and engagement, or in terms of this project, the project team sharing information with people, and people sharing their information with the project team.

Community engagement work elements covered:

- Raising community awareness about the floodplain management plan development
- Identification of stakeholder and community groups
- Identification of community values
- Reviewing Phase 1 outcomes with the community and stakeholders.

5.1.1 Summary

Community engagement for Phase 1 focused on raising awareness and gaining participants for the development of the floodplain management plan. The project was fortunate to be able to draw on a number of well-established community organisations and existing river scheme management committees.

Representatives of the organisations met with the officers involved with the project. These meetings focused on raising awareness of floodplain management planning, collection of values information and identification of conflicts and issues to be addressed during Phase 2.

Engagement with the project was complicated by some external issues, including: a review of regional governance structures which focused community attention and debate on the prospect of a devolved governance structure for the Wairarapa; the formation of the Ruamāhanga Whaitua, a committee which would direct the Regional Plan outcomes for the Ruamahanga river catchment, particularly focused on water quality and quantity limits; and the Wairarapa Water Use Project (WWUP) which was undertaking a review of potential dam and irrigation networks which would provide a boost to the regional economy .

The availability of key stakeholders able to participate in the Phase 1 development of the floodplain management plan was compromised due to the relatively small population size and associated commonality in stakeholder representatives across all issues often resulting in a single representative having interest across a number of groups. At the end of Phase 1 each stakeholder group had participated in supplying information and concerns relevant to their interest area, and participated in the relevant review of sections of produced reports. .

The community as a whole is supportive of the development of a floodplain management plan, but have some reservations about changes which may occur that could negatively impact on positive changes made in river management in recent years. The support for the floodplain management plan development is driven by a need to address long-standing, but generally perceived as non-hazard related issues with current river management practices, or through greater representation and consideration of values in the way rivers are managed. As a whole the FMP development is seen as an opportunity for improvement.

Flood risk was a secondary issue to most groups outside of the agricultural sector and existing scheme. This reflects the perceived low vulnerability of the urban communities to the impacts of flooding driven partly by the infrequent nature of this flooding during the past 20 years. There was generally low awareness of significant historical flooding within the groups. However, there were some individuals who were familiar with and could describe well the impacts of events which had occurred over the last 75 years. There was no awareness of flooding within the groups for events which occurred prior to the 1950s.

The river scheme committees are nervous about the possible changes to their role which may occur as part of the floodplain management plan development, but understand the need for a greater representation of values in the way that flood risk management is delivered. They appreciate that they may not have expertise in some of the value subjects requiring consideration. It has been clearly understood that their economic returns are a value for the Wairarapa and should be considered as such during the floodplain management plan development. This value of economic returns remains as one of the key drivers behind the formation of the current river management schemes, and the success of those schemes at achieving those objectives is acknowledged and will be built on by this FMP.

5.1.2 Key Issues for Phase 2 consideration

- The role of the scheme committees and the way the current rating system works may change upon completion of the FMP, in order to consider a broader range of values and management requirements.
- The understanding of the purpose and outcomes of the FMP process are the cause of some concern to scheme committees, landowners and sections of the community. These range from concern that the development of the FMP may overemphasise some values and may lead to unrealistic expectations of what can be achieved for reasonable funding levels, to concern that existing management practices which cause some concern will continue without appropriate review and monitoring.
- Engagement levels of the community are likely to increase as the result of publication of flood hazard information and the impacts of this on private property not currently identified as subject to flood or erosion hazard.
- The release of flood hazard information generally causes a great deal of upset in affected sections of the community who were unaware of their hazard exposure.
- There are many GWRC and territorial authority projects running concurrently in the project area. There is a strong likelihood of consultation/engagement fatigue if this engagement cannot be streamlined.

5.2 Climatology and Hydrology

The climatology and hydrology investigations capture and report on the natural weather systems present in the catchment. They involve the creation of models which aim to recreate what has been observed and recorded to happen, and then apply this knowledge to forecast what is likely to occur in the future both in normal and extreme weather events. The data focuses on rainfall and river flows, which are essential for the development of flood models.

The climatology and hydrology investigations covered:

- Flood flow estimations for the lower Waipoua River
- Sensitivity to Interdecadal Pacific Oscillation (IPO)
- Updated regional flood frequency characteristic contours
- Investigations for tributary catchment coincidence and timing
- Derivation of normalised hydrograph shapes for six locations
- Commentary on the stationarity for all hydrological records used in the analysis
- Waingawa/Atiwhakatu relative contribution review
- Probable Maximum Flood scenario estimation.

5.2.1 Summary

The climatology and hydrology investigations generated the required outputs to enable the flood hazard models to be run for the flood event simulations. This included work to update regional characteristic contours which affect rainfall intensity, coincidence timing significance between tributaries which affects how the flooding in rivers influences flooding in other rivers, and stationarity which identifies how much the pattern of weather systems change in predictable cycles over 15-30 year intervals.

The additional flood flow estimations resulted in an increase in flood flows modelled for the Waipoua river which accounts for the ungauged catchments both upstream and downstream of the Mikimiki recorder site.

The stationarity assessment to examine sensitivity to the interdecadal pacific oscillation (IPO), which is a natural phenomenon of measured climate change that occurs on a repeating cycle of between 15-30 years. This identified that low flow conditions were sensitive to this phenomenon, but that flood events were not significantly sensitive to its effects. For this reason no additional factors were applied to the hydrological model to account for it.

The probable maximum flood (PMF) results were developed through re-use of the GWRC probable maximum precipitation rainfall model. This was found to have some technical limitations and it was noted that the results for the PMF may form an over-estimation. However, it was also recognised that the purpose of the PMF is to identify worst case scenarios and this possible overestimation was, therefore, not of particular concern.

The reporting recommended opportunities for future improvements in monitoring and quality of data which would improve the accuracy and quality of future investigations.

5.2.2 Issues for Phase 2

- Flow and water level data was sufficient to complete a hydrology review, however, additional records would have improved the quality and accuracy of this piece of work and may therefore be beneficial for future floodplain management planning reviews.

- Some of the recorder sites were noted to be at locations which had unstable channel forms. This leads to uncertainties in the hydrology reporting which could be improved if more stable monitoring sites could be identified. This would be beneficial for future floodplain management planning reviews.

- It was noted that 22 years of data were available. This limited the accuracy of the IPO phase assessments and limited the ability to tailor the IPO for eastern and western sides of the project area. This is only possible to improve by continuing to record and, therefore, create a longer data set. This would be useful for future floodplain management planning reviews.

5.3 Floodplain Hydraulics

The floodplain hydraulics work element captures, recreates and models both known and recorded flood events, as well as predicting future flood event scenarios. It does this through a computer simulation of the rivers and floodplains, taking into account factors including: surveyed channel shape and structures (bridges, and culverts); surveyed floodplain terrain; measured channel and floodplain roughness (which affects how quickly the water travels over different areas); historical flood information; and river hydrology.

The floodplain hydraulics work element consisted of:

- Re-survey or new surveys of the main rivers within the project boundary
- Updating and extending existing flood model for the Waingawa River which covers the lower half of the project area
- Creation of a new Waipoua river model which would include those rivers upstream of the confluence of the Waiohine and Ruamahanga rivers
- Modelling the 1-in-100 year flood spread for the project area
- Modelling the 1-in-100 year flood spread plus predicted climate change impacts
- Modelling of a range of other flood events for the project area.

In addition to these tasks, the following work elements were added to the initial project scope during the project:

- Lidar survey of the project area
- Aerial photography of the project area.

5.3.1 Summary

For the majority of the catchment the modelled flood spreads align closely to what has previously been understood to be the flood risk within the project area, and there are few significant differences between what has been recorded within the combined district plan. However, in the urban area of Masterton adjacent to the Waipoua River, additional flooding has been identified. This area of flood risk is not currently identified within the Combined District Plan.

Archival records show frequent flooding has occurred through the low lying areas of Masterton, and much of this was believed to have been controlled by the Masterton stopbanks first constructed in the 1940s. Recent surveys have identified this stopbank as not being of a sufficient standard to prevent this level of flooding, and as a result the stopbank overtops at a lower-than-designed level flood. This means that many of the residents and businesses of Masterton are living with a 2% chance of being flooded each year.

The peer review of the hydraulic model found the model to be of good quality, and issues raised by this peer review were subsequently addressed through modification of the model.

The current flood model was developed on a 10m x 10m cell size which gives a very detailed picture of flood risk for rural areas, but is considered to be of lower accuracy for urban areas. Following the identification of flood risk in the urban area of Masterton, it is the recommendation of the project team that the urban area be modelled on a smaller grid size to provide a higher level of

accuracy and certainty to property owners in these urban flood risk areas, this will be completed during Phase 2 of the FMP.

5.3.2 Issues

- Masterton Urban area grid size is larger than standard for an urban area. The 10 metre by 10 metre grid size is more appropriate for rural land-use, providing a high level of accuracy in comparison to section or land parcel size. However, improved accuracy of flood spread for urban areas can be achieved through use of a smaller grid size which would enhance information provision to private property owners.
- Areas of Masterton are subject to flooding in a large flood event – this affects the northern areas of Masterton on both banks of the rivers within the urban area. The impacts of this are further discussed in the Flood and Erosion damages section.
- Masterton's wastewater treatment plant is subject to flooding in a large flood event which overtops existing levels of protection.
- The floodplains of the Whangaehu and Taueru Rivers convey a large volume of flood flows compared to the main river channel. This makes calibration of the models in these areas challenging.
- Calibration of the flood flows in the Kopuaranga River is not possible with the current gauging arrangement due to the volume of water which bypasses the Palmers gauging station.

5.4 Geomorphology and River Characteristics

Geomorphology and river characteristics capture the movement of the river through the floodplain. In particular the studies focused on how each river interacts with its beds and banks, and how much and how fast it is transporting sediment through the whole system.

The investigations of Geomorphology and River Characteristics covered:

- Analysis of the changes in bed level over the period of available data
- Development of a gravel budget model for the study area
- Analysis of specific character of gravels within each river.

Work reviewing the impacts of meander patterns and lateral erosion extents are covered within the current flood risk management and erosion and damages section of the report respectively.

5.4.1 Summary

A significant trend of bed degradation which has led to lower bed levels over time and associated continual bank erosion was identified within the Upper Ruamahanga River system – the data identifies this trend as having occurred over the last two decades. There is insufficient data to map a trend prior to this point, however, through observations of historical photography and records and comparison with other river systems it is believed to have been a factor accelerated through land development and river straightening practices. Although bed degradation trends provide some positive benefit in terms of increased channel capacity they also result in the risk of loss of land adjacent to the river as the banks are undermined and collapse. This undermining effect also presents a risk to structures (stopbanks, bridges, rock groynes).

A major part of the river management programme undertaken in the upper Ruamāhanga catchment system is to control bank erosion. This hard edge protection may be a contributing factor to bed degradation (the methodologies used are discussed further in the current flood risk management section of this report). Great care must be given to bank erosion measures in a degrading river bed situation. A commonly observed trend within intensively managed schemes is that: ‘the greater the extent of successful hard edged bank protection the more the river will degrade due to increased energy available to erode the bed which cannot be expended on the banks’. This in turn may result in undermining of the same bank protection structures. The fact that bank erosion is such a significant issue provides a strong indication that the Ruamahanga, Waipoua and Waingawa Rivers are in sediment deficit and have excess energy.

Further contributors to degradation may be reduced natural sediment supply from the upstream catchment. This sediment supply may have been influenced by reforestation through either pest control schemes or deliberate reforestation through attempts to stabilise hill slopes.

This study hasn’t quantified the full extent of this deposition due to the downstream limit of the model not extending fully into the zone of deposition, however, the completed modelling indicates that, on average, over 200,000 m^3

per year of gravel is being carried through and deposited at the lower extent and beyond the boundary of the study area, this is an issue which will need to be addressed through a future FMP for the Lower Wairarapa Valley.

Gravel management into the future will also be influenced by natural events. Significant storms which result in land slips and large or frequent earthquakes are known to increase the amount of gravel entering the system from upstream areas. Earthquakes may also significantly change the lie of the land and result in a need to reinvestigate geomorphology in the context of the new land shape and form.

5.4.2 Key Issues

- Significant degradation of bed levels has occurred over the period of recorded data for the Ruamahanga, Waipoua, and Waingawa Rivers. This is a trend common along much of the lengths of these rivers.
- Bank reinforcement and 'holding the line' may have exacerbated the bed degradation in some locations, particularly where the rivers have been straightened and channelised.
- A lack of material supply from the upper catchment due to historic stabilisation of the hillsides is believed as a possible contributor to the bed degradation issues.
- Historic straightening of the river channels is also identified as a potential cause of bed degradation due to increased energy and the focusing of this energy over shortened lengths of both bed and bank.
- Significant accumulation of sediments may be occurring downstream of the study area boundary and at isolated locations within each river, this may lead to reduced capacity and flooding impacts.
- In some locations bed rock layers have been exposed in recent years.
- Significant natural events may cause major changes in gravel levels and availability.

5.5 Flood and Erosion Damages

Flood and erosion damages capture the modelled impacts of flood risks on the values of the floodplain. The methodology used to estimate this focuses on economic value with factors applied to convert social and health impacts into an economic value. The impacts that do not have an implicit economic value are called the intangible impacts.

Flood and Erosion damages investigations included:

- Identification of property which may be affected by modelled flooding
- Identification of property which may be affected by modelled erosion
- Modelling annualised damages from flooding within the project area
- Modelling annualised damages from erosion within the project area
- Identification of infrastructure which may be affected by flood and erosion risk.

5.5.1 Summary

The Phase 1 investigations of flood damages carried out a high level Flood Damages Assessment (FDA) to provide an indication of the value of flood damages that could result from flooding of the investigation area from events detailed in the recent flood hazard modelling.

The FDA model has been developed to predict potential flood damages and to determine the Average Annual Damages (AAD) under the existing floodplain conditions, based on current structural protection and river management activities. The model can also be used and developed further in Phase 2 to assess the future AAD that would result from the implementation of alternative flood risk management options.

To mitigate uncertainties and other information gaps in the assessment, at this time, the approach taken has been to estimate an upper and lower flood damage figure based on available information and to average the two sets of results. A percentage has then been applied to provide a range within which potential losses would be expected to fall.

The potential damages to urban Masterton are estimated to be in the region of $26 million (with a range of +/-25%) for a 1-in-100 year flood event in terms of tangible direct damages to buildings and contents. This figure is more than doubled when the full range of tangible and intangible losses is added in.

Looking at the full FMP area, the overall estimated potential damage costs to the community (tangible only) is estimated to be around $40 million (with a range of +/-25%) for a 1-in-100 year flood event and produces an annual average damage value of around $1.7 million (with a range of +/-25%).

When adding in an allowance for the potential intangible costs this could generate a figure closer to double that of the tangible costs. However, intangible damages are difficult to translate into dollar value and could vary widely based on a variety of reasons, including the communities' specific physical and psychological resilience characteristics.

Added to this are the erosion damages which mainly impact on rural land immediately adjacent to the river corridor. The total potential average annual erosion damages was calculated to be approximately $0.6M AAD. A total loss figure based on event size was not generated for erosion damages. This is because the process by which erosion occurs is not attributable to a single flood event. Geomorphological process which results in bank erosion is dominated by smaller more frequent events, typically being annual or bi-annual flows.

5.5.2 Issues

- Preliminary modelling outputs have identified flooding overtopping the existing stopbanks in Masterton during large flood events. This affects several key buildings (e.g. fire station, medical clinic) as well as potentially flooding into several hundred homes.
- The modelled flooding of Masterton confirms the need for more detailed investigations at an improved level of accuracy. This would involve creation of a 'nested' 3m grid model for the urban extents of Masterton within the current 10m grid model.
- The existing river management schemes primarily focus on protection of land through use of a range of erosion control methods. This includes in channel management, structural works, and buffer zone management. The operations team at GWRC have reviewed the existing design channel alignments and identified areas where these may require adjustment.
- The preliminary model outputs identify Masterton Wastewater Treatment Plant as being affected by the overflow path which runs through Masterton and re-enters the Ruamahanga River near the settlement ponds and irrigation beds.
- There are a range of service standards and protection standards along the river system. Many of these assets have poorly documented origins and quality. Some assets may be redundant and further detailed comparison of each asset with what is at risk/being protected is required.
- There are a number of locations where critical infrastructure is threatened by erosive forces of the river system. This includes lifeline roads, water supply, wastewater treatment, bridges, power supply and rail.

5.6 Current Flood Risk Management

Current flood risk management captures the way in which the rivers are managed at present and reports on the decisions made to establish current management practices.

Current flood risk management investigations included:

- Descriptions of methods/tools of flood risk management currently used in the project area, including structural, non-structural, gravel management and river management techniques
- Reporting current scheme operation and methods each scheme uses, including rating structure, operational expenditure and any insurance built into scheme management
- Summary of legislative requirements and enablements.

5.6.1 Summary

Over the last 50 years river management schemes have been proposed, developed and are currently maintained. These schemes collectively reduce, mitigate or manage flooding and erosion risk, with the purpose of protecting people, property, infrastructure and productive rural land. These schemes were formed at various times based on the wishes and support of the local community.

Recent years have seen increased pressure on the existing scheme management due to changes in land-use; intensification of agricultural uses; changes in agricultural use types; and subdivision into rural lifestyle. This has resulted in increases in land value, desires to protect land from a broader range of flooding hazards whilst also increasing the awareness of and expectations to protect non-economic floodplain values.

A number of issues arise from this report, including the sustainability of existing scheme management and its impacts on floodplain values, the quality of hazard protection provided by older degraded infrastructure, the current rating systems of these schemes, and their membership and boundaries.

Eight schemes currently operate within the project area, and are managed by River Scheme Advisory Committees who report annually to GWRC. The areas managed by these schemes cover much of the floodplain, however, there are areas of the floodplain outside of scheme management, either due to the desires of the current landowners, or because previous landowners did not believe there was any benefit to being a part of a scheme.

Much of the management of the schemes focuses on the establishment and maintenance of a willow buffer zone along the rivers. However, investment in structural protection (including rock groynes and rock linings), gravel extraction, vegetation management, and stopbank maintenance are all key activities that make up the day-to-day operational management overseen by the river scheme advisory committees.

It has been fortunate for the floodplain communities that there has been a relatively stable period of weather for the past decade. This has allowed for

investment of funds in efforts to manage flood damage and manage the rivers in a way that has established stable channel form. There has been a much reduced emphasis on repair of flood damage. However, a change in size and frequency of storm events would see an increased requirement put on repair and reinstatement, which would create issues for longer-term management and the ability of responsible authorities to respond to events.

5.6.2 Issues

- The current scheme rating is viewed as biased in favour of some landowners, this is often linked to issues of buffer management.
- Scheme rating has been identified to be inaccurate in some areas due to rating databases not being kept up to date.
- Bed degradation has been an on-going process in much of the river system within the project area. Many management techniques are threatened by this continual degradation trend. In addition the further the bed degrades the greater the erosion pressure on the river banks through reduced stability (undermining).
- There are acknowledged concerns about conflicts between ecological values and some of the current management techniques.
- The gravel management policies, including licensing and purpose are not clearly defined, and inconsistent with approaches used elsewhere in the region.
- The processes of gravel management are not clearly defined, and inconsistent with approaches used elsewhere in the region.
- The regional approach to gravel management is inconsistent and many management techniques are informally developed and used. The decisions and design of these techniques often rests with an individual rather than reflecting a combined approach.
- A review of the design channel alignments was completed by the operations team within the Flood Protection Department. These have been highlighted to the project team and are incorporated in the Phase 1 reporting.
- There have been a number of attempts to secure continuous buffer zones for management of the erosion issues posed by the rivers on productive land. This has not yet been resolved and a further attempt to recognise the value of these buffers as an erosion management tool, and then secure these, will be tackled through Phase 2 of the project.
- Access requirements to manage flood risk exist only through informal agreements with landowners. This is becoming increasingly difficult as land is subdivided and ownership passes into a greater number of individuals who have a different expectation of river management and different understanding of property ownership.
- Many rural stopbanks are in very poor condition and are likely to be damaged by storms rather than fail in a flood. This would result in incomplete protection. They may not be cost-effective to retain but this is not clear.
- Some assets are ‘owned’ by multiple parties which leads to complications around responsibility for maintenance, repair, or modification.

- Current Emergency Management procedures including flood warning procedures have not been recently updated. There is a reliance on institutional knowledge and past experience to manage events. While these processes have strength during an event there is a risk to continuity of knowledge without sufficient supporting documentation.
- There are several locations where roads are inundated by frequent floods which pose a significant hazard to life, and it is acknowledged by the community that events which threaten or take life occur on an almost annual basis.

5.7 Ecological Values

Ecological value investigations capture a range of ecological values present within the floodplain. It is a complex subject and for this investigation was split into four key areas focusing on bird life, fish, vegetation and water quality. Some of the reports had been prepared prior to this project in order to support resource consent applications for flood protection activities.

The ecological values investigations focused on:

- Mapping of terrestrial ecology along the river corridors
- Mapping of avi-fauna within the river corridors
- Mapping of known aquatic ecology within the river corridor, and significant tributaries
- Identification of conflicts which may impact on identified ecological values.

5.7.1 Summary

The river systems of the Upper Ruamahanga have a broad ecological diversity. The investigations split the assessment of these into three general categories; aquatic ecosystems; terrestrial ecosystems; and avi-fauna.

Fish abundance and diversity is identified as a key indicator of aquatic ecosystem health. The Wairarapa rivers boast an abundance of a number of important native and introduced species. Recent studies identified minimal short term detrimental effect of flood protection operational activities on the aquatic ecosystems, with quick recovery times exhibited in the observed communities.

The terrestrial ecosystem mapping prioritised the mapping of vegetation as an indicator of habitat form. This identified that the river systems are dominated by willow plantings creating an almost mono culture system. The lack of bank edge native plantings is a concern as this would contribute to increased habitat diversity.

Avi-fauna investigations mapped the nesting patterns and therefore potential habitat suitable for key species known to nest in the river beds or banks. The data also collected sightings of other bird species, but these were not included in the report due to their transitional habits. A key issue identified in these investigations was the vulnerability of the ground nesting birds to predators, particularly in single channel rivers without islands, and areas where channels had weeded over blocking sightlines from nests.

The rivers in the study area are fortunate to be the nesting and breeding grounds for the Bullers Gull, which is a nationally-threatened species. Current management of the rivers has enabled the colonies of this bird to grow despite a national trend of decline that is expected to lead to extinction of the species in the South Island.

5.7.2 Issues

- It is acknowledged that there have been and continue to be conflicts between ecological values and some of the management techniques used in the rivers. It is acknowledged that these techniques have improved over the last few years and that the general direction that this is moving is good. However, there remains potential for further improvement and adjustment to improved understanding of ecological values and impacts.
- Preliminary findings of the avi-fauna reporting have identified a correlation between habitat form, vegetation and opportunities for pest predators to negatively affect valued bird species. This, in particular, focuses on benefits of braided channels, and the benefits of good in channel vegetation management.
- Preliminary outputs of terrestrial ecology mapping is indicating a number of locations with poor riparian values. The presence of good riparian margins is recognised as a strong contributor to the health of a river system and increased opportunity for habitat diversity. This is further improved through diversity in species within these margins.
- There are concerns regarding the security of the riparian margins. Phasing out of willows as an erosion control tool is not currently considered an option. However, success has been gained through a joint planting process of natives and willows – as demonstrated along the Ōtaki River where the friends group works together with flood protection to create a native 'infused' buffer zone.
- It is recognised by this project that stock in streams is an ongoing concern for the Wairarapa rivers. Where opportunities exist to reduce the instance of this occurring they should be followed up by this project.

5.8 Landscape Values

Landscape value investigations captured the subjective value attributed to landscape character and form. It drew on both the recently completed landscape character investigations developed to inform the Regional Plan, and then refined character values for each river, focusing on modification of the reach from a pristine value. This has given each reach a value on a scale of 1 to 10, with '10' being a pristine river environment and '1' being an extremely modified river environment. The reaches within the project area ranged between '3' and '7'.

Landscape Value Investigations included:

- Identification of the landscape values associated with project areas
- Identification of conflicts with landscape values which may exist in the river corridors.

5.8.1 Summary

Scenic value is generally very high in the upper reaches of the western rivers of the Study Area, particularly where these pass through the Tararua Forest Park identified as an Outstanding Natural Landscape. As these rivers flow into the Upper Wairarapa Plains, they pass through productive farmed rural landscapes and come in closer proximity to urban areas. As a consequence, the level of landscape modification tends to increase.

Within the Wairarapa Plains, river corridors have undergone various levels of modification including previous flood management control measures and ongoing gravel extraction works. Such modification was more apparent on the Ruamahanga and Waingawa Rivers with the Waipoua and Whangaehu Rivers also deviating from their former sinuous form in localised areas. Where such modification has occurred, this has tended to reduce associated scenic values, particularly where the former meandering or braided character of the river has been compromised.

Outside of the river corridor, the presence of native vegetation on one or more banks and the presence of strongly defined natural edges were key factors that contribute positively to scenic value. While this tended to occur more frequently in the upper reaches of the rivers, pockets of remnant and regenerating vegetation were noted throughout the project area, with cliffs also providing a key characteristic in the lower reaches of the Ruamahanga river. Such values should be taken into account in future flood management works.

Along many of the eastern rivers, the presence of invasive willow trees along the margins (as opposed to managed willow) forms a key factor which has negatively impacted on landscape value. This establishment of willow has affected the character of the Kopuaranga, Whangaehu and Taueru Rivers in particular, and provides a perception of 'choking' the river corridor in some areas. Associated with vegetation enclosure, the range of vegetation types for riverbank stabilisation has also tended to reduce landscape values in some areas. In such areas there may be an ability to increase landscape values through increasing the use of local native species. This factor was evident

along the Whangaehu and Kopuaranga Valleys where the use of flax, cabbage trees and kanuka has been expanded along the river margin in some areas.

5.8.2 Issues

- There is occasional criticism of the visual impact of the managed river systems, however, these are focused around those areas most often trafficked by the community and therefore limited to areas around bridges and the sections of the river around Masterton. There is opportunity to look at ways in which the visual appeal of the accessible areas can be improved, and how the management techniques applied to these areas might become less intrusive.
- Some sections of the community have expressed interest in beautifying or improving the values of an area through community initiatives. There is little resource available to these individuals to direct them to the appropriate groups, and a co-ordinated approach to management of these groups is not available.
- Past river management activities have created a burden through the river system through use of crack willows. These species are being removed through targeted control methods, however, there is a high risk of the species re-introducing themselves to an area.
- In all river management locations, some of which are easily accessible and therefore visible, the community is able to inspect and comment on their impression of the management technique. These techniques are sometimes viewed as being untidy and comments or complaints are received.
- Use of monoculture willow plantings within the study area are having a negative impact on scenic landscape values in some locations.
- Willows are adding to the choked appearance of the eastern rivers in some locations.

5.9 Recreation Values

Recreation value investigations captured the ways in which the rivers are used by groups and individuals for pastimes, hobbies, or recreation. The investigations identified a broad range of activities linked to the rivers from swimming to duck hunting. The information collected drew on published material as well as interviews and meetings with interest groups.

Recreation value investigations included:

- Mapping of recreational activities and opportunities within the river catchment (this was expanded to include some tributaries)
- Identification of conflicts with recreational values within the river corridor.

5.9.1 Summary

All of the rivers across the Study Area were recognised as having at least some level of recreation value. The Ruamahanga, Waingawa and Waipoua Rivers were typically identified as having higher recreation values with more limited recreation uses identified along Whangaehu and Taueru, typically on account of the accumulation of willow along the margins and the perceived degraded water quality. The Kopuaranga is similarly enclosed by willow margins in some areas, however, it was recognised as important for both fishing and game bird hunting.

In general terms, the presence of a pool, run and riffle form provided a common value observed across the variety of recreation uses, particularly recreational values relying on the surface of the water and habitat values associated with fish and game. Such values were generally considered vulnerable to changes through gravel extraction and flood management works. Potential conflicts between user groups in accessing such areas may also need to be taken into account, although no current levels of conflict were identified.

The use of rivers for recreation purposes relied on the ability to obtain access through both public and private land. While public access points have been identified within the project database, private access to rivers exists but is not specifically identified across much of the project area and reflects informal agreements between land owners and recreational groups which are subject to change dependent on the state of that relationship.

A perception of degradation of water quality was a key theme identified which impacted on the availability of recreation values. Such values were more typically associated with the eastern rivers in the Study Area including the Whangaehu and Taueru Rivers. Cultural differences in the desirability of recreation use was also noted, with areas downstream from the Oxidation Ponds situated adjacent to the Ruamahanga River being identified as having reduced recreation values to Māori as a consequence.

In terms of user safety associated with flood management works, some ongoing issues were identified by both kayakers and jet boat users. This presence of railway irons and submerged cables (including cabled willows) were identified as a key potential safety risk in some areas. The unmanaged accumulation of

debris was also noted. Jet boat users reported a good working relationship with GWRC where railway irons identified as dangerous were removed.

A common theme across all recreation groups was the importance of the landscape setting to recreation use. This spanned from wilderness opportunities in upper reaches, but also across the range of passive and active recreation values identified within the Study Area, including those in close proximity to urban areas. Taking into account existing landscape values when implementing change will therefore be an important consideration.

5.9.2 Issues

- Degraded landscape values in some locations detract from the recreational experience, and therefore limit recreational opportunities in those areas.
- Water quality is a major concern for recreational user groups, particularly in the eastern rivers.
- Water quality downstream from Masterton Wastewater Treatment Plant is a concern for recreational users in these locations, and of greater concern to Māori.
- Some of the management techniques are known for being potential hazards to certain user groups – in particular historic railway iron groynes – however current practices ensure their removal when discovered. In addition to this the use of certain management techniques in popular recreation areas is seen as hazardous to those users and has resulted in those user groups avoiding those areas – this includes cabled willows.
- Informal access agreements and tolerance of recreational users within certain areas of the river systems are changing as a result of ownership changes following subdivision and lifestyle land-use.
- There are limited identified conflicts in values between certain user groups. In general, the river users have commonality in the underlying river system processes which affect their areas of interest. There are perceived conflicts between ecologists and sport fishermen due to the nature of trout and native fish, however, the physical environment of the Wairarapa rivers limits the predatory nature of trout which supports survival of native species. Other conflicts exist between swimmers, jet boaters, kayakers, dog walkers and fisher interest groups.
- The use of a pool, run, riffle count was a commonly requested management tool by all user groups, and is viewed as contributing to a healthy river system. The use of pool, riffles and runs has been a management tool developed and used in a number of other rivers in the region. Diversity of river form is a common request across all interest groups.

5.10 Cultural Values

Ngāti Kahungunu ki Wairarapa and Rangitāne o Wairarapa are the two Iwi that are Tangata Whenua within the Wairarapa Valley. Both iwi have a close relationship with the rivers, wetlands and floodplains that are the focus of the floodplain management planning process. This relationship is both spiritual and physical and encompasses interests that are both historic and contemporary.

GWRC and Tangata Whenua have a special relationship, which stems from the Treaty of Waitangi, and is defined in modern legislation including the Treaty of Waitangi Act and the Resource Management Act. The Memorandum of Partnership between GWRC and Tangata Whenua sets out the principles for conducting this relationship.

The cultural values investigation was split into two parts due to sensitivities around the information related to cultural values and sites, and the necessity for the project team and iwi representatives to reach a better understanding of how to work in partnership in the development of a floodplain management plan.

Cultural value investigations commenced with the capture of site-specific locations of cultural values. It was noted early in this process that the division of cultural values into their own category, while highlighting the importance of Māori to the FMP process, does not fully represent that Māori values also include broader more holistic issues that extend across both heritage and contemporary values. This led to the development of a second more detailed report intended to develop and improve the relationship and a more holistic understanding of cultural value.

Current work within Ruamāhanga Whaitua and the Regional Plan aim to formalise a better method of ensuring broader cultural values are an integral part of decision-making processes and not separated from economic, environmental or social aspects. This project will address this through ongoing work on improving the partnership between all interested parties.

Cultural values investigations included:

- Improving the project teams understanding of Māori perspective and tools for resource management
- Mapping sites of cultural significance
- Summarising cultural values within the project area
- High level identification of conflicts with cultural values within the project area.

5.10.1 Summary

Engagement with Iwi is an integral part of the FMP process. To this end, the Wairarapa River Management Agreement sets out the process to better understand the relationship and values Tangata Whenua have with the Wairarapa rivers, particularly in relation to river management works. Tangata Whenua involvement within the Ruamāhanga Whaitua Committee will also contribute to the FMP.

Both spatial and non-spatial cultural values must be considered in the FMP process. While broader contextual values - including the significance of each river – has been summarised within the values database, the focus of this investigation sought to establish a finer scale identification of the key sites where such values occur and which should be taken into account when considering, designing and managing future flood protection works. Further understanding of non-spatial cultural values is set out in a separate cultural values report prepared by representatives of Ngāti Kahungunu ki Wairarapa, Rangitāne o Wairarapa, and GWRC.

Given the nature of historic Māori settlement along the rivers across the study area, several cultural sites have been identified within the Flood Focus Area. Some of these sites may have been forgotten through the passage of time and have only recently been rediscovered. These sites include several historic pa, village and urupa, often surrounded by areas associated with gathering of resources and food. The value of water in adjoining areas also will have cultural significance particularly around the confluences of rivers, where blessings and other sites with associated spiritual, physical, and mental health may exist.

In summary, the following key cultural issues were identified in response to cultural values investigations undertaken during this study:

- All of the rivers provide recognised cultural value which will require further engagement with Iwi to ensure change is managed appropriately.
- It is important that the identification of a site is treated as a trigger of needing to obtain further information and better understanding of the site – the current information should not be considered as a complete record of all information that is known by Tangata Whenua. The identification of cultural values is committed to identify surface information only with information outside of such areas limited for a number of reasons.
- Though sites have been identified as a point on a plan, there is often also an important relationship between points (e.g. the relationship between pa sites, mahinga kai and urupa).
- The lack of identified sites does not indicate an absence of value in an area. This may mean that information has been withheld, may not yet have been identified, or has been deliberately not recorded for other reasons.

5.10.2 Issues

- Working relationships and lines of communication between GWRC, stakeholders and Tangata Whenua need to be further developed for Phase 2 of the project.
- Cultural values include non-spatial components which consider a holistic picture of the river environment, rather than as individual components.
- Māori and non-Māori understand and value the natural environment differently but similarities between cultures exist.
- Flood protection works have the potential to affect:
  - Sites of special spiritual, historical or cultural value to Tangata Whenua, including mahinga kai and waahi tapu

- The mauri of a water body (including habitat issues)
- Important values including the mana of iwi, hapu and whānau, and the ability of Tangata Whenua to provide manaakitanga (hospitality).

Opportunities should be looked for to reduce the negative impacts and improve the positive impacts of flood protection works. Iwi representatives have commented positively on the impacts of some of the more permanent flood protection works which reduce the frequency of disturbance to the river system and allow natural processes to stabilise.

- Tangata Whenua have found it difficult to have their values or their role as kaitiaki recognised in the decision-making process. This is an issue which needs to be worked through during the project to ensure that involvement in decision-making is improved.
- Tangata Whenua want to see greater emphasis on levels of government protecting 'public good' values of rivers, for example those relating to their ecological, historic and recreational values. They feel that in the past too much emphasis has been given to the protection of private property at the expense of these values.
- Tangata Whenua note that historically, flooding was seen as a natural process with positive benefits. They also believe that preventing rivers from moving around is detrimental to the Mauri of the river. One possible solution to this is the use of a pool/run/riffle count for river management.
- Tangata Whenua state that while they accept that the practice of actively managing rivers for the purpose flood and erosion control is now firmly entrenched, this management needs to be sensitive to environmental and cultural values, and opportunities to enhance these values should be actively identified and taken as part of our river management work.
- Tangata Whenua want to see council and other agencies working in a joined-up way to reduce the administrative burden placed on them, and to support more enduring outcomes. They also support an intergrated catchment management approach, as espoused in the concept of ki uta ki tai/mountains to sea.

5.11 Heritage

Heritage value investigations captured predominantly sites of heritage value within the floodplain. These were in general situated away from rivers and significant flood risk.

Heritage values investigation included:

- Understanding the historical context for the development of the Ruamāhanga catchment within the project area
- Identification and mapping of heritage sites within the project area
- Identification of conflicts with heritage values within the project area.

5.11.1 Summary

The Ruamahanga River and its tributaries played an important role in shaping the historic settlement pattern which has occurred within the Wairarapa Valley. This is common to both early Māori and subsequent European settlement. Early settlement historically focused along the margins of the river, however, there are now a relatively limited number of heritage sites contained within the Flood Focus Area from the period following European arrival. The sites which remain have been identified in the project database and will form an important consideration through the FMP process.

5.11.2 Issues

No specific impacts on heritage values have been identified as part of the Phase 1 investigations, however, this assessment was completed prior to the development of the new flood maps. There are likely to be some heritage properties within the flooded urban area of Masterton.

5.12 Land-use

Land-use investigations captured how the land within the catchment was inhabited, what purposes it was being used for, and to a limited extent where this may change in the future. One of the primary purposes of this work was to inform the flood and erosion damage modelling.

Land-use values investigation included:

- Identification and mapping of current land-use within the project area including agricultural diversity and urban services
- Understanding of the land-use context within the project area floodplains
- Identification of potentially vulnerable infrastructure within the floodplain.

5.12.1 Summary

The investigation of land-use values identified details of current and future land-use contained within the Wairarapa Combined District Plan (WCDP). The primary source of reference was the WCDP which includes land-use relevant to both urban and rural contexts, future development sites, key infrastructure (highlighted through designations) and sites of potential contamination included on the Selected Land Use Register (SLUR).

Rural Land-use

Excluding indigenous vegetation (which is predominantly located within the Tararua Forest Park in the Upper Ruamāhanga), the most common land-use is dry stock farming (e.g. beef, deer, grazing and sheep), which represents 61% of the land area within the Study Area. Cropping, plantation forestry and dairying represent 14%, 5% and 3% respectively. However, given the age of this data, some land-use changes would have occurred, principally the conversion of dry stock farms and/or cropping farms to dairying.

There is a relatively consistent pattern and proportion of land-use types across each river in this study. The more intensive land-uses are generally located and concentrated on the flat floodplain close to the river corridors. However, the three rivers on the eastern side of the Upper Wairarapa Valley (i.e. Kopuaranga, Whangaehu and Taueru have a comparatively greater proportion of dry stock farming compared to more intensive land-uses (e.g. dairying and horticulture).

Viticulture has been increasing in land area over recent years. This type of land-use is generally concentrated near the river corridors on suitable land/soil types, such as at the end of Dakins Road near the Ruamahanga River.

Most primary production activities include a residential dwelling and/or farm worker accommodation. There has been a recent trend of more ‘rural living’ or ‘lifestyle blocks’, whereby land is subdivided into smaller landholdings with the primary purpose for residential occupation, but an element of rural use (e.g. small-scale grazing or horticulture). These areas of ‘rural living/lifestyle blocks’ are generally concentrated around Masterton, such as north of Masterton on the western side of the Ruamahanga River (e.g. Southey Road

and Willow Park Drive) and to the west of Masterton along both sides of the Waingawa River (e.g. Norfolk Road, Totara Park Drive, Upper Manaia Road, Tararua Drive, and Upper Plain Road). This pattern of more intensive rural living is shown by the 'Building Density' sub-category in the project database. From discussions with Masterton and Carterton District Council planning officers there are no current applications for large-scale rural-residential subdivisions in the Study Area.

There is also an assortment of other non-primary production activities (land-uses) scattered through the Study Area. These 'other' activities generally support or are associated with the primary production activities or rural residents. Examples include schools (Opaki and Rathkeale), quarries (including gravel extraction and processing sites), golf course (Mahunga), aerodrome (Hood) and drag racing track (Masterton Motorplex).

River Catchment (ha)	Upper Ruamāhanga	Waingawa	Waipoua	Kopuaranga	Whangaehu	Taueru	TOTAL
Dairy	125	728	194	1412	654	309	3,422
Beef	1870	1368	2470	2981	3925	9411	22,025
Deer	135	38	45	51	58	535	862
Grazing	37	89	25	65	8	36	260
Sheep	2176	815	6056	6987	6777	23390	46,201
Mixed Sheep/Beef	242	313	814	1200	57	7277	9,903
Cropping	2944	3050	3018	3210	2590	3443	18,255
Horticulture	11	50	100	0	6	0	167
Exotic Plantation	269	239	85	227	415	4989	6,224
Indigenous Vegetation	5560	7672	2910	289	12	512	16,955
Other	2355	2147	814	12	8	51	5,387

Figure 3.12.1a - Rural land-use in each River catchment

Urban land-use

Masterton is the largest urban area within the Study Area and comprises residential, commercial and industrial uses. The residential environment is the largest component of the urban area with smaller areas of commercial and industrial use (see table below). The residential areas extend from the northern suburb of Lansdowne to the north of the Waipoua River, south through Colombo and central Masterton, with Solway located at the southwest end of Masterton. All residential areas are typically 'standard' residential density (lot sizes between 600-800m^2), with a few retirement villages located within the

existing residential areas. Masterton's population was 18,132 in the 2013 census.

Commercial development is concentrated in the centre of the town along Chapel, Queen and Dixon Streets. This development is a mix of retail, commercial, community and recreational activities. The northeast extent of the commercial area adjoins the Waipoua River in the centre of Masterton.

Industrial development is concentrated in two locations. Firstly on the northern edge of Masterton along Ngaumutawa Road, Akura Road, Railway Crescent and Bentley Street. A portion of this industrial area immediately adjoins the Waipoua River. Secondly, the Waingawa industrial area is located to the southwest of Masterton, on the true right bank of the Waingawa River adjacent to the State Highway 2 and Wairarapa Railway Line bridges. Both industrial areas are a mix of light and heavy industrial activities, such as timber processing, engineering workshops, rural supplies and services, and manufacturing.

Zoning	Area (ha)
Residential	1,270 hectares
Commercial	78 hectares
Industrial	366 hectares

Figure 3.11.1b – Land area for urban zoning in Masterton (incl. Waingawa)

The majority of the area zoned for urban purposes has already been developed. Within the already developed areas there is the ability for more intensive development to occur, such as infill residential subdivision and new commercial or industrial development.

In addition to Masterton, there are two small rural settlements within the Study Area: Mauriceville (adjacent to Kopuaranga River) and Taueru (adjacent to Tauweru River). These settlements each comprise approximately 20-25 dwellings, a school and a community hall.

Future Development

New areas of 'future development' have been identified in the District Plan for greenfield residential and industrial development. This land is located immediately adjacent to the existing urban area with a new residential area on State Highway 2 north of Masterton, and industrial areas on Ngaumutawa Road and at Waingawa. The size of these future development areas are listed in the table below:

Zoning	Area (ha)
Opaki Road, North of Masterton (Residential Zone)	29.6 hectares

Ngaumutawa Road East (Industrial Zone)	13.4 hectares
Chamberlain Road (Industrial Zone)	25.7 hectares
Waingawa (Industrial Zone)	130 hectares

Figure 3.12.1c – Land Area for future development

From discussions with Masterton and Carterton District Council officers, the first stage of development has already commenced in each of these new areas. However, the rate of actual development has been relatively slow. There are no other identified urban growth or development areas within the Study Area.

Parks

There are a number of parks and reserves within the Masterton urban area, the locations of which are identified on the project database. Two of particular note are Queen Elizabeth Park which the Waipoua River passes through, and Henley Lake adjacent to the Ruamāhanga River (also supplies water to the lake). Queen Elizabeth Park is Masterton's premier park and recreation area, with playground, park land, sports fields and other sporting facilities. There are a number of esplanade reserves located immediately adjacent to the rivers throughout the Study Area.

A large portion of the western extent of the Study Area is part of the Tararua Forest Park. Refer to Landscape Values within the project database for further information in relation to the Forest Park.

Infrastructure and Other Features

Major infrastructure and services for Masterton and the wider Wairarapa are located throughout the Study Area, including in or near the river corridors.

The Masterton urban area (including Waingawa) is serviced by reticulated water and wastewater systems. The water supply for the Masterton urban area is from the Waingawa River, with the Masterton Water Treatment Plant located on the true left bank in Upper Plain Road. The Homebush Wastewater Treatment Plant is located to the southeast of the Masterton urban area immediately adjacent to the Ruamahanga River. This treatment plant historically discharged treated effluent to the river, but is currently in the process of being upgraded to enable predominantly land-based treatment and disposal.

The former (now closed) Masterton landfill is also located near the Ruamahanga River to the southeast of the Masterton urban area. This site is now operated as a refuse/recycling collection facility.

Electricity and public telecommunication networks service and connect the entire Study Area, except within the Tararua Forest Park (however this area is covered by the DOC/SAR radio repeater systems). The main electricity and telecommunication lines generally follow main roads, including river crossings near or on main road or rail bridges. In rural areas, the majority of electricity

and telecommunication lines are overhead lines, and a mix of underground and overhead lines in the Masterton urban areas. The electricity substations and telecommunication exchanges are located within or adjacent to the Masterton urban area, except for the electricity substation on Cornwall Road close to the Waingawa River.

There are a number of cellphone towers within the Study Area with the majority located on elevated land.

State Highway 2 is the major road through the Study Area connecting Masterton and the surrounding area and districts. State Highway 2 crosses the Waingawa, Waipoua and Ruamahanga Rivers. The Masterton heavy traffic bypass follows a section of Paierau Road which crosses the Waipoua River. There are a number of local roads with numerous one- or two-lane bridges which cross the rivers in this study.

The Wairarapa Main Trunk Railway Line traverses the Study Area with stations at Waingawa (freight only), Solway, Renall Street, and Masterton. South of Masterton, the railway is used for passenger and freight services, while north of Masterton the line is used for freight only. The railway line crosses the Waingawa, Waipoua and Ruamahanga Rivers.

Selected Land Use Register (SLUR)

The Selected Land Use Register (SLUR) provides a database of historical land-uses where hazardous substances may have been used, stored or disposed of in the Study Area. This GIS layer comprises a Site ID as provided by GWRC to identify the potential contamination in this area. This information is potentially relevant to the FMP process as land disturbance may occur as a result of flooding or during development of flood risk management options.

5.12.2 Issues

- The flood hazard model shows new areas beyond the district plan zones as affected by flood hazard.
- A number of small rural communities are identified as vulnerable to flooding including Mauriceville and the properties around the confluence of the Waipoua River and the Serpentine Stream.
- There are several locations of infrastructure vulnerable to various levels of flooding or erosion including:
  - Sections of Masterton Wastewater Treatment Plant
  - Sections of Masterton Water supply pipeline
  - Water intake and treatment structures
  - Water race intake structures
  - Bridge crossings
  - Lifeline Roads
  - Sites registered on the Selected Land Use Register (SLUR).

5.13 Planning

Planning investigations captured the current legislative framework which guides and controls development, protects critical infrastructure and advises on land-use within the project area. It is primarily driven by the district plan, however, a number of other legislative controls exist which also have influence on this.

Planning investigations included:

- Understanding of the current district planning framework operational within the project area
- Identification of planning techniques operating in a planning context
- Identification of flood risk management assets currently protected by designations and identification of gaps.

5.13.1 Summary

The planning controls in the Wairarapa Combined District Plan relating to flood hazards apply on a 'district-wide' basis rather than 'zone' basis. This approach means the same controls (rules) apply to the Rural, Commercial, Industrial and Residential Zones, with one exception. This exception applies in the subdivision rules in the Rural Zone, where areas identified as 'Flood Hazard Area' (discussed further below) are zoned 'Rural (Special)' (where a 4 hectare minimum lot size applies) rather than the standard rural zoning of 'Rural (Primary Production)' (where a 1 hectare minimum lot size applies).

The overall objectives and policies for natural hazards seek to manage activities and development within areas at significant risk from flooding to avoid, remedy or mitigate the adverse effects.

To achieve this objective and implement the policies, a key aspect of the planning controls (rules) is the mapping of areas at high risk from flooding. The Wairarapa Combined District Plan manages activities and development based on mapping two tiers of flood risk:

- '**Flood Hazard Area**' identifies land at risk from flood events with a projected 1:50 year return period; and
- '**Flood Alert Area**' identifies land at risk from flood events with a projected 1:100 year return period.

In addition, the District Plan identifies '**Erosion Hazard Area**' for localised areas subject to riverbank erosion area. The three areas identified in relation to flooding have been included within the project database under the land-use and planning layers.

In summary, within the 'Flood Hazard Area' irrespective of the underlying zoning (e.g. Residential or Rural), any new habitable building (e.g. dwelling, place of assembly) or additions/alterations to an existing habitable building requires a resource consent as a discretionary activity. Non-habitable buildings up to 4m in height and 15m^2 in gross floor area are permitted, with any non-

habitable buildings exceeding these thresholds requiring resource consent as a restricted discretionary activity. Furthermore, any subdivision within the 'Flood Hazard Area' is a discretionary activity.

No specific rules or standards apply to the 'Flood Alert Area'. However, if resource consent was required for the proposal under another rule (e.g. controlled activity subdivision), flooding would be a relevant consideration in the assessment of the application.

In all areas, river control and flood protection works carried out or supervised by Greater Wellington Regional Council are permitted and are exempt from the 'Flood Hazard Area' standards and thresholds. Notwithstanding this, these works would be subject to the other rules in the District Plan, such as works within a listed heritage site or indigenous vegetation clearance. In addition, the works would be subject to any relevant Regional Plan rules and National Environmental Standards.

Designations

As shown in the project database, there are a number of designations within the Study Area. GWRC has existing designations for flood protection works and structures for the Ruamahanga, Waipoua and Waingawa Rivers. These designations enable GWRC to maintain, operate, upgrade and protect the flood protection works. Designations also exist for other infrastructure works and services, such as wastewater treatment plant, state highway and railway line. If GWRC plans to undertake works in land subject to these other designations, it would need approval from the Requiring Authority of the relevant designation.

5.13.2 Issues

- Current planning provisions identify only the 1-in-50 year return period flood. Updated flood modelling identifies a full range of flood hazard zones which in some cases extend beyond the current WCDP hazard zone areas.
- Current planning controls allow for subdivision within the flood hazard area as a discretionary activity
- Current planning controls deem construction within the erosion hazard areas as a non-complying activity
- There are no identified gaps within the designations of essential flood protection structures or current management tools (e.g. floodways).

6. Floodplain Management Plan Objective Recommendations

The following are recommended as objectives for further development of the Te Kāuru / Upper Ruamāhanga Floodplain Management Plan. The objectives listed below are proposed as draft objectives for further development with the community during the early stages of Phase 2:

- To provide cost-effective, sustainable flood hazard management for the community which creates opportunity to enhance river values.
- To provide flood hazard protection and erosion control to a level of service agreed by the community.
- To provide flood hazard management across the whole continuum of flood risk and recognise that greater than design flood events can occur.
- To work in partnership with the community to develop floodplain management plans.
- To work in partnership with Iwi to develop floodplain management plans.
- To ensure that future development and land-use is compatible with flood risk through use of appropriate planning and development controls, and where practical seek to change existing land-use to reduce or eliminate identified risks.
- To improve the recognition of impacts (positive and negative) on cultural values of flood hazard management activities through use of the partnership agreement which exists between Iwi and GWRC.
- To improve recognition of impacts on the environmental and ecological values of flood hazard management activities and to consider alternative approaches to reduce negative impacts.
- To improve recognition of impacts on the recreational values of flood hazard management activities, and to consider alternative approaches to reduce negative impacts.
- To recognise the contributions and role of the community (which includes the current scheme committees) towards flood risk management.
- To develop a sustainable floodplain management plan that informs and aligns with the LTP of the affected local authorities.
- To recognise, support and work in synergy with overlapping projects and initiatives.
- Ensure work aligns with Integrated Catchment Management principles to enable ICM plan/s to be developed in the future as an expansion of this project.

7. Appendix 1 – Phase 1 Investigation Reports

The following table is a list of reports referenced or published by Greater Wellington Regional Council in support of the Phase 1 investigations for the development of the Te Kāuru /Upper Ruamāhanga Floodplain Management Plan.

Report	Author	Reviewer	WGN# reference
Geomorphology	Kyle Christensen (GWRC)	Mark Hooker (GWRC)	1252216
Hydraulic Modelling	Susan Borrer (GWRC)	Peer Review - Graham Macky (DHI)	TBC
Peer Review of Hydraulic Modelling	Graham Macky (DHI)	N/A	TBC
Current Flood Risk Management	George Harley (GWRC)	Colin Munn (GWRC)	1295918
Erosion Damages	Mark Hooker (GWRC)	Kyle Christensen (GWRC)	1308722
Flood Damages	George Harley (GWRC)	Kyle Christensen (GWRC)	1272138
Cultural, Land-use, Heritage, Recreation and Landscape Values Summary Report	Rhys Girvan (Boffa Miskell Ltd)	Alistair Allan (GWRC)	1300884
PMF Hydrology	Laura Keenan (GWRC)	Peer Review - Charles Pearson (NIWA)	1236214
Peer Review of PMF Hydrology	Charles Pearson (NIWA)	N/A	1236270
Hydrology Investigations	Kyle Christensen (Pattle Dellamore and Partners)	Peer Review - Charles Pearson (NIWA)	1231644
Peer Review of Hydrology Investigations	Charles Pearson (NIWA)	N/A	1217231
Cultural Values Report	Anna Carter (GWRC)	Lee Rauhina-August/Mike Grace/Dane Rimene/Ra Smith/Alistair Allan	1250435
Upper Wairarapa FMP Scoping Report	Hamish Wesney (Boffa Miskell)	Jan van der Vliet (GWRC)	1142790
Upper Wairarapa FMP Phase 1 Project Plan	Alistair Allan (GWRC)	Jan van der Vliet (GWRC)	1164215
Phase 1 Summary Report	Alistair Allan (GWRC)	Mark Hooker (GWRC)	1295918

Ecological Effects of flood management activities in Wairarapa Rivers	Russell Death (Massey University)	N/A	1312060
Diversity, abundance and distribution of birds on selected rivers in the Wellington Region	McArthur, Playle, Govella (GWRC)	N/A	1254006