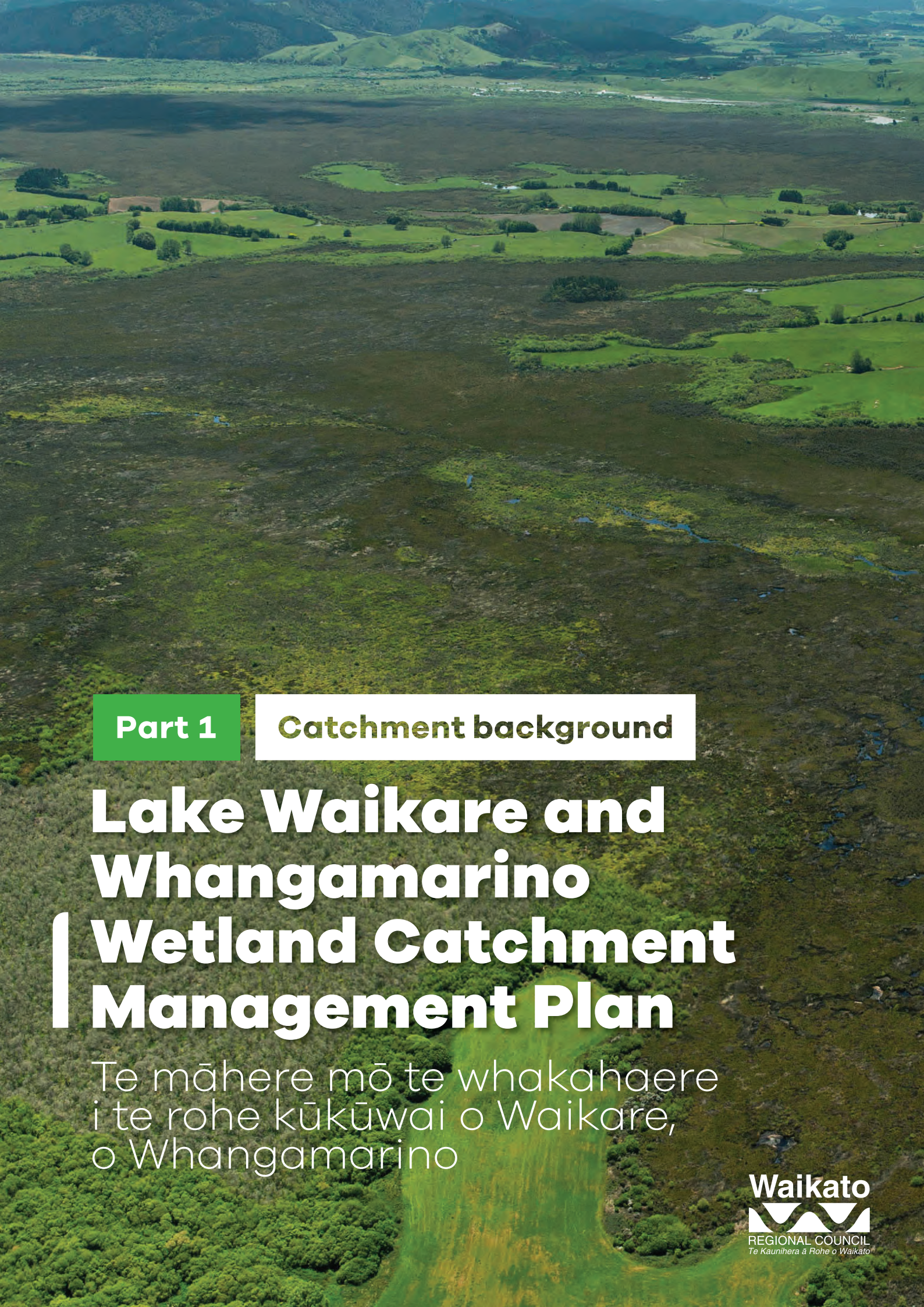

Part 1

Catchment background

Lake Waikare and Whangamarino Wetland Catchment Management Plan

Te māhere mō te whakahaere i te rohe kūkūwai o Waikare, o Whangamarino

Waikato Regional Council
Te Kaunihera ā Rohe o Waikato

Peer reviewed by Sarah Lealand, Lower Waikato Zone Manager, on 19 September 2018.

Approved for release by Brendan Toohey, Manager Central Waikato/Lower Waikato/Waipā/West Coast catchments.

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Ngaa Muka Development Trust (Glen Tupuhi and previous chair, Moko Tauriki)
Primary Stakeholders Catchment Trust (PSCT) (including Chair Jim Cotman, Kirstie Hill, Chris Falconer, Murray Twining, Trevor Simpson, Brendan Balle, Jason Barrier and David Short)
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Waikato Regional Council's Integrated Catchment Management Directorate
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Waahi Whaanui Trust (Hori Awa and previous representative, Taroi Rawiri)
Watercare Services (Joseph Chaloner Warman and Mark Bishop)

Disclaimer

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Executive summary

This *Lake Waikare and Whangamarino Wetland Catchment Management Plan* (CMP) forms part of a broader lower Waikato zone management planning and implementation work programme. The CMP is developed to help **address issues and opportunities** identified within the Lake Waikare and Whangamarino Wetland catchment, and provides a framework to be utilised to **guide the future work programmes** of all those involved with the catchment's management and development. The CMP will also assist in obtaining resourcing and funding to deliver specific actions and recommendations outlined in the action plan.

A number of key documents have helped to frame the collaborative catchment management plan approach, the most important of which is *Te Ture Whaimana o te Awa o Waikato – The Vision and Strategy for the Waikato River* (Waikato River Authority, 2009).

An overarching CMP purpose has been developed and has been defined through the CMP development consultation process undertaken to date. The purpose of this CMP is:

> ***conserve, enhance and, where appropriate, restore the river, land and wetland environment through effective land, water and resource planning across the Lake Waikare and Whangamarino Wetland catchment; through a coordinated, collaborative approach.***

The CMP has been developed in two parts.

Part One provides a detailed catchment description, an overview of the statutory, policy and institutional documents and drivers, a detailed description of the key catchment issues and opportunities, and the strategic aims and objectives for this CMP. Part One has been informed through a 'state of understanding' process, whereby existing research and initiatives within the catchment have informed the key gaps and areas which require further work. In addition, the CMP has been developed collaboratively by engaging with a wide range of parties from government organisations to local iwi, communities and private landowners. This consultation through the development of the CMP has helped inform the CMP content.

Within Part One, key catchment issues and opportunities (including those identified through the consultation process) have been developed, which were also informed through a 'state of understanding' process. From these, five 'management areas' have been identified that represent a predominant theme for the catchment, and the implementation of the CMP, with some issues and opportunities linking to a number of management areas.

These management areas include (in no particular priority order):

- CMP implementation
- water management (including quantity, quality and flood management)
- soil and land management
- biodiversity
- economic, social and cultural values.

For each management area, a strategic aim has been identified that sets out a broad aspirational statement for a given management area for the next 80 years, along with a number of objectives which indicate how the CMP will be pursued. The key catchment issues have helped to inform each strategic aim and objective.

Part Two of the CMP builds on the knowledge gained from the Part One process and details an action plan that has been developed to represent achievable steps, actual activities and/or initiatives (actions) necessary to reach the aspirations set out in the strategic aims and objectives. The actions have, where possible, taken advantage of the key catchment opportunities and address the key catchment issues.

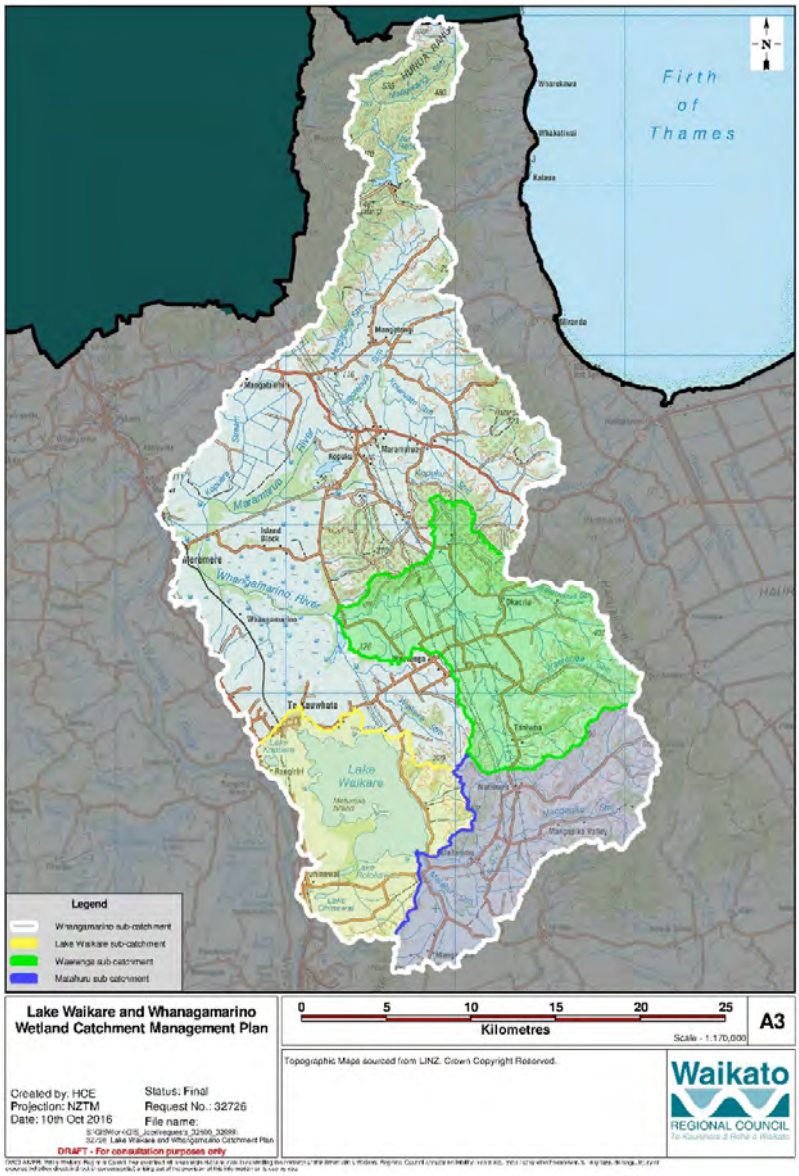
Ultimately, the action plan will achieve the overall CMP purpose and will address the key catchment issues and opportunities which have been identified.

As the CMP is a non-regulatory and non-binding document, no organisation or individual is bound by the action plan. If there are actions identified on private land, the landowner is not obliged to undertake them or allow others to undertake them. Nor do the actions presented in this CMP bind the Waikato Regional Council or other organisations to fund or enact these actions.

Ongoing monitoring and review of the CMP is a vital component of the catchment management process. Under the management of the governance structure, reviews at appropriate timescales have been recommended to ensure all partners and participants concerned with the implementation activities are involved as appropriate.

1. Introduction

A catchment is defined as a geographical drainage area of a river and its tributaries. The Lake Waikare and Whangamarino Wetland catchment area includes the sub-catchments of Lake Waikare, Whangamarino Wetland, Whangamarino River and the Matahuru and Waerenga streams, as shown below in *Map 1: CMP Catchment Area*. The catchment drains via the Whangamarino River into the Waikato River between Meremere and Mercer.



Map 1: CMP Catchment Area

Catchment management planning offers a way forward to integrate the different administrative, planning and regulatory systems and multiple demands on the catchment. It recognises the health of

our rivers, lakes, wetlands and land use, and can enable all those with an interest in the catchment to communicate, liaise and work more effectively together (Bissett, et al., 2010).

Catchment management planning promotes the development of greater understanding between parties and allows them to work towards shared objectives (including actions on the ground) to achieve sustainability and improved environmental quality. This Lake Waikare and Whangamarino Wetland Catchment Management Plan (CMP) is developed for this specific catchment, as identified above.

1.1 Purpose

A number of key documents have helped to frame the collaborative catchment management plan approach, the most important of which is *Te Ture Whaimana o te Awa o Waikato – The Vision and Strategy for the Waikato River* (Waikato River Authority, 2009), being:

> *Tooku awa koiora me oona pikonga he kura tangihia o te maataamuri.*
>
> *The river of life, each curve more beautiful than the last.*
>
> *Our vision is for a future where a healthy Waikato River sustains abundant life and prosperous communities who, in turn, are all responsible for restoring and protecting the health and wellbeing of the Waikato River, and all it embraces, for generations to come.* (Waikato River Authority, 2009)

Waikato Regional Council's 2016-19 Strategic Direction guides work and sets priorities for the council's work up to 2019. It also reflects community desires and needs and identifies key factors that will determine whether the council is successful in achieving its strategic direction.

Priorities under the council's strategic direction which are aligned to the implementation of this CMP include:

- support **communities** to take action on agreed outcomes
- forge and strengthen **partnerships** to achieve positive outcomes for the region
- positively influence future **land** use choices to ensure long term sustainability
- manage **fresh water** more effectively to maximise regional benefit
- increase communities' understanding of **risks and resilience** to change
- shape the **development** of the region so it supports our quality of life.

The implementation of the CMP will assist the council in delivering its strategic direction (Waikato Regional Council, 2017).

In addition, an overarching CMP purpose has been developed and has been defined through the CMP development consultation process undertaken to date.

CMP purpose:

> ***Conserve, enhance and, where appropriate, restore the river, land and wetland environment through effective land, water and resource planning across the Lake Waikare and Whangamarino Wetland catchment; through a coordinated, collaborative approach.***

This CMP is formulated to help **address issues** identified within the Lake Waikare and Whangamarino Wetland catchment, and provides a framework to be utilised to **guide the future work programmes** of all those involved with the catchment's management and development. The CMP will also assist in obtaining resourcing and funding to deliver specific actions and recommendations outlined in the action plan.

As the CMP is a non-regulatory and non-binding document, no organisation or individual is bound by the action plan. If there are actions identified on private land, the landowner is not obliged to undertake them, or to allow others to undertake them. Nor do the actions presented in this part bound the Waikato Regional Council or other organisations to fund or enact these actions. Waikato Regional Council and local authority funding occurs through their individual long term plan and annual plan processes, while national organisations such as the Department of Conservation and the Auckland/Waikato Fish & Game Council have their works programmes funded through their legislative mandates and central budgets. Consequently, if the outcomes sought from the CMP are deemed important for the community, it is important for the community to advocate CMP implementation to provide support for these organisations to secure adequate and sustained funding.

Through the CMP's continued development and implementation, the land and water resources within the Lake Waikare and Whangamarino Wetland catchment will be conserved, enhanced and, where appropriate, restored.

1.2 Scope and strategic fit

The CMP forms part of a broader Lower Waikato Zone management planning and implementation work programme that guides future work programmes within the Lake Waikare and Whangamarino Wetland catchment. The CMP will be crucial in obtaining funding to deliver specific operational actions, as outlined in this action plan.

The CMP is also a tool for implementing the Waikato-Tainui Raupatu Claims (Waikato River) Settlement Act 2010 and assists in giving effect to *Te Ture Whaimana o te Awa o Waikato – The Vision and Strategy for the Waikato River*. The Waikato River Authority is the custodian of the Vision and Strategy – the primary direction-setting document for the Waikato River and its catchments.

The CMP implements a number of non-regulatory responsibilities under a variety of statutes, policies and plans which are key to several of the CMP's collaborative parties, including landowners, Waikato-Tainui, Department of Conservation (DOC), Auckland/Waikato Fish & Game Council (F&G), Waikato District Council and Waikato Regional Council.

The statutory and policy context for the CMP is illustrated in Figure 1.

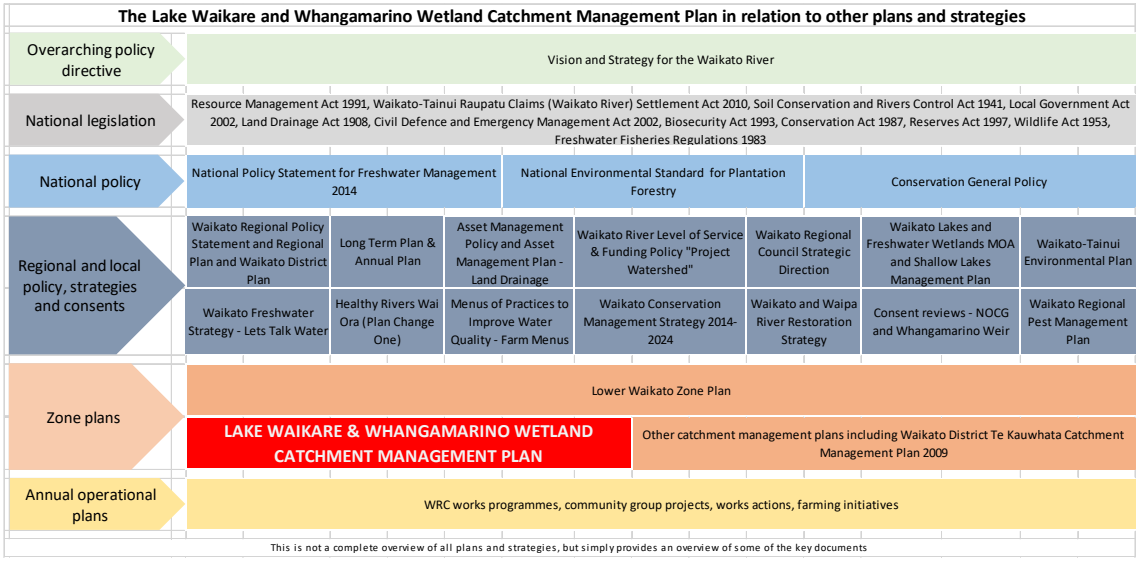


Figure 1: The Lake Waikare and Whangamarino Wetland Catchment Management Plan in relation to other national and regional plans and strategies

1.3 CMP structure

The CMP has been developed in two parts, as depicted in Figure 2 below. Part One of the CMP provides a detailed catchment description, an overview of the statutory, policy and institutional documents and drivers, a detailed description of the key catchment issues and opportunities, and the strategic aims and objectives for this CMP.

Part One has also been informed through a 'state of understanding' process, whereby existing research and initiatives within the catchment have informed the key gaps and areas which require further work. In addition, consultation through the development of the CMP has helped inform the CMP content.

Part Two of the CMP builds on the knowledge gained from the Part One process and provides the action plan to assist in achieving the overall purpose of the CMP.

Section 7 of Part One sets out the monitoring and review of the CMP, which is considered a key component of the overall catchment management process and ensures objectives are achieved. It is anticipated that Part One of the CMP is unlikely to change remarkably over the short-medium term, therefore, it is recommended to review the full CMP (including both Part One and Part Two of the CMP) every 10 years; and a review of Part Two (i.e. the action plan) every three years.

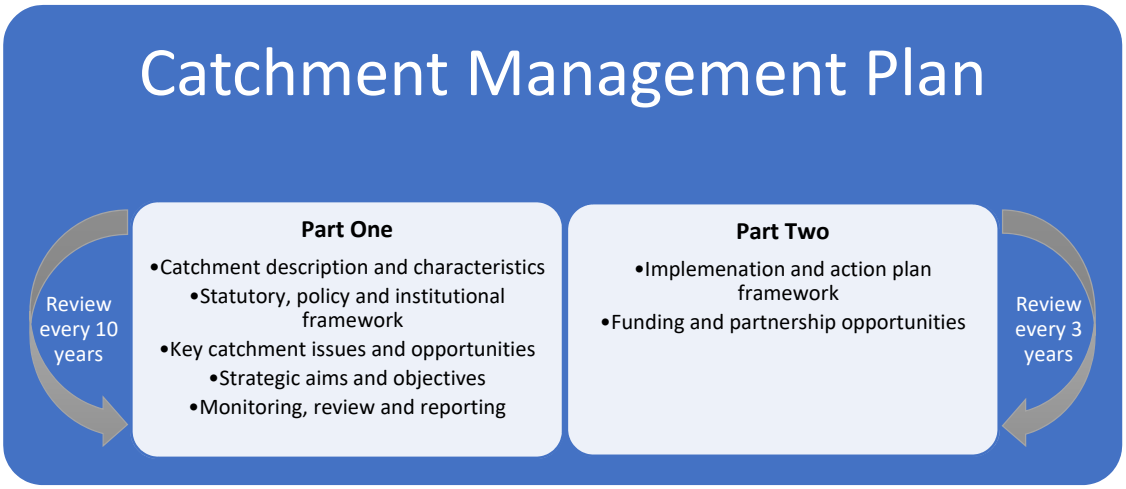


Figure 2: CMP structure

1.4 Collaborative plan development

The CMP has been developed collaboratively by engaging with a wide range of parties – from government organisations to local iwi, communities and private landowners. To assist with facilitation of this process, the services of Helen Ritchie was engaged to ensure clear direction and collaboration throughout.

The key parties who have collaboratively developed this CMP include:

- Waikato Raupatu River Trust
- Ngā Muka Development Trust
- Waahi Whaanui Trust
- Department of Conservation (DOC)
- Auckland/Waikato Fish & Game Council
- Waikato District Council
- Waikato Regional Council
- Primary Stakeholders Catchment Trust
- Watercare Services Limited
- communities and private landowners within the catchment.

This collaborative approach to the CMP development was in response to several key drivers, including:

- the new Waikato River co-management framework
- the desire to have a coordinated multi-agency, non-regulatory plan that reflected the aspirations of river iwi and all other stakeholders
- a plan that supported the long term and sustainable use of land and water resources for the agricultural industry

- declining water quality, sedimentation impacts, modified hydrological regimes and invasion of pest plants and animals in the catchment as a whole, including Lake Waikare and Whangamarino Wetland.

The CMP development included the utilisation of a project team which was supported by a wider project group including project governance, a "working group" to provide direction and input into the CMP development process and technical input/direction. The project group structure is outlined in Figure 3.

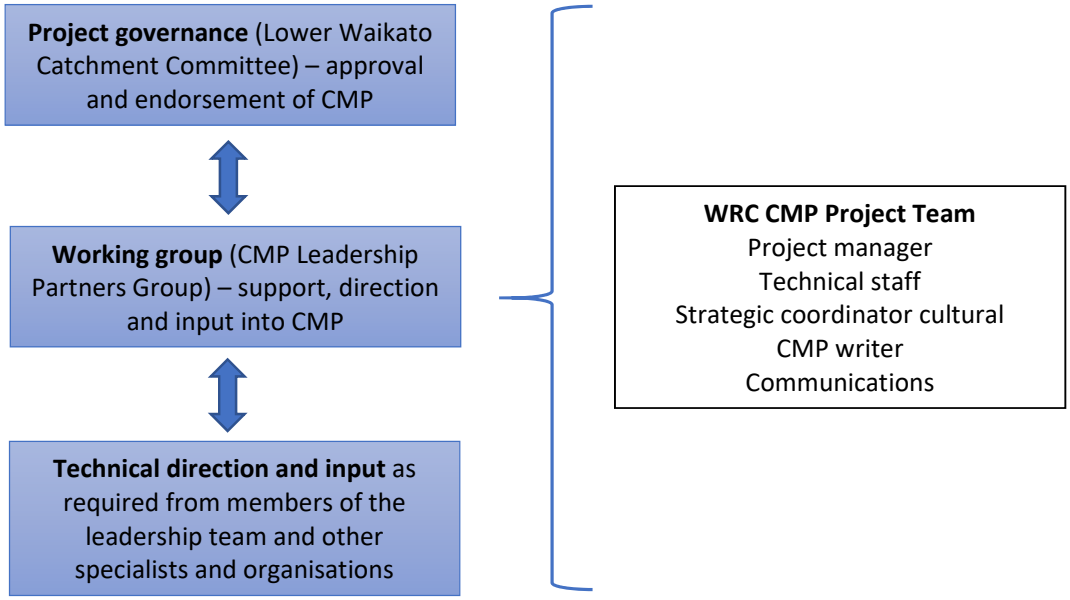


Figure 3: CMP Governance and Project Structure

In order to support the development of the CMP, and to assist with collaboration into the development process, an engagement plan was developed that was underpinned by the following key overarching principles (Ira, et al., 2015):

Building long term relationships

- We consistently listen to and work alongside each other in a spirit of respect, helpfulness, sharing, clarity and support that builds mutual understanding.

Understanding our values

- We respect, restore and protect the relationships of iwi, according to their tikanga and kawa, and of local communities, regarding natural, physical, cultural and historic resources for our shared social, cultural and economic wellbeing.

Coordinated efforts

- We work together in a planned and efficient way to restore and enhance the health and wellbeing of Lake Waikare and Whangamarino Wetland now and for generations to come.

Ownership and accountability

- We ourselves will implement strategies and encourage others to carry out what needs to be done to meet the vision of national, regional, local and iwi policies, plans and strategies.

Learning together

- We help others to understand what the CMP will mean for them and how it will make a difference to the values we hold dear.

The CMP has been prepared in accordance with the spirit and philosophy of these key principles.

2. Background

The Lower Waikato Zone consists of the Waikato River catchment between Ngāruawāhia and the Tasman Sea. It covers an area of 283,757 hectares, which is 20 per cent of the total Waikato River catchment area (Waikato Regional Council, 2011).

The overall Lake Waikare and Whangamarino Wetland catchment covers a total area of 797.1 square kilometres, and includes the sub-catchments of Lake Waikare, Whangamarino Wetland, Whangamarino River and the Matahuru and Waerenga streams. The catchment drains via the Whangamarino River into the Waikato River between Meremere and Mercer. This is illustrated in Figure 1.

Within this catchment is Whangamarino Wetland and Lake Waikare, which constitute the second largest bog and swamp complex in the North Island and the largest lake in the lower Waikato basin. Whangamarino Wetland is listed as a wetland of international significance under the Ramsar Convention for being an outstanding example of a wetland characteristic of its region, and Lake Waikare contains high biodiversity values providing habitat for a range of indigenous fauna (Reeves, et al., 2012).

In addition, there are four small lakes to the west of Lake Waikare: Ohinewai (16ha), Kopuera (52ha), Rotokawau (22ha) and Penewaka Lagoon (4ha). All but Penewaka Lagoon are linked to Lake Waikare by drains.

Whangamarino Wetland also receives water from the Waikato River catchment, via Lake Waikare, as part of the Lower Waikato-Waipā Flood Control Scheme (LWWFCS). The construction of the LWWFCS in the 1960s was a historically significant milestone within the Lower Waikato Zone, and has enabled land use to become more intensive within the wider catchment.

Agriculture (dairy and dry stock farming) is the dominant economic activity within the Lake Waikare and Whangamarino Wetland catchment area. The rural industry in this catchment contributed an estimated $156.7 million, or approximately 0.7 per cent of the Waikato gross regional product (GRP), in 2005 (Keenan, 2017).

In addition, there are other significant industrial activities and key infrastructure, some of which have national or interregional importance, including state highways 1 and 2, the North Island Main Trunk railway, the national grid transmission lines and the Mangatangi Dam.

It is widely acknowledged that Lake Waikare, Whangamarino Wetland and their catchments have multiple important values and interests to a variety of stakeholders. Often these values are inter-related. The challenge is to ensure these values and interests are not competing but instead are brought together to achieve common objectives for the catchments of Lake Waikare and Whangamarino Wetland.

The future management and enhancement of Lake Waikare and Whangamarino Wetland is a key focus for iwi, many key stakeholders, landowners and the wider community. There is a general desire to

have a coordinated approach with managing these catchments, and therefore the development of a collaborative catchment management plan was initiated.

2.1 Cultural perspective

The Whangamarino, Maramarua, Kopuku, Hunua, Rangiriri, Te Kauwhata and Meremere areas are all areas of cultural importance to iwi, hapū and whānau who established marae in these places to sustain their people with drinking water and fisheries. The predominant iwi being Waikato, in particular Ngāti Mahuta, Ngāti Naho, Ngāti Hine, Ngāti Tamaoho, Ngāti Makirangi; and varying interests of other iwi such as Ngāti Hako and Ngāti Paoa of Hauraki (J. Williams, *pers. comm*. 2017). Other iwi interests in this catchment are yet to be articulated and on plan review it is expected that these are incorporated.

The waters of the Waikato River were sent forth from Tongariro to heal his sister, a heartbroken and unwell Taupiri Maunga. Its waters had the power to heal, energise and bring life to the natural environment and its people. From that time, the Waikato River has continued to nurture the natural resources within its reach. It is the central nervous system of the Waikato and through its streams she extends her mauri (life force) to lakes, wetlands, forests and communities. The relationship was mutual where she opens inland corridors for our fisheries and birds who in turn provide her with nutrients, seeds for dispersal and pulsed waters for cleansing. Today, the relationship is unbalanced due to the accelerated impact of people who in turn have interfered with her natural evolution. This is evident in many areas of the Waikato, but none as visual as the Lake Waikare and Whangamarino Wetland catchments (J. Williams, *pers. comm*. 2017).

As the Waikato River slumbers past the lowlands of the Waikato region and begins the haerenga (journey) to the Tasman Sea, it carries the events of the recent days, as it has done for thousands of years. In recent times, it has seen its bed and banks realigned, pierced with structures and tainted with foreign substances. Prior to these developments, the river was witness to tribal warfare, romances and invasions, whilst sharing her resources with its hapū and marae. The river and Lake Waikare provided a tough environment which created a strategic advantage for tangata whenua.

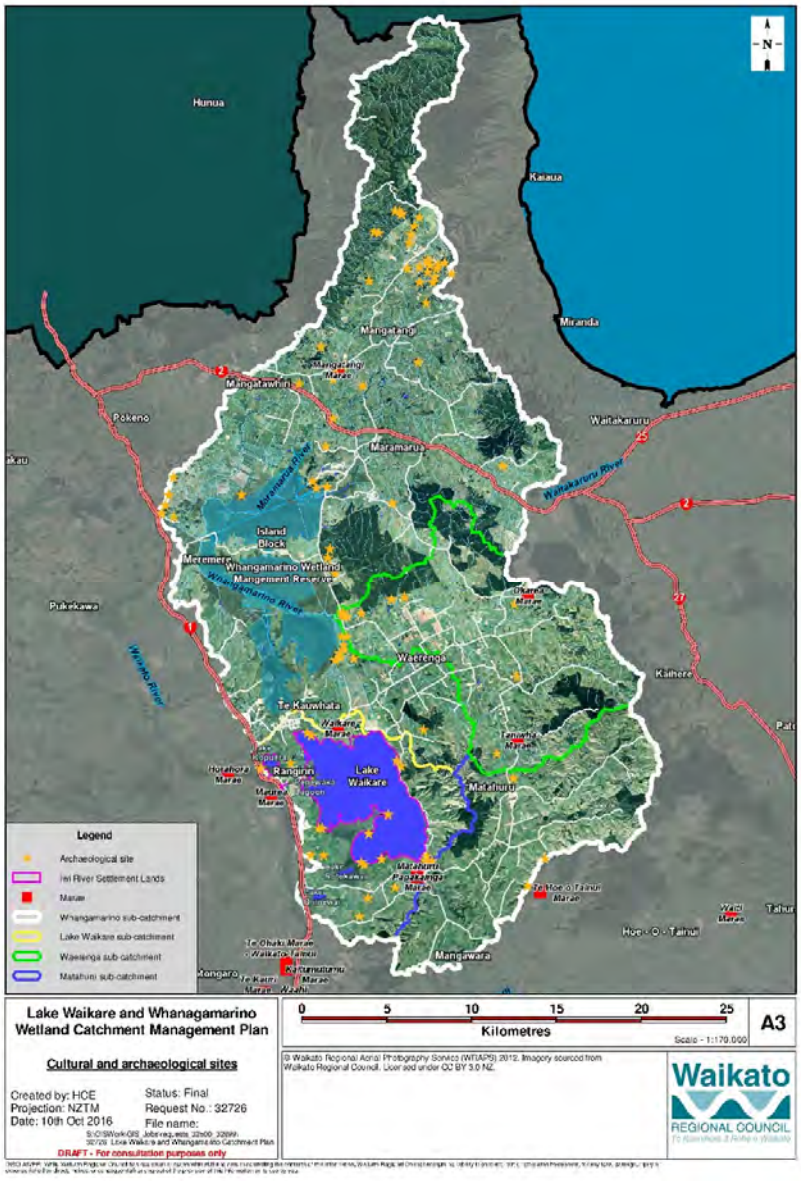
> *"The Waikato River and the Waikari (Waikare) Lake, between which the road must pass, are here separated by an island of flax, the ground of which is sometimes only swampy, and sometimes entirely under water. In this island an army might lie hid, invisible and invulnerable, for the flax-leaves will turn a rifle-bullet, and unless completely surrounded by troops on the river-bank, above and below the island, and by boats on the Waikato and Waikari, would have safe retreat in case of need."* (Gorst, 1959)

The river and Lake Waikare were also witness to the birth of the Kīngitanga, a movement established to unite the people and bring calm to the nation beginning with a young Pōtatau Te Wherowhero, destined to be the first Māori King:

> *"Te Wherowhero never missed his daily morning swim on the broad bosom of the beloved Waikato River. He followed the fowlers to the bird-snaring forest trees in the Moerangi ranges, the trappers to the rat trails in the forest-clad hills of Hākarimata, and the fishermen to the eel-weirs at the outflowing waters of the tribal lakes of Waahi, Hakanoa, Waikare, Whangape and others. He learnt to net the kahawai at the outflow of Waikare lake."* (Jones, 2010)

Marae have long been established in the area to capitalise on the rich resources and to maintain the presence of their iwi, hapū and whanau, as illustrated in *Map 2: CMP cultural and archaeological sites*. Lake Waikare, Whangamarino and the lower northern end of the Waikato River provided an abundance of kai (food), such as tuna (eel), kahawai, kanae, kōaro, kōkopu, īnanga, kōura, kaeo and a variety of birds. The natural relationship between Whangamarino and Lake Waikare was an integral process for gathering of kai for the tangata whenua who understood that one of the most productive times for gathering fish was during the floods from the wetland to the lake. This ensured that a sustainable storage of food was available throughout the leaner times of the year (J. Williams, *pers. comm*. 2017).

The tangata whenua continue to live in their catchment with the full knowledge that times have changed, their waters are unwell, and an expectation that their resources will continue to sustain a quickly growing community at the doorstep of our region's largest city. It is their right to protect, sustain and use the resources as they have done for many centuries, and as kaitiaki of the area, they will do so forever (J. Williams, *pers. comm*. 2017).



Map 2: CMP cultural and archaeological sites

2.1.1 Ngā pakanga whenua (New Zealand wars)

Many historical accounts provide detail to the Waikato wars between 1863 and 1865. The key groups to the battles were Waikato and the colonial forces from the British Empire. To the settler government this was a war to remove the "rebels", but to Waikato and many other tribes in Aotearoa, this was an invasion. The Lake Waikare and Whangamarino catchment was the scene of many battles including the battle of Meremere, Rangiriri and Maramarua where the Redoubts still hold a presence. The Waikato wars saw the loss of many lives, for both the colonial and Māori forces.

The Waikato war started with the British army invasion at Mangatawhiri on 12 July 1863. The most important battle of the Waikato campaign was fought at Rangiriri in November 1863.

A Māori defensive line that was constructed along a ridge between the Waikato River and Lake Waikare was attacked by the British Army with an initial force of 850 naval officers and men. At daybreak on 21 November 1863, Māori hoisted the white flag, and the British army entered the pā to negotiate the Māori surrender. The resulting casualties were high from both sides, and were higher than any other engagement of the wars. The battle also resulted in 183 Māori captives who were sent to Auckland as prisoners of war (Keenan, 2017).

The defeat at Rangiriri effectively meant the end of the wars for Māori. Although they would continue for another nine years, the wars had been lost (Keenan, 2017).

Lake Waikare and Lake Kopuera has important cultural significance, with the latter a significant area of sacredness to Ngāti Hine and the iwi. Lake Kopuera is considered a "no-go" area, as there are many bones that lay on the bed (and the bed of Lake Waikare) from the Waikato war causalities.

It has been said the name Ko-pu-era means "those who were shot (gunned)", as the lake was previously named Karaka. This is one of the reasons Waikato-Tainui sought the return of Lake Kopuera and Lake Waikare via the Waikato-Tainui Raupatu Claims (Waikato River) Settlement Act 2010; so, that the bones of their people can rest in the name of Pōtatau Te Wherowhero (J. Williams, *pers. comm*. 2017).

2.2 Agricultural history

The following is a historical account of the agricultural history provided by Mr. Malcolm Lumsden, 2018:

Historically, the floodplain of the lower Waikato was poorly drained, low lying, floodable land, wetlands and lakes. European settlement resulted in much of this land being developed for agricultural purposes. (Waikato Regional Council, 2011)

Along the western side of Lake Waikare, early farming development took place in the late 1860s with a school being built at Ohinewai in 1882. By 1873, new settlers took up land grants from the Government following land surveys in the area. In this year, land was developed at the southeastern corner of Lake Waikare and sheep farming commenced. History also tells of the high flooding in the 1878 and 1885 era.

In the north of the Waerenga catchment, access was by boat along the Whangamarino and Kopu rivers. Barges were used, with horse paths along the banks to shift the barges, and ultimately both coal and metal were barged out of Kopuku and Falls roads. Farm access to Waerenga was by both river and across Lake Waikare.

In 1907, after 52 hours of continuous rainfall, the scene between Hamilton and Mercer was described as utter devastation. Boats were used to row down the railway line and the main street of Huntly, with the water described as being six metres deep between Ohinewai and Rangiriri.

An example of early development is a large 1374 acre (556 hectare) estate developed by the Craig family in 1911. That land extended from south of Rangiriri to almost Ohinewai and it is recorded that

at one point 5000 sheep arrived from Gisborne. Ohinewai had one of the largest railway yards in the North Island with Craigs supplying animals to be railed to the Auckland abattoir several times a week. The Craigs grew fodder for their 400 horse transport business in Auckland.

Farming in the catchment got underway piece-meal until road access was provided. During the depression in 1929, forestry planting in the north of the catchment was instigated with the development of the Maramarua forest. Development of the Waerenga and Waiterimu areas slowly took place and much of the hill country land was partly developed by the start of World War II. The availability of bulldozers and aerial topdressing post war completed the hill country development process.

Much of the early drainage was now already in place and had been dug by hand. This formed the blueprint for the drainage upgrades associated with the initial Lower Waikato-Waipā Flood Control Scheme (LWWFCS). Following the historic flood in 1958, the initial LWWFCS design report was issued in 1959 (Munro, 2016). Construction of the LWWFCS commenced in 1961 and was completed in 1982.

Hindered by flooding, it wasn't until the 1960s and the commissioning of the Lower Waikato Valley Authority and the LWWFCS that lowland improvement began to regain land lost to flooding in the 1950s. Protection of approximately 1500 hectares of productive farm land around Lake Waikare from flooding proved a boost to the Ohinewai community. With increasing numbers being employed in agriculture, the local communities and schools flourished around the catchment.

A lot of sheep country gave way to dairy and beef cattle farming. Historically, most lowland development was complete by the mid-1970s to enable farmers to pay for flood protection rates. Livestock numbers within the catchment have remained reasonably static and while stock classes may have changed, overall stock units on much of the land have not increased significantly since then.

Today, with the economic change, several schools have closed as the rural population and post war 'baby boom' has receded. Productive output remains steady as bigger, more well-managed and modernised farms have developed and farming has become sustainable. Agriculture remains the power house of this catchment and will into the future.

The following is a historical account of the agricultural history summarised from an interview with Mr. Malcolm Buckley, 1994:

Mr. Malcolm Buckley arrived to the local area known now as Island Block in 1929. Flax production was the principle industry at that time, and included flax harvesting, flax drying and transportation mainly to Melbourne, Australia.

At the time, the Whangamarino River had natural levees and kōwhai growing on the embankments. Before World War I, weeping willows were planted to stop erosion, and later pussy willows established as 6-foot sleepers of pussy willow were utilised for the railway lines which were constructed within the wetland to harvest flax.

The development of synthetic materials, especially for wool packs, destroyed the market for flax production.

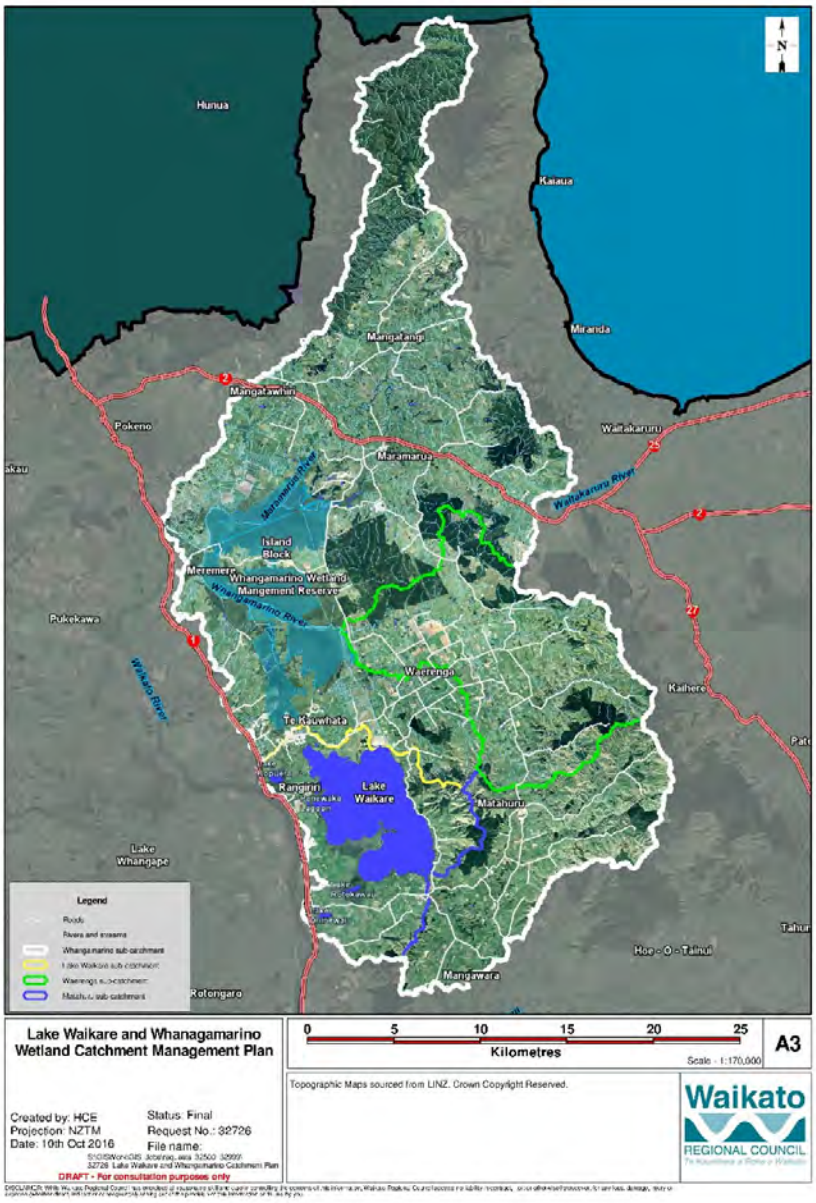
Mr. Buckley bought 14 cows, initially from Pokeno, for seven pounds each from the money he received from the sale of flax. At the time, there was little European grasses in the district and the stock would forage in the wetlands. Principally, income from stock was for meat, and dairying was not established in the area until the late 1920s.

Kauri logs also existed in the wetland and were removed with logging winches and then later excavated when larger tractors were available. These swamp logs could measure 6 to 8 foot in diameter. These logs were left on the wetland margins to dry for at least one year. If they were still sound at the end of this period then they would be milled and utilised primarily for joinery, window frames and doors. Many houses that were built on Te Kauwhata Swamp Road have been constructed out of swamp kauri. In addition to the logs, kauri gum was also found on the wetland margins which was processed for sale in a factory in Te Kauwhata.

2.3 Physical characteristics

The overall Lake Waikare and Whangamarino Wetland catchment covers a total area of 797.1 square kilometres and includes four principal sub-catchments, Lake Waikare, Whangamarino Wetland and the Matahuru and Waerenga streams as detailed in *Map 3: CMP sub-catchments*. The catchment drains via the Whangamarino River into the Waikato River between Meremere and Mercer.

Whangamarino Wetland and Lake Waikare constitute the second largest bog and swamp complex in the North Island and the largest lake in the lower Waikato basin. The lake and wetland are a vital part of the Lower Waikato-Waipā Flood Control Scheme (LWWFCS), providing flood storage for the Waikato River. Both ecosystems have become considerably degraded since the implementation of the flood control scheme due to a range of factors, including poor water quality, modified hydrological regimes and invasion of pest plants and animals (Reeves, et al., 2012).



Map 3: CMP sub-catchments

2.3.1 Waikato River

The Waikato River is the longest river in New Zealand, and has a catchment of 14,260 square kilometres, or 12 per cent of the area of the North Island. The river starts from high in the central North Island volcanic zone, 2797 metres above sea level, flowing into Lake Taupō. The river flows through eight hydroelectric dams and finally into the Tasman Sea at Port Waikato after a journey of 425 kilometres from Lake Taupō (Waikato Regional Council , 2016).

Lake Waikare and Whangamarino Wetland are catchments of the Waikato River, and the lake and wetland form key components of the LWWFCS.

The Waikato River is a tupuna (ancestor), a taonga (treasure), and the mauri (life force) of Tainui waka and Ngāti Tūwharetoa.

In 2010, the Waikato River Authority was established as the custodian of *Te Ture Whaimana o te Awa o Waikato – The Vision and Strategy for the Waikato River* (Waikato River Authority, 2009).

The Vision and Strategy responds to four fundamental issues.

1. The degradation of the Waikato River and its catchment has severely compromised Waikato River iwi in their ability to exercise mana whakahaere or conduct their tikanga and kawa.
2. Over time, human activities along the Waikato River and land uses through its catchments have degraded the Waikato River and reduced the relationships and aspirations of communities with the Waikato River.
3. The natural processes of the Waikato River have been altered over time by physical intervention, land use and subsurface hydrological changes. The cumulative effects of these uses have degraded the Waikato River.
4. It will take commitment and time to restore and protect the health and wellbeing of the Waikato River.

The catchment management plan is consistent with the overarching purpose of the Vision and Strategy – to restore and protect the health and wellbeing of the Waikato River (Waikato River Authority, 2009).

2.3.2 Whangamarino sub-catchment

2.3.2.1 Whangamarino Wetland

Whangamarino Wetland is located approximately 45km north of Hamilton and lies to the east of State Highway 1, between Te Kauwhata and Mercer. It is a large lowland freshwater wetland comprised of marsh, swamp, fen and bog and is listed as a wetland of international significance under the Ramsar Convention. The wetland is contained within three shallow basins drained by the Maramarua and Whangamarino rivers and the Reao Stream. Its large catchment – 597 square kilometres, excluding the Lake Waikare catchment – extends in the north to the headwaters of Mangatangi Dam in Hunua Ranges. To the east it is bounded by the Maungaroa Fault and on the west by low hills adjacent to State Highway 1 (Reeves, et al., 2012).

The wetland originally covered 10,300 hectares, however large areas have been drained and modified since World War II and, by 2008, 6508 hectares remained (Wildland Consultants Ltd, 2011b). DOC administers the majority of the remaining wetland (4640ha), with the balance owned by the Auckland/Waikato Fish & Game Council (748ha) and private landowners (1192ha).

In December 1989, 5690 hectares of the wetland became formally recognised under the Ramsar Convention as a wetland of international importance. The wetland's Ramsar designation was inspired by the native species and ecosystem values that it supports, particularly the diverse and numerous water birds, including herons, rails, waders and waterfowl (Duggan, et al., 2013).

Whangamarino Wetland contains extensive areas of peat bog, a comparatively rare wetland type in New Zealand (Ausseil, et al., 2008). Peat bogs are derived from the remains of plants that have built up over hundreds of years, and their surfaces can be several metres higher than surrounding fen and swamp (Johnson, et al., 2004). Their main source of water is from rainfall and they are therefore dominated by plant species that are adaptive to live in very low nutrient environments. This makes them particularly sensitive to nutrient inputs from surface water and groundwater.

Whangamarino Wetland provides important habitat for a high diversity of indigenous plants and fauna, including 10 threatened plant species (Wildland Consultants Ltd, 2009). The wetland is now the only known location for the tiny and nationally critical swamp helmet orchid (*Corybas carsei*) (Duggan, et al., 2013).

The dominant vegetation within the peat bogs is comprised of *Machaerina* species, mānuka and wire rush. The swamp, fen and marsh wetland types have a greater species diversity, but also a large number of exotics. The wetland is rich in mosses and 13 new species have been added to the list of New Zealand flora from this area. Lichens are also well represented (Department of Conservation, 2017).

The wetland contains the largest populations in New Zealand of the threatened Australasian bittern (*Botaurus poiciloptilus*) (Robertson, et al., 2011). It is a significant site for other uncommon wetland birds, including marsh crake (*Porzana pusilla affinis*), spotless crake (*Porzana tabuensis tabensis*), North Island fernbird (*Bowdleria punctate vealeae*) and New Zealand dabchick, and is also a stronghold for the threatened black mudfish (*Neochanna diversus*) (Waugh, 2007). Pest fish species are prolific and difficult to control. Catfish and koi carp have a particularly significant impact as their aggressive feeding behaviour stirs up bottom sediments (Leadership Group 2018). Pest fish species also prevent the re-establishment of aquatic plants and therefore provide a significant barrier to the restoration of lakes and wetlands.

Early Māori utilised the resources of the wetland, including tuna (eels), birds and harakeke (New Zealand flax) for cultural and traditional purposes and the rivers were used for transport and recreation. Dense vegetation limited use of much of the wetland, but provided sanctuary during times of war. Māori used peat margins to preserve taonga such as waka, tools and weapons (Duggan, et al., 2013).

Whangamarino Wetland is a popular game bird hunting location, with 748 hectares of the wetland owned by the Auckland/Waikato Fish & GameFish & Game Council. Thousands of game birds utilise the wetland attracting hunters from Auckland and the greater Waikato region. Recreational fishers frequently visit Whangamarino targeting coarse fish and the wetland is renowned throughout New Zealand for bird watching (Duggan, et al., 2013).

The Whangamarino Historic Walkway and Falls Road Pā provide viewpoints from which visitors can observe the wetland landscape, and present opportunities for interpretation of the history and the natural and cultural heritage of Whangamarino Wetland. Protection of the peat bog and associated values is the highest priority for Whangamarino Wetland.

Knowledge gained from the Arawai Kākāriki Wetland Restoration Programme has advanced the management and restoration of this wetland, and increased community involvement and understanding of wetland values. Visitors enjoy diverse recreation opportunities and improved access to the wetland, and information about wetland values is readily available. The locally treasured Te Teo Pā and Meremere Pā are actively conserved, with Te Teo Pā a part of the Whangamarino Historic Walkway. Visitors enjoy the wetland scenery and learn about its history and natural values at Te Teo Pā and Falls Road Pā.

Modification of catchment land use and the hydrological regime are the overriding threats to Whangamarino Wetland. Inclusion within the LWWFCS, land clearance and agricultural intensification has dramatically changed wetland hydrology and increased the ingress of nutrients and sediment into sensitive low-nutrient habitats. The establishment and spread of a range of weeds and pests is also threatening many of the species, ecological communities and habitats that make up Whangamarino Wetland (Duggan, et al., 2013).

2.3.2.2 Whangamarino River

The Whangamarino River is a lowland river draining Whangamarino Wetland and associated catchment. The main tributary is Maramarua River which starts in Hunua Ranges and forms the northern catchment of Whangamarino River.

In 1994, the Department of Conservation and Auckland/Waikato Fish & GameFish & Game Council commissioned the construction of a rock rubble weir (commonly referred to as the “DOC weir”) immediately downstream of the confluence with Maramarua and Whangamarino rivers. The weir was designed to reinstate a hydrological regime that offered to recreate a 'wet/dry' seasonal cycle within the wetland at RL 3.4 metres, and to mitigate the effects of lowered river levels caused by historic Waikato River dredging. The weir was subsequently reconstructed in 2000 in terms of its overall height (increased from RL 2.8 metres to RL 3.1 metres), and its permeability decreased (from a permeable rock weir to a very low permeable structure) to ensure it provided improved minimum water levels to over 2000 hectares of the mineralised swamp in Whangamarino Wetland (Department of Conservation, 2017). The effect of the weir includes day to day water levels in the watercourses to be close to bank levels, enabling increased spills into the wetland flood plain.

2.3.2.3 Maramarua River

Maramarua River starts in Hunua Ranges and forms the northern catchment of Whangamarino River.

2.3.2.4 Mangatangi Stream

The headwaters of Mangatangi Stream originate in Hunua Ranges north of the CMP catchment area and are dammed to form Mangatangi Dam which provides water supply for Auckland. The upper Mangatangi Stream catchment is in native vegetation and is owned and administered by the Auckland Council.

Hunua Ranges hold valuable populations of trout due to their self-sustaining nature (Auckland/Waikato Fish & GameFish & Game Council, *pers. comm*. 2017).

Mangatangi Stream is a tributary of Maramarua River.

2.3.3 Lake Waikare sub-catchment

2.3.3.1 Lake Waikare

Lake Waikare is located approximately 30 kilometres north of Hamilton and lies to the east of State Highway 1, between Ohinewai and Te Kauwhata; and is the largest and oldest of the lakes in the lower Waikato valley.

The lake bed was formally administered by DOC and Land Information New Zealand (LINZ), but has been transferred to Waikato-Tainui as part of the Waikato-Tainui Raupatu Claims (Waikato River) Settlement Act 2010.

DOC administers approximately 500 hectares of reserve around the lake edge, which includes a large area of wetland on the western shoreline which extends and surrounds Lake Rotokawau. Waikato Regional Council owns 95.91 hectares of land in the vicinity of the northern outlet canal which contains flood control assets, including Pungarehu Canal, a northern outlet gate and associated stopbanks (Reeves, et al., 2012).

The lake catchment area is approximately 21,055 hectares and is bounded by Waikato River in the west and the Hapuakohe Range in the east. Taupiri Range is situated to the south and a low ridge (Te Kauwhata-Waerenga Road) separates Lake Waikare from Whangamarino Wetland to the north. Four small lakes are to the west of Lake Waikare: Ohinewai (16ha), Kopuera (52ha), Rotokawau (22ha) and Penewaka Lagoon (4ha). All but Penewaka Lagoon are linked to Lake Waikare by drains (Reeves, et al., 2012).

Geothermal activity occurs on the eastern side of the lake, in and around Punikanae Rock where a silica sinter depositing spring is located. This is the only known sinter depositing spring outside of the Taupō volcanic zone (Lake Waikare Low Enthalpy Geothermal Resource, New Zealand: Initial Field Study, 2015).

Lake Waikare has important cultural significance, as there are many bones that lay on the bed (and the bed of Lake Kopuera) from the Waikato war casualities. This is one of the reasons that Waikato-Tainui sought the return of Lake Waikare and Lake Kopuera, so that the bones of their people can rest in the name of Pōtatau Te Wherowhero (J. Williams, *pers. comm*. 2017).

Historically, circa 1840, the Lake Waikare sub-catchment was most likely covered in secondary forest on the hills and freshwater wetland with enclaves of kahikatea (*Dacrycarpus dacrydioides*) forest on the flats. Over time there would have been a gradual transition to dominance by taller species such as rewarewa (*Knightia excelsa*), kamahi (*Weinmannia racemosa*), mangaeo (*Litsea calicaris*), rimu (*Dacrydium cupressinum*) and tanekaha (*Phyllocladus triomanoides*) (Leathwick, et al., 1995).

The current land use is a mix of dry stock (predominantly sheep and beef) and dairy farming and some cropping.

The lake's surface area is 3442 hectares with an average depth of 1.5 metres and a maximum depth of 1.8 metres (Dean-Speirs, et al., 2014). Lake Waikare operates as a flood storage reservoir within the Lower Waikato-Waipa Flood Control Scheme (LWWFCS) and is managed under a strict seasonal fluctuation regime of approximately 0.3 metres. The lake is connected to Whangamarino Wetland by the artificial Pungarehu Canal which was constructed as part of the LWWFCS.

Prior to the completion of the LWWFCS in 1965, Lake Waikare was part of an extensive hydraulically linked lake-wetland system that included lakes Kopuera, Ohinewai and Rotokawau, Waikato River, and Whangamarino Wetland. As a result of the LWWFCS works, the average lake level was lowered by circa one metre, and the lake level fluctuation range was reduced from 2.71 metres to 0.35 metres (Reeves, et al., 2002).

The elimination of the natural seasonal fluctuation in water levels resulted in the loss of approximately 840 hectares of seasonally inundated wetland that had previously linked lakes Waikare and Rotokawau, which was subsequently cleared and converted to pasture for farming. It is estimated that since 1963, the wetlands surrounding the shores of Lake Waikare have reduced by 67 per cent (Reeves, et al., 2002).

Water quality monitoring of Lake Waikare was initiated by the Waikato Valley Authority in 1982, and Waikato Regional Council has monitored the lake every second month between 1996 and 2012. Data indicates that between 2006 and 2010 there has been no significant change in the hypertrophic state of Lake Waikare, which is extremely nutrient enriched (Dean-Speirs, et al., 2014).

Lake Waikare has extremely high levels of suspended inorganic sediment which reduces light penetration into the water column. Aerial photographs from the 1940s indicate that the lake experienced increased turbidity when extensive land clearance occurred in the Matahuru catchment. Anecdotal information suggests that this turbidity declined whenever Waikato River flooded, indicating that the turbidity was locally derived and that inflowing Waikato River water had a flushing effect. However, the construction of the LWWFCS prevented flooding, and the circa one metre water level reduction would have increased wave velocities, thereby increasing sediment entrainment and turbidity within the water column (Reeves, et al., 2002).

Historically, Lake Waikare supported a range of aquatic plants, although submerged aquatic plants were comparatively less abundant in Lake Waikare than in other lakes in the lower Waikato region. Between the late 1960s and 1970s, substantial areas of Lake Waikare were covered in submerged vegetation, including the dominant *Egeria densa* and *Myriophyllum triphyllum* (Dean-Speirs, et al., 2014).

Reeves et. al. (2002) suggest that submerged vegetation is likely to have gradually declined since the 1940s due to decreased light penetration arising from increased turbidity and nutrient enrichment associated with land clearance, lake level reduction and modification of wetland margins, including grazing. A phytoplankton bloom around 1977/78 is thought to have precipitated the final collapse of the already stressed submerged aquatic vegetation in the lake (Dean-Speirs, et al., 2014).

While the extent and hydrology of Lake Waikare has been significantly modified by the LWWFCS, it still retains high biodiversity values and was ranked 39 out of 96 lakes in the Waikato region for

biodiversity management (Wildland Consultants Ltd, 2011a). The large size of Lake Waikare ensures that it continues to provide valuable habitat for many indigenous species, including six threatened species (Reeves, et al., 2012).

Prior to 1965, a range of fish species were known to inhabit Lake Waikare, including eels, mullet, smelt, *Galaxiid* species (including īnanga and banded kōkopu), bullies, shrimp, grey mullet, lamprey and brown trout. Black mudfish are still known to occur within marginal wetlands, and freshwater mussels (*Echyridella menziesii)* were reported from the lake in 2013 (Dean-Speirs, et al., 2014).

The construction of the northern control gates as part of the LWWFCS created a barrier to fish passage, although a small pipe system was created for climbing species (for example elvers). In 2003, a new rock ramp fish pass was constructed to bypass the Lake Waikare control gate that provided for fish movement between Lake Waikare and Pungarehu Canal (Dean-Speirs, et al., 2014).

The presence and dominance of exotic fish – particularly koi carp, rudd and catfish – in Lake Waikare is of concern as these species are known to browse aquatic plants, disturb sediments and dislodge aquatic plants during feeding. Because they occur in such high densities within Lake Waikare, pest fish removal methods have been the focus of recent research and management initiatives. In collaboration with other agencies and stakeholders, Waikato Regional Council has installed a permanent carp cage trap at the outlet of Lake Waikare in conjunction with the existing fish pass (Dean-Speirs, et al., 2014).

Lake Waikare is a significant area for water birds, although its habitat value has declined markedly since the collapse of submerged aquatic vegetation and the construction of the LWWFCS. In particular, major reductions in the abundance of black swans and large black shags were observed as a result of habitat changes and reduced food supplies (Dean-Speirs, et al., 2014).

Dabbling ducks, in particular grey duck and mallard duck, make up the mainstay of a 'hunter's bag' in Whangamarino Wetland. Whangamarino Wetland and Lake Waikare were once described as being the heart of the 'Waikato duck factory', holding some of the largest aggregations of game birds in the region. However, recreational game bird hunting is decreasing in Waikare and a lesser extent in Whangamarino Wetland which can be witnessed by the increasing number of abandoned hunting structures. Population levels of a number of key species are also decreasing, as are harvest rates, due to a degradation in habitat quality and quantity. However, despite this, the Whangamarino is still a nationally significant recreational hunting area (Auckland/Waikato Fish & Game Council, *pers. comm*. 2017).

A number of species of conservation significance have been reported at the lake, including white heron, fernbird, Australasian bittern and New Zealand dabchick (Wildland Consultants Ltd, 2011a).

2.3.3.2 Lake Ōhinewai

Lake Ōhinewai is located within a pastoral catchment on the outskirts of the Ōhinewai peat bog. The lake is fed by a single main drain entering the lake from the southwest. Lake Ōhinewai drains from its northeastern end into Lake Rotokawau which is subsequently connected to Lake Waikare. Lake Ōhinewai is administered by DOC, with a lake area of 16 hectares and an average depth of 4.5 metres (Dean-Speirs, et al., 2014).

The catchment area of Lake Ōhinewai is approximately 347 hectares with a primary land use of dairy and dry stock farming. The lake's margin is now fully fenced to exclude stock and has been recently planted with native species (Dean-Speirs, et al., 2014).

Water quality sampling was undertaken in the lake during the early 1980s. In 1981, the lake was moderately peat stained with low turbidity. At that time the lake was classified as being eutrophic. In the most recent Waikato Regional Council monitoring undertaken between 2006 and 2013, the water quality data indicates the water quality had significantly declined and the lake is presently hypertrophic (Dean-Speirs, et al., 2014).

Lake Ōhinewai is currently devegetated and has been in this condition since at least 1991. Native fish species are known from Lake Ōhinewai, although the amount of habitat has been substantially reduced. Common bully and eels have been recorded from the lake previously, and longfin eels and freshwater mussels occur in the lake. The lake also contains a number of invasive fish species, including koi carp, brown bullhead catfish, goldfish and mosquito fish (*Gambusia)* (Dean-Speirs, et al., 2014).

Lake Ōhinewai is used for recreational game bird hunting (Auckland/Waikato Fish & Game Council, *pers. comm*. 2017).

2.3.3.3 Lake Kopuera

Lake Kopuera is situated south of the Te Kauwhata township in close proximity to Lake Waikare. The lake bed was formally administered by DOC but has been transferred to Waikato-Tainui as part of the Waikato-Tainui Raupatu Claims (Waikato River) Settlement Act 2010.

Lake Kopuera has a lake area of 52 hectares and an average depth of 1.5 metres. The lake catchment area is approximately 250 hectares, with a primary land use of dairy and dry stock farming (Dean-Speirs, et al., 2014).

There are no direct inflows into Lake Kopuera, and the lake drains into Lake Waikare. Lake Kopuera was lowered in 1965 as part of the construction of the Lower Waikato-Waipā Flood Control Scheme (Dean-Speirs, et al., 2014).

There are no recent water quality monitoring results, with the last monitoring undertaken in 1982. At that time, the lake was described as being a very turbid green colour, attributed to the direct inputs of cowshed effluent and/or the effects of lake level changes (Dean-Speirs, et al., 2014).

The margin of Lake Kopuera is partially fenced, and it is estimated that around 2500 metres of fencing would be required to completely fence the entire lake margin. To date, Waikato Regional Council has contributed to the costs of 2.1 kilometres of fencing around the margin of Lake Kopuera. Lake Kopuera still supported a relatively intact narrow marginal fringe when it was surveyed in 1990, despite having been invaded by grey and crack willow (Dean-Speirs, et al., 2014).

Because there is very little recent information about the condition of Lake Kopuera, the *Waikato Region Shallow Lakes Management Plan* (Dean-Speirs, et al., 2014) identified that it is a priority to visit the lake and assess its present condition and management requirements.

2.3.3.4 Lake Rotokawau

Lake Rotokawau, also known as Black Lake, is located southwest of Lake Waikare and is connected to it by a channel of circa 500 metres (Dean-Speirs, et al., 2014).

Lake Rotokawau and the surrounding wetland is administered by DOC and has a lake area of 22 hectares and an average depth of 1.2 metres. The catchment area of the lake is approximately 1804 hectares in total, and is unique amongst lower Waikato lakes in that it is completely surrounded by a 145 hectare wetland reserve. The remainder of the catchment's primary land use is dairy and dry stock farming. Lake Rotokawau has been formed by peat deposition on two sides of the lake that essentially acted like a dam (Dean-Speirs, et al., 2014).

The submerged vegetation of the lake was most recently surveyed in 2007. Although it was formally dominated by native plants, the lake became devegetated in the 1990s and there has been no evidence of plant regeneration since (Dean-Speirs, et al., 2014).

Black mudfish (*Neochanna diversus*) are known to exist around the margins of the lake and are classified as 'at risk' on the DOC threat classification system (Department of Conservation, 2011).

As a result of a hydrological connection with Lake Waikare, and the altered water level as a result of the Lower Waikato-Waipā Flood Control Scheme, lake levels in the lake itself and the surrounding wetland have declined significantly since 1965. Water quality monitoring results undertaken in the lake over the 2007/08 summer indicated the lake was heavily nutrient enriched (hypertrophic), but these surveys also coincided with a severe drought which may not accurately reflect the lake's condition (Dean-Speirs, et al., 2014).

Key threats include the impacts of nutrient inputs, water level controls on the wetland and the potential introduction of alligator weed which has been found both within the nearby Te Onetea Stream and Whangamarino Wetland. Sedimentation has also been identified as a problem for Lake Rotokawau, as well as the large number of koi carp within the lake and which represent a major impediment to in-lake restoration.

2.3.3.5 Penewaka Lagoon

The DOC-administered Penewaka Lagoon, also known as Lake Penekawa, and its surrounding 42 hectare reserve are part of the Lake Waikare wetland and lake complex. Penewaka Lagoon has a lake area of 4 hectares and an average depth of one metre. The catchment area of the lagoon is estimated as 26 hectares, with its land use primarily dairy and drystock farming. The lake margin has now been fully fenced to exclude stock (Dean-Speirs, et al., 2014).

This is a highly productive rain and groundwater fed ephemeral wetland system, and both the lagoon and surrounding reserve provides an important area for game and threatened indigenous avifauna. Bittern and fernbird are frequently observed at the site (Auckland/Waikato Fish & Game Council, *pers. comm*. 2017).

Penewaka Lagoon was included in the Waikato Regional Council shallow lakes indicator programme in 2010/11 but holds no previous water quality information. These monitoring results indicate the lake

is extremely nutrient enriched (hypertrophic). The lagoon is known to dry up during drought years and can experience periods when it is free from koi carp and catfish, with reasonable water clarity (Dean-Speirs, et al., 2014).

Penewaka Lagoon has been subject to restoration programmes undertaken by the Auckland/Waikato Fish & Game Council funded by the Game Bird Habitat Trust (Auckland/Waikato Fish & Game Council, *pers. comm*. 2017); and planting with funding from Waikato Catchment Ecological Enhancement Trust (WCEET) and Honda TreeFund (Dean-Speirs, et al., 2014).

2.3.4 Waerenga sub-catchment

2.3.4.1 Waerenga Stream

The Waerenga sub-catchment provides the main inflows into the southern half of the wetland. The catchment has very similar geology and soils to the Matahuru sub-catchment, although there are larger areas of gley soils along the more extensive lowlands. Historical vegetation cover would have been the same as the Matahuru sub-catchment (Leathwick, et al., 1995). The current vegetation cover is mainly pastoral (90 per cent) with some plantation forest on the northern hills (LCDB2[1]).

2.3.5 Matahuru sub-catchment

2.3.5.1 Matahuru Stream

Matahuru Stream is the main inflow to Lake Waikare, with headwaters in steep pastoral land with underlying greywacke rock and tephra. Soils in the headwaters are a mixture of ultic and recent soils with gley and granular soils common on the flats (Collier, et al., 2010).

2.3.5.2 Mangapiko Stream

Mangapiko Stream is a tributary of Matahuru Stream.

2.4 Socio-economic overview

2.4.1 Communities and population

The latest *New Zealand Census of Population and Dwellings* (Statistics New Zealand, 2017), of which data is available at the time of writing, was undertaken in March 2013. This census indicates that the overall Waikato region population is 403,638 – being approximately 9.5 per cent of the national total. The region is one of the faster growing parts of New Zealand, with a projected Waikato region population of 517,400 by 2043 (Statistics New Zealand, 2017).

Within the Waikato district, the population is 66,500 and is 16.5 per cent of the Waikato region total. The 2043 projected population for the Waikato district is 101,700 (Statistics New Zealand, 2017), with growth strong in the northern part of the district largely due to its proximity to Auckland.

[1] Land Cover Data Base – LCDB2 GIS Layer

This population growth will place pressure on existing infrastructure and natural resources across the region and the catchment.

Within the catchment area, there are several small settlements and villages, the largest being Te Kauwhata. These settlements service the surrounding rural communities, including:

- one college and seven primary schools
- two public libraries
- four community halls
- seven marae which provide meeting places for tangata whenua.

Te Kauwhata

Te Kauwhata is a village 51 kilometres north of Hamilton and is the largest settlement within the Lake Waikare and Whangamarino catchment area, with a population of 1473 (Statistics New Zealand, 2017). Te Kauwhata services the surrounding rural and horticulture sectors, as well as light industrial and commercial activities such as vehicle garages, light engineering companies, an eel and salmon processing plant, and truck and freight companies (Waikato District Council, 2017).

Originally known as Wairangi, Te Kauwhata grew around a railway station built in the late 1870s. In 1886, trial plantings of exotic trees began nearby and, in 1892, a government research station started. Until 1992 the Te Kauwhata Viticultural Research Station carried out horticultural research, focusing on viticulture, and was the first home of the New Zealand wine industry (Waikato District Council, 2017).

The Waikato District Council's *Te Kauwhata Catchment Management Plan* (Beca Infrastructure Ltd, 2009) identifies the Te Kauwhata village as an area of future growth of some 200 hectares. New developments are proposed to the northwest (towards State Highway 1) into the Travers Road area, and to the north of the village along Blunt Road towards Whangamarino Wetland.

The Te Kauwhata catchments have three main receiving waters for stormwater discharge, these being Whangamarino Wetland, Lake Waikare and the stream running through the Travers Road catchment (Beca Infrastructure Ltd, 2009).

With the urban/residential growth expected to continue in Te Kauwhata village, consideration and management of the impacts (both positive and negative) on the receiving environment is required; particularly in relation to stormwater and wastewater treatment.

Meremere

Meremere is a settlement just north of Whangamarino Wetland, approximately 30 kilometres north of Huntly, with a population of 468 (Statistics New Zealand, 2017).

Meremere is a significant historic site in relation to the Waikato Wars of 1863-1864, with the Meremere Redoubt located at the village. The township itself began to grow in the 1950s when the Meremere power station was built. However, when the power station was decommissioned in the 1990s, the population of the settlement declined (Waikato District Council, 2017).

Rangiriri

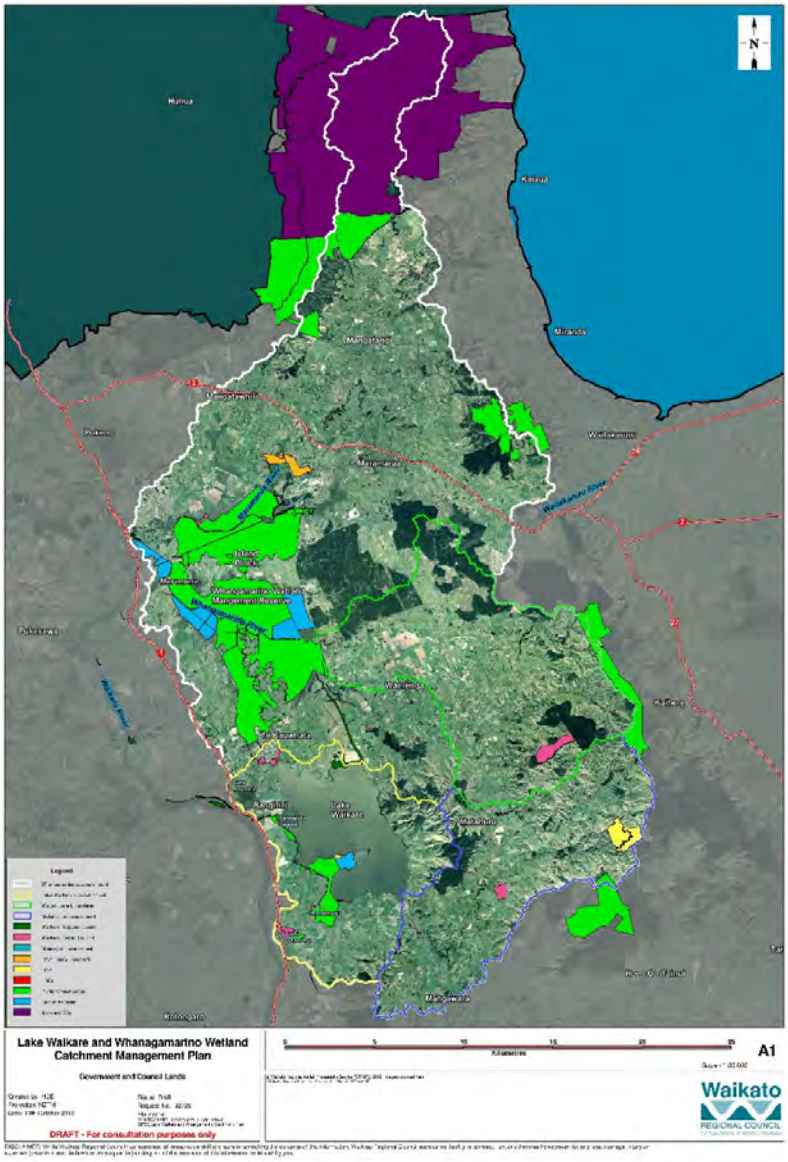
Rangiriri today is a small settlement west of Lake Waikare, and just south of Lake Kopuera. The Waikato River runs just west of the settlement, and between the river and Rangiriri is State Highway 1.

The Waikato War started with the British army invasion at Mangatawhiri on 12 July 1863. The most important battle of the Waikato campaign was fought at Rangiriri in November 1863 (Keenan, 2017).

2.4.2 Land ownership

There are a variety of landowners within the Lake Waikare and Whangamarino wetland catchment area. A large percentage of the catchment area, including 1192 hectares of Whangamarino Wetland, is in private ownership. This demonstrates that private landowners are an important stakeholder and partner for this CMP.

The remaining parts of the catchment area are owned and/or administered by Crown agencies, territorial authorities, iwi or the Auckland/Waikato Fish & Game Council, as detailed within *Map 4: Government and council owned/administered land*, and detailed below.



Map 4: Government and council owned/administered land

Waikato-Tainui

In accordance with the Waikato-Tainui Raupatu Claims (Waikato River) Settlement Act 2010, ownership of the bed of Lake Waikare and some marginal strips, as well as Lake Kopuera and its margin, were transferred from Land Information New Zealand (LINZ) and the Department of Conservation (DOC) to Waikato-Tainui.

Department of Conservation

DOC administers approximately 500 hectares of reserve around the edge of Lake Waikare, including a large area of wetland on the western shoreline which extends and surrounds Lake Rotokawau.

DOC administers the majority of Whangamarino Wetland, with 4640 hectares.

DOC also administers other smaller pockets of conservation land across the Lake Waikare and Whangamarino catchment area, including part of the Mangatangi Stream sub-catchment.

Land Information New Zealand

LINZ owns and/or administers an area of land of Treaty Settlements Landbank land, which is currently utilised as a livestock farm and a further area of land southeast of the Lake Waikare and Whangamarino catchment area. These can be seen in Figure 7.

Waikato Regional Council

Waikato Regional Council owns and administers 95.91 hectares of land in the vicinity of the northern outlet canal which contains flood control assets, including Pungarehu Canal, a northern outlet gate and associated stopbanks (Reeves, et al., 2012).

Waikato District Council

Waikato District Council (WDC) owns land across the Lake Waikare and Whangamarino catchment area, and this includes:

- land located north of Lake Waikare, known as the Waikare Lake Reserve, where there is a boat ramp for access to Lake Waikare. WDC upgraded the roading access and parking areas in 2014
- land located south of Lake Waikare, known as the Waikare South Reserve, where there is a small planted area and a 100 metre walkway. WDC upgraded the parking and walkway in 2016. Additionally, WDC is working with a local family who are interested in further developing the site into a local park with native plantings
- land associated with the Te Kauwhata wastewater treatment plant.

Auckland Council

Mangatangi Dam is owned and operated by Watercare, while Watercare leases the catchment area of this dam from Auckland Council.

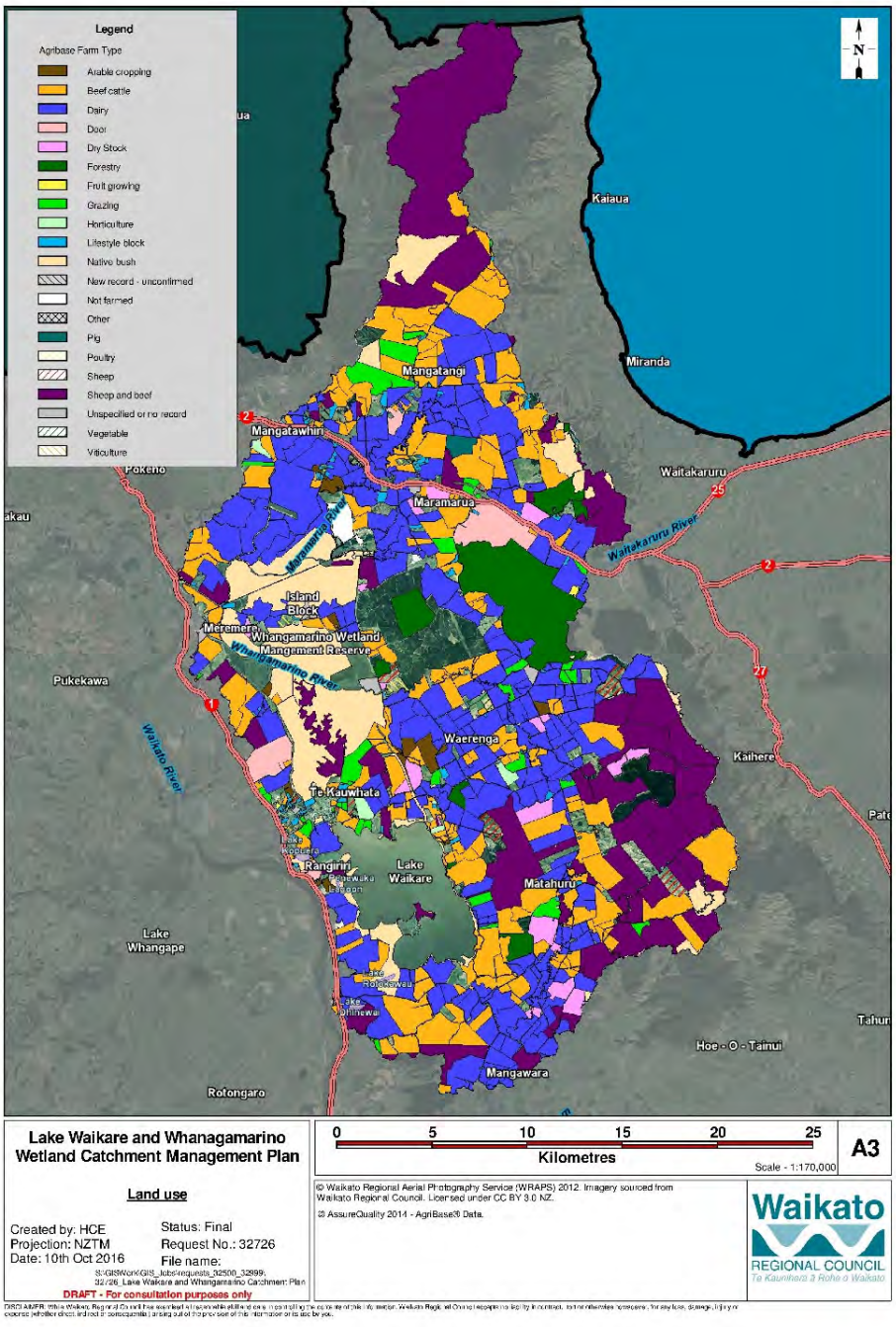
Auckland/Waikato Fish & Game Council

The balance of 748 hectares of Whangamarino Wetland is owned by Auckland/Waikato Fish & Game Council.

Auckland/Waikato Fish & Game Council also owns 74 hectares of marginal strip on the Lake Waikare peninsula to the lake's southwest.

2.4.3 Land use

The Lake Waikare and Whangamarino Wetland catchment area is 797.1 square kilometres, with almost two-thirds of this area in high-producing pasture.



Map 5: CMP AgriBase land use activities

As illustrated in *Map 5: CMP AgriBase land use activities*, AgriBase[2] farms within the CMP catchment associate nearly 64,000 hectares with rural industry sectors. This excludes approximately 10,883 hectares of native forest/wetland and 1388 hectares of unspecified farm types.

The proportion of land use by the rural industry sector within the CMP catchment area is as follows in Table 1 (Keenan, 2017):

Rural industry sector	Proportion of land use within catchment
Sheep and beef cattle farming	47%
Dairy cattle farming	28%
Forestry	4%
Arable cropping	1%
Poultry, deer and other livestock farming	3%

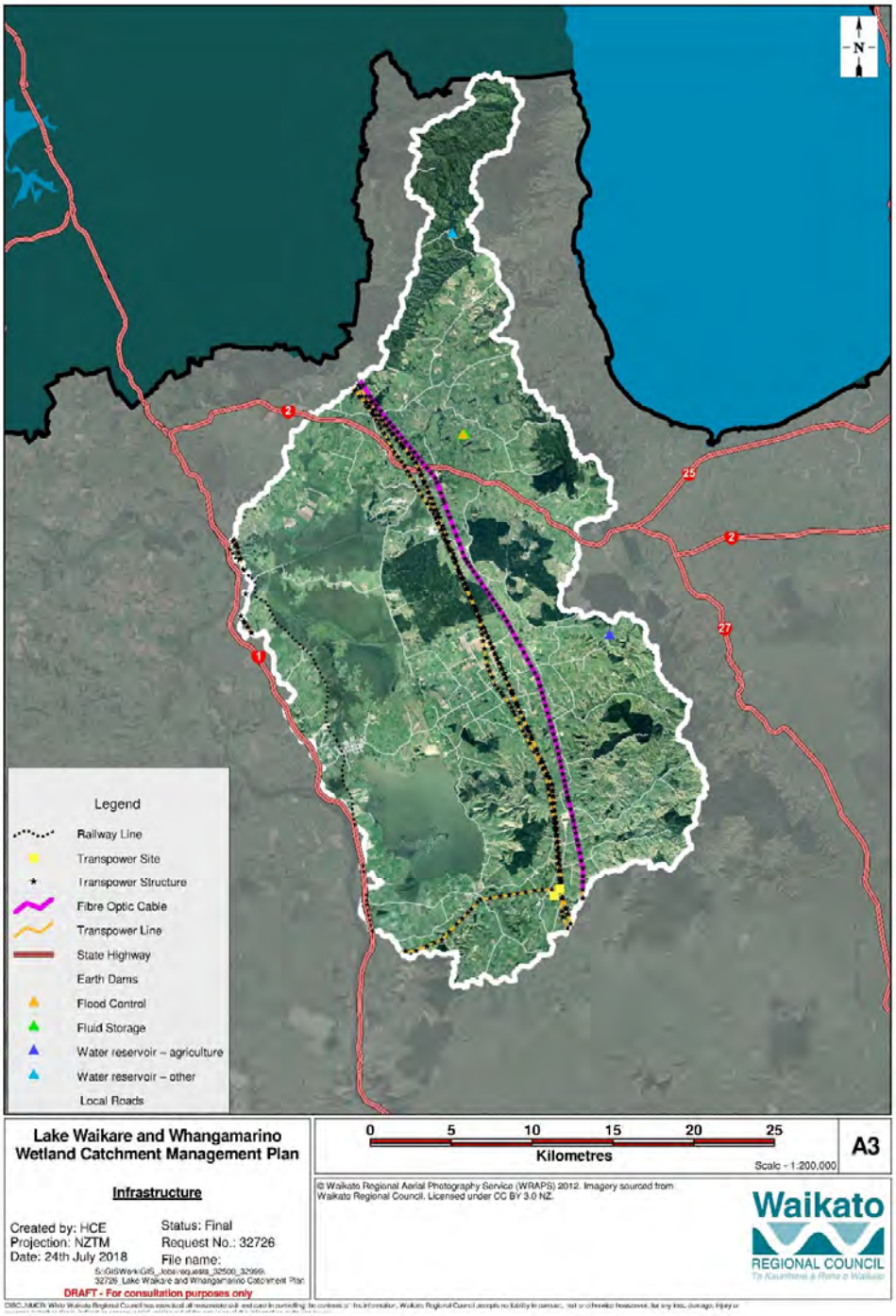
Table 1: CMP rural land use proportion (Keenan, 2017)

Te Kauwhata village has been identified as an area of future growth of some 200 hectares. New developments are proposed to the northwest (towards State Highway 1) into the Travers Road area; and to the north of the village along Blunt Road towards Whangamarino Wetland. The current land use in these future development areas is a mixture of open pasture and horticulture (vineyards and olive plantations) (Beca Infrastructure Ltd, 2009).

2.4.4 Key infrastructure

The CMP catchment area includes several key national, regional and catchment assets and infrastructure[3], as illustrated below in *Map 6: CMP key assets and infrastructure.*

[2] AgriBase is a national spatial farms database which holds information on approximately 142,000 current New Zealand farms.
[3] Infrastructure is defined by section 2 of the Resource Management Act 1991.



Map 6: CMP key assets and infrastructure

2.4.4.1 Lower Waikato-Waipā flood control scheme

The Waikato Valley Authority, one of the predecessor organisations which amalgamated in 1989 to form the current Waikato Regional Council, was established by Act of Parliament in 1956 to address the flooding issues in the Waikato River catchment. Following the historic flood in 1958, the initial

Lower Waikato-Waipā Flood Control Scheme (LWWFCS) design report was issued in 1959 and formed the basis of a business case to central government for establishing the governance structure, funding and management agreements between the Crown and local residents represented through their local authorities (borough councils) and drainage boards. (Munro, 2016)

Waikato River has a total catchment area of some 14,250 square kilometres and is the largest in the North Island and is the longest river in New Zealand. The lower Waikato is part of the catchment between Ngāruawāhia and Port Waikato and is approximately 20 per cent of the total Waikato River catchment.

Waikato River is a complex, large river system characterised by long durational flood events. Waikato Regional Council and Mercury (previously known as Mighty River Power) work closely together to minimise the impacts of flooding, primarily under the *Waikato River High Flow Management Plan*. This plan is required to demonstrate how the hydro system will be operated to meet dam safety requirements; to limit the adverse effects of a flood including the effects on Lake Taupō, the hydro reservoirs and the Waikato River downstream of Karāpiro; and details how Mercury will assist Waikato Regional Council in its role as flood coordinator (Munro, 2016).

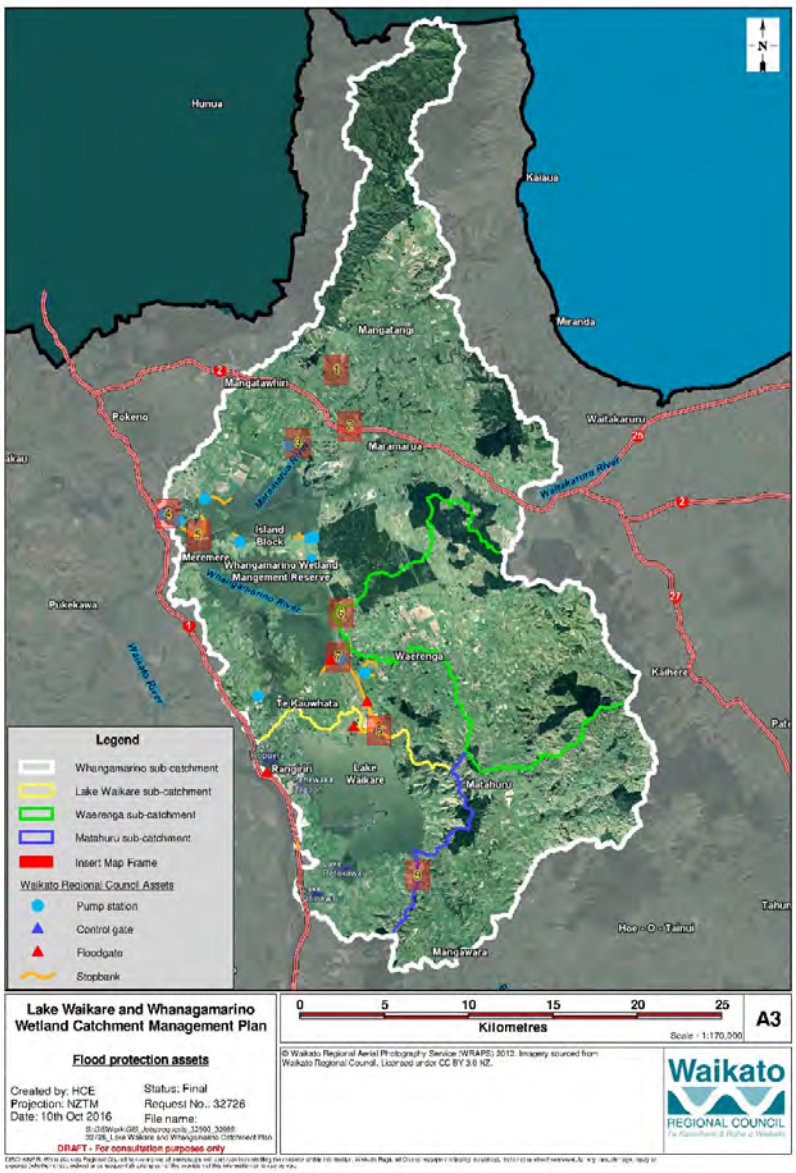
The LWWFCS is an integral component of the wider Waikato River flood management system and provides both flood storage and risk attenuation in large flood events. The LWWFCS is a comprehensive river control scheme designed to provide flood protection and drainage improvements within the flood plains of the lower Waikato and Waipā rivers, and to address a range of issues including the ones below (Munro, 2016).

- The severe floods which caused significant damage to the land, local economy and the livelihood of people around Lake Taupō, Te Kūiti, Ōtorohanga and the lower Waikato region.
- The regular disruption to the national land transport network (State Highways 1, 2 and 3 and the North Island Main Trunk railway) during floods for long periods of time, affecting the national economy.
- While the scheme was in its initial implementation stages in 1964, the Tongariro power development was being investigated, including the diversion of additional water into the Waikato catchment. This resulted in the Tongariro offset works including additional funding to form part of the LWWFCS.
- The siltation of the lower Waikato River due to the 1927 Arapuni Dam failure. The results of the Waikato River siltation survey in 1932 estimated approximately 7 million cubic yards of sediment was deposited in the lower Waikato River between Huntly and Tūākau, raising the riverbed and causing more frequent flooding.
- The Waikato hydro dams' effects on the lower Waikato River flows, especially during flood conditions.
- The technical feasibility and economic viability of each element of the LWWFCS, with the overall objective of establishing an appropriate level of flood protection and achieving maximum economic benefit.

The floodplain of lower Waikato River in its natural state contained many wetlands and shallow lakes. These features had a major influence on the flood hydrology of the river, with substantial interchanges of flow between Waikato River and the wetlands and lakes occurring. The two dominant flood storage features were Whangamarino Wetland and Lake Waikare. Because of the large volumes of storage available in both Lake Waikare and Whangamarino Wetland, these features had a large dampening effect on peak flows in Waikato River. It did mean, however, that the river was in flood for very long periods of time as large volumes of stored water were held and released from these natural storage areas.

The design of the LWWFCS was based on mimicking the natural processes within the two storage areas at Lake Waikare and Whangamarino Wetland, but in a controlled fashion. The benefits of the flood storage in reducing peak flows were thus retained (Munro, 2016).

The design concept included lowering and controlling Lake Waikare levels to allow storage of approximately 75 million cubic meters in a large 100-year flood event. The majority of this volume is diverted from Waikato River over a spillway at Rangiriri and the rest comes from the catchment of Lake Waikare. The lake level is controlled via control gates at Te Onetea Stream inlet, stopbanks along the northern foreshore natural sill and the control gate at the Lake Waikare northern outlet. The northern outlet canal (Pungarehu Canal) was also constructed downstream of the gate to direct Lake Waikare flows into Whangamarino River and wetland (Munro, 2016). These assets are illustrated below in *Map 7: CMP flood protection assets*.



Map 7: CMP flood protection assets

The benefits of these controls include:

- protecting State Highway 1 and the main trunk railway from flooding up to a 50-year event with improved control on transportation during floods
- lowering of the river flood levels between Huntly and Port Waikato in a 100-year event
- reducing the heights of the stopbanks and hydraulic pressure on the stopbank's sandy foundations, as well as reducing the pumping head in the adjacent protected areas
- protecting approximately 1500 hectares of productive farm land around Lake Waikare from flooding most of the time.

To protect the farmland from around the wetland from high flows due to backing up of Waikato River into the wetland via Whangamarino River, a gate was installed on Whangamarino River immediately upstream of its confluence with Waikato River. The design was for this gate to be closed whenever Waikato River starts to bank up into the wetland, thereby the wetland area would only flood from its own catchment rather than the whole river catchment. To ensure that flooding within the wetland is not exacerbated by the Lake Waikare catchment flows, the Lake Waikare gate is closed whenever the Whangamarino gate is closed (Munro, 2016).

The Lake Waikare fish pass was constructed in 2001 to meet the requirements of the resource consents associated with the LWWFCS. Its purpose is to allow fish (especially elvers/eels) to migrate from the Whangamarino wetland into Lake Waikare. A koi trap structure with a processing plant was added to the structure in 2011 to reduce the effects of koi carp on the lake water quality (Munro, 2016).

Since the implementation of the LWWFCS, both the lake and wetland ecosystems have become considerably degraded due to a range of factors, including poor water quality, modified hydrological regimes and invasion of pest plants and animals (Reeves, et al., 2012).

2.4.4.2 State Highway network

The NZ Transport Agency is a Crown entity and is responsible for managing and delivering transport solutions and systems and behalf of the government, including operating and improving the state highway network.

Waikato is part of the “golden triangle”, connecting Auckland, Waikato and the Bay of Plenty, making it a convenient access point for freight and logistics (New Zealand Trade and Enterprise, 2016). Freight movements between Hamilton, Auckland and Tauranga represent over half of all national freight movements (New Zealand Trade and Enterprise, 2016).

Roads of national significance are identified as New Zealand's essential state highways which provide the main links between our major areas of economic activity, facilitating the efficient transport of goods and people (Saha International Limited, 2010).

The Waikato Expressway – State Highway 1 has been identified as one of seven roads of national significance and follows the western boundary of the Lake Waikare and Whangamarino catchment area. The annual average daily traffic volume for 2015 was 23,657 as recorded at State Highway 1 Taupiri (NZ Transport Agency, 2016).

State Highway 2 which connects Auckland with Coromandel and the Bay of Plenty region crosses the Lake Waikare and Whangamarino catchment area between Mangatawhiri and just west of the State Highway 2 and State Highway 25 intersection. The annual average daily traffic volume for 2015 was 15,569 as recorded at State Highway 2 Mangatawhiri (NZ Transport Agency, 2016).

2.4.4.3 North Island Main Trunk Railway

KiwiRail Holdings Limited (KiwiRail) is a New Zealand State-owned enterprise responsible for rail and ferry operations and rail infrastructure (KiwiRail, 2017).

The North Island Main Trunk railway connects Auckland with Wellington by rail, with the final section being completed in early 1909 (KiwiRail, 2017). The railway is located west of Lake Waikare and Whangamarino wetland within the CMP catchment area.

Nearly 45 per cent of the national total of rail freight, originates in, has a destination in, or passes through the Waikato region (New Zealand Trade and Enterprise, 2016).

2.4.4.4 Electricity generation and national grid

The Huntly power station is owned and operated by Genesis Energy Limited and is located on west of the Waikato River in Huntly and is New Zealand's largest power station by capacity. Genesis Energy Limited announced in early 2016 that the last two coal and gas-fired electricity generators at the station will operate until December 2022 (Genesis Energy Limited, 2017).

Although located outside of the catchment plan area, it is an important contributor to local employment, and a key industrial activity with national importance within the lower Waikato zone.

Transpower New Zealand Limited is the state-owned enterprise that owns and operates New Zealand's high voltage transmission network (the national grid), which carries electricity throughout the country.

The national grid is vitally important with the ongoing New Zealand expanding population, an economy becoming increasingly reliant on electricity with an expectation of a reliable supply and the increasing amount of remote and intermittent (for example wind) generation being built (Transpower New Zealand Limited, 2017).

The National Grid 220kv and 400kv transmission lines traverse the CMP catchment area, on the eastern side of Lake Waikare and Whangamarino wetland.

2.4.4.5 Water supply sources

Watercare is a council-controlled organisation, wholly owned by the Auckland Council, and provides water and wastewater services to the Auckland region.

Watercare operates 14 water supply reservoirs; five of them located northwest of Auckland in the Waitakere Ranges, two near Helensville, four to the southeast in the Hunua Rages, and one east of Papakura. Watercare also draws from groundwater, and from various rivers, including a take from the Waikato River, near Tuakau.

Altogether the dams supply about 80 per cent of Auckland's water and were constructed between 1910 and 1977. The water from the Hunua dams is treated at the Ardmore Water Treatment Plant, and the water from the Waitakere dams is treated at the Huia and Waitakere Water Treatment Plants. (Watercare, 2017).

Of the Watercare dams, one is within the CMP catchment area, Mangatangi Dam. Mangatangi Dam is within the headwaters of the Mangatangi Stream. The sub-catchment of Mangatangi Dam is in native vegetation and is owned and administered by the Auckland Council.

Constructed in 1977, Mangatangi Dam has over double the capacity of the other Hunua dams covering a lake area of 185 hectares and a capacity of 35.3 gigalitres. (Watercare, 2017).

The protection of the water catchments and reservoirs during the early 1900s was a fundamental driver in allowing the regeneration of land to native forest that was later incorporated as part of Hunua Ranges Regional Park. The water catchments within the regional park contain a number of bush walking tracks and the reservoirs are the destination of some walks. To protect the water in the reservoirs from contamination people and dogs are prohibited within a 20-meter buffer zone around the dams and contact with water within a reservoir is prohibited. (M. Bishop, Watercare, *pers. comm*. 2018).

Auckland is growing by the size of Hamilton every four years (Waikato Regional Council , 2016) and consequently there is an ongoing demand for water – including that provided by Mangatangi Dam. Therefore, this catchment directly supports Auckland, being the largest contributor to the national gross domestic product (GDP).

2.4.4.6 Drainage districts

In the Waikato region, there are rural areas that are very flat and have limited natural drainage outlets. Over time, networks of drains have been developed within these areas to support pastoral farming and to alleviate flooding. Many of these areas have been formalised to constitute land drainage areas, some managed by Waikato Regional Council, some managed by territorial authorities and some are self-managed. Outside of these drainage areas or drainage districts, and outside of council's river scheme areas, drainage systems are the responsibility of private landowners to manage (Wood, 2016).

Historically, there were numerous territorial authorities across New Zealand ranging from boroughs, counties and special purpose authorities including those administering river control functions. By 1912 there were almost 4000 territorial authorities of various sorts.

Early land drainage responsibilities were held by drainage boards, borough councils and county councils. Drainage boards established under the Land Drainage Act 1908 were autonomous, elected boards which could rate and undertake drainage works in a defined area. Drainage boards could apply for funding from central government to part fund works that they undertook, hence there were numerous drainage boards established. Drainage boards implemented works within flat land that required drainage but were also established over river catchments to undertake river and stream improvements as there was no other mechanism available to manage and implement such works (Wood, 2016).

In 1941 the Soil Conservation and Rivers Control Act was adopted and catchment boards became established. Catchment boards were also autonomous, elected boards which struck their own rate for works, and they had responsibilities for upper catchment stability, river management and flood protection work. They also had an overview role of the various drainage board and drainage district works.

The Town and Country Planning Act 1953 gave the former county councils the power to set up drainage districts. Drainage districts were set up over local areas to enable a targeted rate to be levied by the county council to fund land drainage work within the drainage district. The formation of a

drainage district also enabled central government subsidies to be applied for to contribute to drainage district costs.

By the mid-20th century the provision of rural drainage services was very fragmented across numerous organisations with a range of maintenance tasks undertaken to varying levels of service.

Local government amalgamation in 1989 consolidated around 850 single and multi-purpose local bodies into 86 multi-purpose local authorities, including the formation of regional councils with broad environmental responsibilities.

Local government amalgamation resulted in rural drainage services being managed in two ways. The function of all drainage boards was transferred to regional councils and these are now called council administered drainage areas. All drainage districts established by borough and county councils were transferred to the relevant territorial authorities to manage and these are still called territorial authority administered drainage districts.

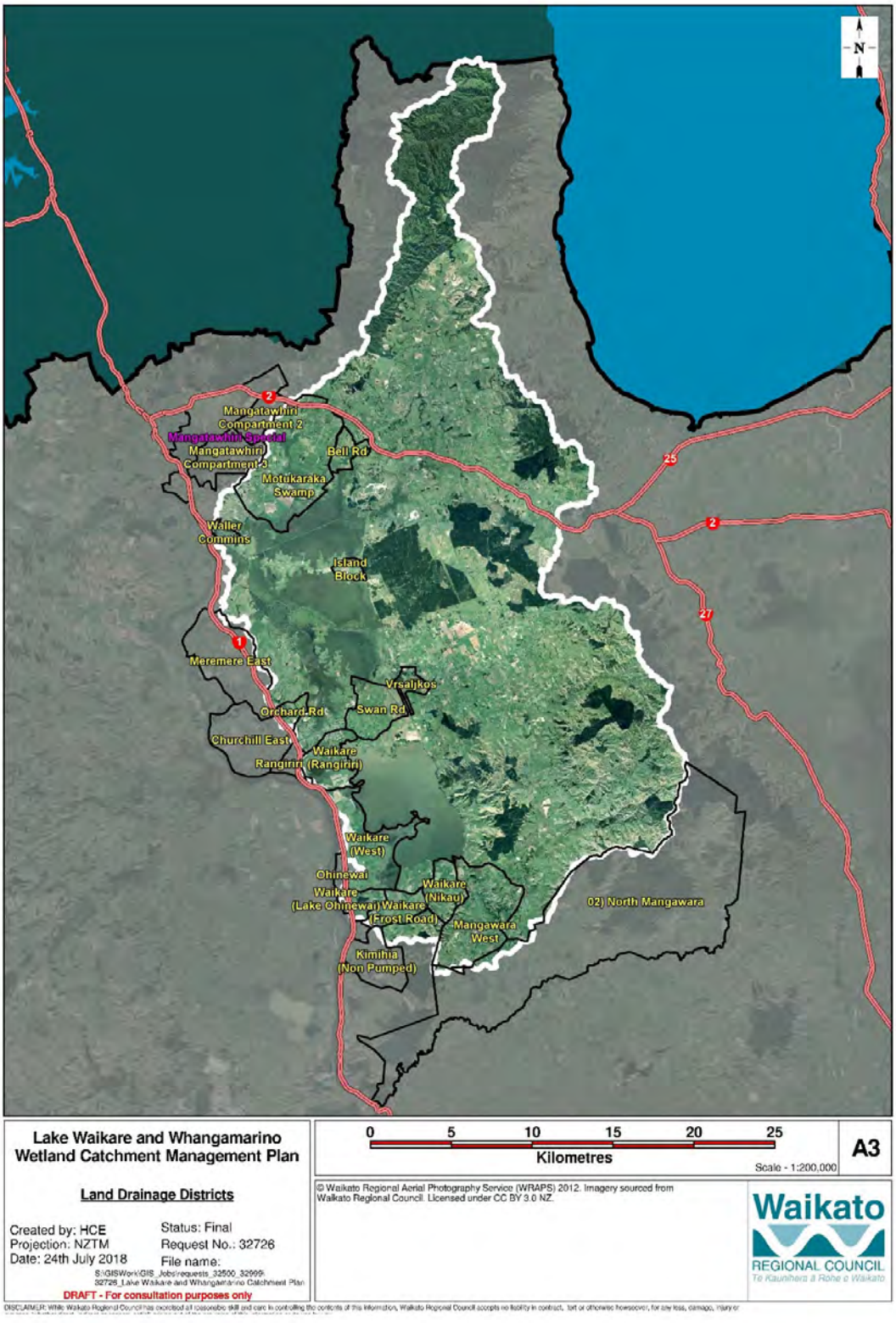
Over time, a number of TAs transferred their drainage districts to Waikato Regional Council (Council), including Waikato District Council (Wood, 2016).

Today, Waikato Regional Council manages some 92 separate drainage districts within the greater Waikato and Hauraki region.

Waikato Regional Council has established the following operational requirements in its *Asset Management Plan for Land Drainage* which are key to ensure the drainage objectives can be achieved.

- Provision and maintenance of an effective land drainage network that allows landowners the ability to manage the water table on their properties.
- Provision of the land drainage service to an agreed standard.
- Provision of a fair and equitable land drainage service to all ratepayers.
- Reduction of surface flooding resulting from rainfall events.
- Where gravity drainage allows, the clearance of water from the land to avoid damage to pasture (Waikato Regional Council, 2004).

There are several drainage districts within the Lake Waikare and Whangamarino Wetland catchment, including the ones listed, and as shown on



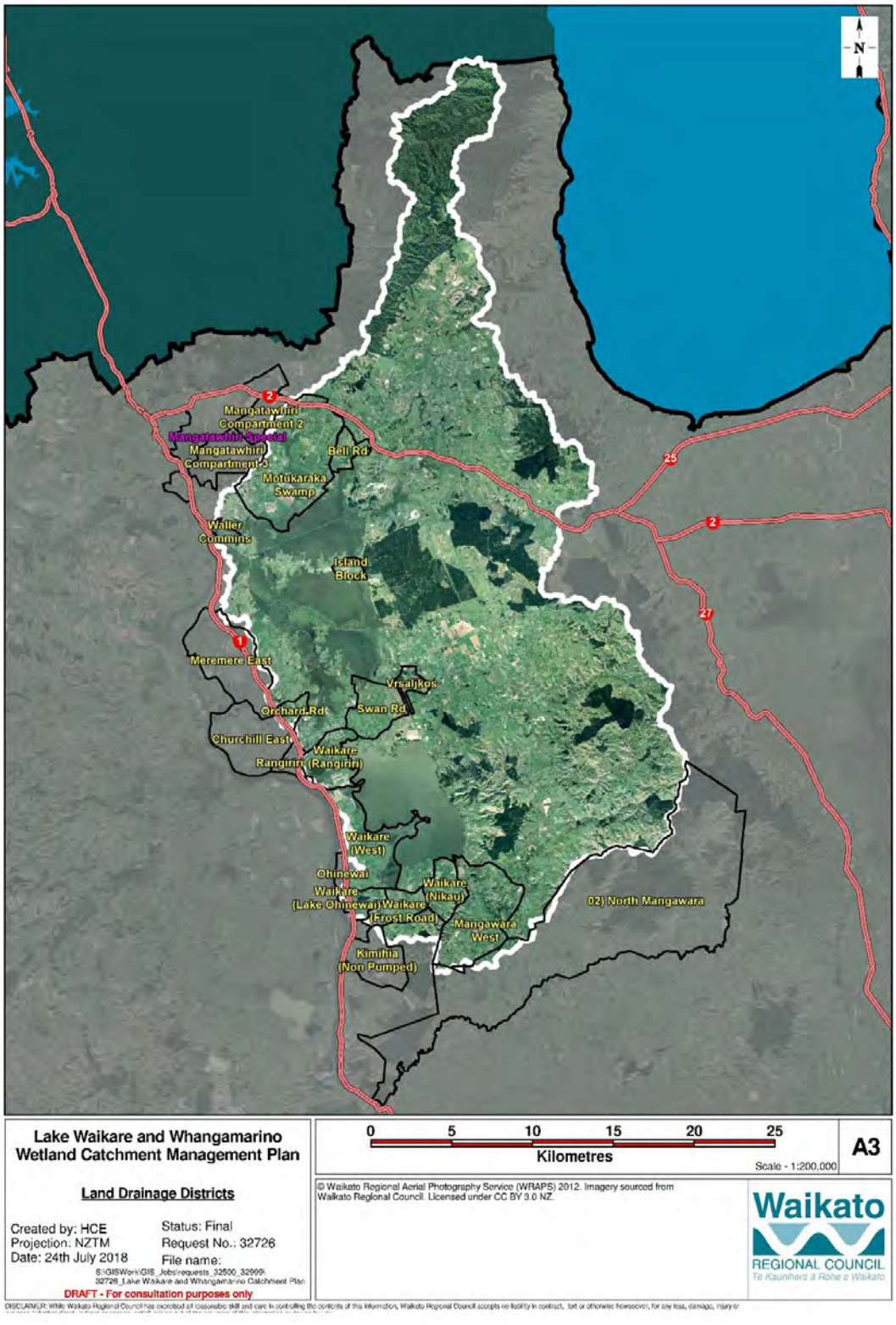
Map 8: CMP land *drainage* districts.

Drainage districts which discharge into Lake Waikare:

- Waikare Rangiriri
- Waikare West
- Waikare (Waikare Ohinewai and Waikare Frost)
- Waikare Nikau
- Mangawara West (Matahura).

Drainage districts which discharge into Whangamarino:

- Orchard Road
- Swan Road
- Vrsaljkos
- Island Block
- Travers Road (managed by Waikato District Council, west of Te Kauwhata)
- Motukaraka (via the Maramarua River)
- Bell Road (via the Maramarua River).



Map 8: CMP land drainage districts

2.4.5 Economic activity

The Waikato region is the fourth largest contributor to the New Zealand economy, and is considered an agricultural powerhouse and a key supplier to New Zealand's dairy industry with approximately 34 per cent of the national dairy herd (New Zealand Trade and Enterprise, 2016).

Agriculture (dairy and dry stock farming) is the dominant economic activity within the CMP catchment area, directly contributing an estimated $76 million (or $137.6 million once the wider effects are taken into account[4] to the Waikato gross regional product (GRP) in 2015 (Keenan, 2017).

Including other rural industry sectors, such as forestry, horticulture, poultry, deer and other livestock farming, the Lake Waikare and Whangamarino Wetland catchment area contributes $83 million directly, or approximately $156.7 million (0.7 per cent) to the Waikato GRP including wider effects, in 2015 (Keenan, 2017). It is noted that there is an increasing amount of apiculture activity in the catchment but this is likely not well reflected in the figures provided above (Keenan, *pers. comm.* 2018).

2.4.6 Tourism and recreation

International tourism contributes $11.8 billion to New Zealand and is the largest non-primary sector export earner. In 2015, New Zealand received over 3 million visitors and the tourism industry directly and indirectly employs 295,908 people (Tourism New Zealand, 2017).

For the year ending October 2016, there were approximately 51,725 international visitors to the Waikato district, with a total spend of $104 million by all domestic and international visitors (Ministry of Business, Innovation & Employment, 2017).

New Zealand's natural environment is a key reason to visit for international travellers: 57 per cent of international visitors surveyed in 2015 rated that New Zealand's environment exceeded their expectations, and a further 42 per cent rated that it met their expectations (Tourism New Zealand, 2017).

There are several interests and aspirations of anglers and hunters in the catchment. Lake Waikare, Whangamarino and the surrounding wetlands and lakes are historically, and continue to be, a fundamental asset providing recreational locations and destinations for game bird hunters to engage in their sport (Auckland/Waikato Fish & Game Council, *pers. comm*. 2017).

[4] These 'wider effects' include the additional income of those not directly involved in farming activities, such as farm suppliers, processors, transport operators, and the like.

2.4.6.1 Recreational and historical sites

Whangamarino Wetland

Whangamarino Wetland is a popular game bird hunting location, with 748 hectares of the wetland and 74 hectares of marginal strip on the Lake Waikare peninsular to the lake's southwest owned by Auckland/Waikato Fish & Game Council. Thousands of game birds utilise the wetland and the four large peat domes of the Whangamarino create a wilderness experience which is a key attribute attracting hunters from Auckland and the greater Waikato region (Auckland/Waikato Fish & Game Council, *pers. comm*. 2017).

Hunters also access parts of the wetland and Lake Waikare which are not owned by Auckland/Waikato Fish & Game Council, as well as lakes Rotokawau and Ohinewai (Auckland/Waikato Fish & Game Council, *pers. comm*. 2017).

Recreational anglers frequently visit Whangamarino targeting coarse fish and the wetland is renowned throughout New Zealand for bird watching (Duggan, et al., 2013).

The area is a unique asset to the Auckland/Waikato Fish & Game region in that, as against other Fish & Game regions, the population it serves is far greater. With the bulk of the population centred north of the Bombay Hills and the major resource located southwards, considerable travel and associated expenditure is incurred by the majority of game bird hunters in the region (Auckland/Waikato Fish & Game Council, *pers. comm*. 2017).

Te Araroa Trail

The Te Araroa Trail is a continuous 3000 kilometre walking track from Cape Reinga to Bluff managed by Te Araroa Trust (Te Araroa Trust, 2017).

Within the Lake Waikare and Whangamarino Wetland catchment, the Te Araroa Trail commences near Oram Road, off State Highway 1 between Meremere and Mercer, adjacent to the Whangamarino River control gates. The trail then follows the eastern side of Waikato River just west of the catchment area, and crosses to the western side of Waikato River at Rangiriri.

Whangamarino historic walk

The Whangamarino historic walk is accessed from Oram Road, off State Highway 1 between Meremere and Mercer, adjacent to the Whangamarino River control gates.

The track starts through regenerating native bush of tree ferns, mahoe, mapou, hangehange and other shrubs before climbing a grassy spur, with views over Waikato River and State Highway 1. At the top of the spur are some fortification ditches which were part of Te Teoteo's Pā, a pre-European pā site. A short distance further is Whangamarino Redoubt, occupied by British forces during the Waikato Wars of 1863/64. The track then follows an old roadway used during the wars, back to Oram Road. This section of the track also forms part of the Te Araroa Trail (Department of Conservation, 2017).

Meremere Redoubt

Meremere Redoubt is located in Meremere village, just off State Highway 1. It is one of 22 earthwork forts built between Auckland and Pirongia. Initially a Māori stronghold, it was occupied by British forces during the Waikato Wars of 1863/64 when the Māori forces abandoned it to regroup at Rangiriri (Department of Conservation, 2017).

Meremere Redoubt has been well preserved and is an outstanding example of its type in an easily accessible location. The site has wide views of the surrounding area and Waikato River. It is possible to also glimpse Whangamarino Redoubt where British forces fired upon the original Māori position (Department of Conservation, 2017).

The Department of Conservation now maintains the site to stabilise the defensive earthworks and to allow visitors to easily see them (Department of Conservation, 2017).

Rangiriri battle site and heritage centre

Rangiriri Heritage Centre is located in Rangiriri village and includes a unique collection of memorabilia dating from the 1863 battle of Rangiriri.

The most important battle of the Waikato Wars of 1863/64 was fought at Rangiriri in November 1863. A Māori defensive line was constructed along a ridge between Waikato River and Lake Waikare. Near Rangiriri village there is also a Māori war and early settler's cemetery (New Zealand History, 2017).

3. Statutory, policy and institutional framework

3.1 Legislative and statutory plan context

The catchment management plan (CMP) implements a number of non-regulatory responsibilities under a variety of statutes and policies, including:

- Resource Management Act 1991 (RMA)
- Waikato-Tainui Raupatu Claims (Waikato River) Settlement Act 2010
- Soil Conservation and River Controls Act 1941
- Local Government Act 2002
- Land Drainage Act 1908
- Civil Defence and Emergency Management Act 2002
- Biosecurity Act 1993
- Conservation Act 1987
- Reserves Act 1997
- Wildlife Act 1953
- Freshwater Fisheries Regulations 1983
- Convention on Wetlands of International Importance (Ramsar Convention on Wetlands)
- National Policy Statement for Freshwater Management 2017
- Te Ture Whaimana o te Awa o Waikato – The Vision and Strategy for the Waikato River
- Waikato Regional Policy Statement.

These statutes and policies are administered by, or include specific powers and functions for, several parties including Waikato Raupatu River Trust, Department of Conservation (DOC), Auckland/Waikato Fish & Game Council, Waikato District Council and Waikato Regional Council.

A summary of the key statutory policy documents and legislation that have guided the implementation actions proposed within this CMP are summarised below:

Vision and Strategy for the Waikato River

The primary direction-setting document for the protection of the Waikato River and its catchments is Te Ture Whaimana o te Awa o Waikato (Vision and Strategy for the Waikato River).

Developed by the Guardian Establishment Committee (predecessor to the Waikato River Authority) in consultation with the Waikato community, as part of the wider Waikato River treaty settlement co-management negotiations, the Vision and Strategy for the Waikato River is administered by the Waikato River Authority. It was initially given statutory recognition via the Waikato River Acts in 2010 and 2012.

The Vision and Strategy for the Waikato River is included in its entirety into the proposed Waikato Regional Policy Statement, therefore regional and district plans must give effect to it. If there are any inconsistencies between the Vision and Strategy and any Resource Management Act planning document, including any national policy statement, then the Vision and Strategy prevails.

Fundamental to the vision are the following key principles:

- Commitment to the restoration and protection of the river in its widest sense (including iwi and community relationships).
- Adoption of a precautionary approach.
- Recognition given to cumulative effects.
- Application of a holistic, integrated approach to the management of resources.
- Recognition and application of two worlds of knowledge – Mātauranga Māori and western science.

Regional Policy Statement (2012)

The Regional Policy Statement (RPS) has objectives for managing fresh water (3.14), riparian areas and wetlands (3.16), ecological integrity and indigenous biodiversity (3.19), natural hazards (3.24), and values of soils (3.25). It also has new policies regarding managing fresh waterbodies (Chapter 8), indigenous biodiversity (Chapter 11), natural hazards (Chapter 13) and soils (Chapter 14). These objectives and policies are relevant to the implementation actions set out within this CMP.

Waikato Regional Plan (2007)

The Waikato Regional Plan (WRP) applies across the whole of the Waikato region (except for the coastal marine area) and provides the regulatory framework for resource management. The WRP implements the RPS, relevant national direction, and Treaty settlement legislation.

A full review of the WRP (together with the Regional Coastal Plan) is currently being planned by the council. Ultimately the two plans will be combined and replaced by one: the Waikato Resource Management Plan. Notification of the first phase of the plan review (most of the current coastal plan and priority topics for the regional plan) is expected in 2019/20, with adoption of the revised plan programmed for 2025.

Proposed Waikato Regional Plan Change 1 – (Waikato and Waipā River Catchments)

The council has notified and is in the process of implementing proposed Plan Change 1 – Waikato and Waipā River Catchments (Healthy Rivers: Plan for Change/Wai Ora: He Rautaki Whakapaipai). Plan Change 1 seeks to achieve reduction, over time, of sediment, microbial pathogens, nitrogen and phosphorus entering waterbodies (including groundwater but excluding coastal waters) in the Waikato and Waipā river catchments.

Plan Change 1 priority sub-catchments within the Lake Waikare and Whangamarino Wetland catchment is included in the maps section within this document, titled:

Map 9: Healthy Rivers: Plan for change priority catchments

The District Plan

The District Plan applicable to the CMP area is the Waikato section of the District Plan. The District Plan promotes the sustainable management of natural and physical resources in the Waikato district, primarily through the strategic management of growth and by managing the effects of land use on the environment.

The Proposed Waikato District Plan 2018 (Stage 1) was notified in July 2018, and at the time of writing is within the submission period. The proposed plan combines both the Franklin and Waikato sections into a single District Plan with a consistent approach to development and growth across the district.

Regional Pest Management Plan 2014-2024

The Waikato Regional Pest Management Plan (RPMP) sets out the strategic and statutory framework for managing plant and animal pests in the Waikato region. Objectives and the management approach for specific plant and animal pests present within the Lake Waikare and Whangamarino Wetland catchment are contained in this plan. It is noted that the RPMP review is planned to commence in late 2017 starting with the release of a discussion document in early 2018.

National Direction on natural resource management

Central Government, through the Ministry for the Environment, has a programme of national direction work that seeks to provide overall direction and consistency around management of natural resources. This involves either development, or review, of national environment standards, national policy statements, and national regulation.

Key national directions that will affect catchment management include the National Policy Statement for Freshwater Management (2017), national regulation around stock access to water and swimmability standards, and the Proposed National Environmental Standard for Plantation Forestry (2017). These national regulations may also impact on the level of service that the flood and drainage control schemes deliver. This catchment management plan will need to be amended to give effect to any national direction.

Waikato River Treaty settlements

The council acknowledges the special position of tangata whenua within the region and recognises the need to work with iwi/hapū in river and catchment management.

The Waikato-Tainui Deed of Settlement was passed into law in May 2010 and is a key Treaty settlement for the catchment. The agreement established a river management authority to oversee governance of the river (the Waikato River Authority), and the Vision and Strategy for the Waikato River is input in its entirety directly into the RPS. This Treaty settlement has resulted in land ownership

changes and many large areas of soil conservation and river control (SCRC) land being vested in the Waikato Raupatu River Trust.

The Conservation Act (1987)

The Conservation Act was developed to promote conservation of New Zealand's natural and historic resources. To achieve this, the Act established the Department of Conservation, bringing together under one department the conservation functions formerly managed by five different government agencies.

Under the Act, the Department of Conservation has a number of functions. These include:

- the management of all land and natural and historic resources, for conservation purposes, held under the Conservation Act
- the preservation of indigenous freshwater fisheries (so far as is practicable)
- the protection of recreational freshwater fisheries and freshwater fish habitats
- conservation advocacy
- promotion of the benefits of international co-operation on conservation matters
- promotion of the benefits of the conservation of natural and historic resources in New Zealand, the Subantarctic Islands, the Ross Dependency and Antarctica
- the provision of educational and promotional conservation information
- fostering recreation and allowing tourism on conservation land, providing the use is consistent with the conservation of the resource
- provision of advice to the Minister.

Reserves Act 1977

The Reserves Act gives the Minister of Conservation (Minister) a number of specific powers in relation to reserves. They are mostly delegated to the Director-General, local authorities or various reserve governance bodies. An exception is the approval of bylaws in relation to reserves. The Minister has power to grant concessions for activities carried out in reserves vested in the Crown or controlled and managed by administering bodies.

Wildlife Act 1953

The Wildlife Act deals with the protection of wildlife throughout New Zealand and New Zealand fisheries waters. Permits are necessary to deal with certain wildlife. Most species of wildlife (including mammals, birds, reptiles and amphibians), native or introduced, are absolutely protected under the Act, subject to Schedules 1-8 of the Act. No-one may kill or have in their possession any such bird or animal, unless they have a permit.

Conservation General Policy

The Conservation General Policy is the highest level of statutory policy for conservation management. The general policy was prepared under section 17C of the Conservation Act to provide unified policy for the implementation of the act listed in the First Schedule of that Act. It provides guidance for the administration and management of all PCL&W and all natural and historic resources managed for the purposes of the acts in the First Schedule. It also provides guidance for consistent management planning for the wide range of places and resources administered or managed by the Department of Conservation. Conservation management strategies and plans implement general policy and cannot derogate from it.

3.2 Non-statutory policy context and perspectives

A number of the parties who have collaboratively developed this CMP have provided their policy context and perspectives for inclusion, and are summarised below:

3.2.1 Waikato Regional Council

Waikato Regional Council Strategic Direction 2016 to 2019

Waikato Regional Council's strategic direction guides work and sets priorities for the council's work up to 2019. It also reflects community desires and needs and identifies key factors that will determine whether the council is successful in achieving its strategic direction.

Priorities under the council's strategic direction are:

- support **communities** to take action on agreed outcomes
- forge and strengthen **partnerships** to achieve positive outcomes for the region
- positively influence future **land** use choices to ensure long term sustainability
- manage **fresh water** more effectively to maximise regional benefit
- increase communities' understanding of **risks and resilience** to change
- enhance the value of the region's coasts and marine area
- shape the **development** of the region so it supports our quality of life.

The implementation of the CMP will assist the council in delivering its strategic direction (Waikato Regional Council, 2017).

Regional Asset Management Plan

The council has developed a Regional Asset Management Plan (RAMP) across all eight of its zones. The RAMP confirms the levels of service (LOS) for asset management planning across the region. Asset management planning enables the relationship between LOS and the cost of the service to be determined.

LOS provide the link between the corporate and asset management objectives and the more detailed technical and operational objectives. Community outcomes are those that a local authority aims to achieve through the provision of infrastructure services. They form the basis for the council's service delivery, thus determining the LOS provided to the community. The community outcomes for the council are set out in the council's Strategic Direction 2016-2019 and will be reflected in the 2018-2028 LTP.

The Waikato and Waipā River Restoration Strategy (WWRRS) (2017)

The Waikato River Restoration Forum was established in 2014 with a purpose of maximising opportunities to realise the Vision and Strategy for the Waikato River catchment. The forum is made up of representatives from the five river iwi, the Waikato River Authority, Waikato Regional Council, DairyNZ, Fonterra, territorial local authorities, Mercury, Genesis Energy and the Department of Conservation.

The first objective of the forum was to support the development of a strategic plan for river restoration initiatives; to encourage a more integrated and coordinated approach to funding and non-regulatory catchment and river management. A five to 20 year action plan for the Waikato and Waipā Rivers and their catchments was proposed to be developed with wide stakeholder input.

The development of this plan – the Waikato and Waipā River Restoration Strategy (WWRRS) was formally led through a partnership between Waikato Regional Council, DairyNZ and the Waikato River Authority.

The purpose of the WWRRS is to guide future 'on the ground' activities for all organisations funding and/or undertaking river and catchment restoration, through the identification of specific, technically achievable and prioritised actions. Key objectives of the WWRRS are:

- to inform decision making of River Restoration Forum members engaged in restoration activities
- to act as a guide for all groups engaged in delivering restoration initiatives
- to encompass an approach that allows groups much longer planning periods to prepare for funding applications and project implementation
- to further build on the work carried out in 2010 to develop the Waikato River Independent Scoping Study (NIWA, 2010) by focusing on non-regulatory actions and considering the likely available funding
- to identify projects that are likely to make the greatest difference in improving the health and wellbeing of the Waikato and Waipā Rivers and reflect the values and goals of the iwi and communities within the catchment.

The WWRRS is non-binding and does not in any way restrict the ability of any funding or management organisation to fund or undertake any project that meets their criteria. However, it provides direction for funders who are seeking to invest in effective projects, and to organisations, iwi, communities and individuals who undertake work and want to deliver high impact results (Neilson, et al., 2018).

The WWRRS covers a wide range of restoration and protection activities in the catchment and focuses on six core work streams: erosion and sedimentation, water quality, biodiversity, fish, access and recreation and iwi cultural priorities.

The entire Lake Waikare and Whangamarino Wetland catchment is in geographical scope for the WWRRS. For the purpose of the WWRRS, restoration priorities were developed in conjunction with those for Central Waikato Zone.

Priority catchments, streams and sites within Lower Waikato Zone (including the Lake Waikare and Whangamarino Wetland catchment) have been identified in the WWRRS. These priorities have been included as actions identified in the action plan within Part Two of this CMP.

Lower Waikato Zone Plan

The Lower Waikato Zone Plan provides the broad direction for the implementation of Waikato Regional Council's integrated catchment management activities within the Lower Waikato Zone. It is important to note that the Lower Waikato Zone Plan is underpinned by the CMP.

The zone plan includes:

- an overall vision for the zone
- 30-year goals for the zone
- implementation actions for the next 10-year period to meet the goals identified
- processes (and measures) for monitoring and reviewing the plan.

The CMP and the Lower Waikato Zone Plan are similar in that they are non-regulatory documents which include implementation methods to achieve the aspirations of the community and deliver the Vision and Strategy for the Waikato River.

Given that Lake Waikare and Whangamarino Wetland catchments encompass the Lower Waikato Zone, the zone plan addresses similar issues to the CMP, such as measures to best address sediment sources impacting the lake and wetland, lake water quality and biodiversity. Integration between the CMP and the zone plan will ensure implementation actions of both plans are coherent and coordinated to achieve goals of the zone.

Waikato Region Shallow Lakes Management Plan

This Shallow Lakes Management Plan draws together information about the 71 shallow lakes of the Waikato region and the policy and legal framework for their management. This includes the lakes and wetlands within the Lake Waikare and Whangamarino Wetland catchment area.

The plan identifies the key management issues for shallow lakes, with a specific focus on matters that the regional council has responsibility for (i.e. water quality, lake water levels and biodiversity values).

Waikato Freshwater Strategy (2017)

This strategy identifies a programme of action to achieve the best use of fresh water through time via better allocation systems using new methods based on better information. It recognises that freshwater management is a complex problem that has not been addressed in an integrated manner. The current state of the region's fresh water is the result of ad hoc management in response to disparate directions from central government and a preference for economic development that competes with an incomplete understanding of site specific environmental limits.

Waikato District Lakes and Freshwater Wetlands Memorandum of Agreement

Community, iwi and council concern led to the signing of the Waikato District Lakes and Freshwater Wetlands Memorandum of Agreement (MOA) on 7 June 2011. The MOA group – involving Waikato Regional Council, Waikato District Council, Waikato-Tainui, the Department of Conservation and Auckland/Waikato Fish & Game Council are working together on projects to protect, enhance and restore shallow lakes and wetlands in the Waikato district. Having the MOA's signatories working together means we may be able to achieve more within the catchment.

3.2.2 Waikato Raupatu River Trust

Waikato Tainui Environmental Plan

Waikato-Tainui have an iwi management plan (Waikato Tainui Environment Plan, Tai Timu, Tai Pari, Tai Ao) which sets out the aspirations for environmental, economic, social and cultural enhancements. The Waikato Tainui Environmental Plan contains objectives to grow the tribal estate and manage our natural resources, whilst providing guidance to external agencies about Waikato-Tainui's values, principles, knowledge and perspectives on, relationship with, and objectives for natural resources and the environment.

3.2.3 Department of Conservation

Department of Conservation Mandate

Conservation, as defined under section 2 of the Conservation Act 1987, is the:

> *'preservation and protection of natural and historic resources for the purpose of maintaining their intrinsic values, providing for their appreciation and recreational enjoyment by the public, and safeguarding the options of future generations'.*

The Department of Conservation (DOC) administers most of the Crown land in New Zealand, protected for scenic, scientific, historic or cultural reasons, or set aside for recreation. This is almost a third of New Zealand's land area, including national forest and maritime parks, marine reserves, nearly 4000 land reserves, river margins, some coastline and many offshore islands (Department of Conservation, pers. comm. 2018).

Vision, purpose and outcomes

DOC's vision talks about New Zealand as the greatest place in which to live and the greatest environment for indigenous creatures. The vision also reflects DOC's commitment to sustainability and working in partnership. DOC's overarching purpose is 'conservation leadership for our nature', recognising the role that we all play as guardians of 'our nature'.

To focus DOC's effort and move towards this vision, DOC has developed a set of 'stretch goals'. These are 10-year goals that provide clear targets to achieve DOC's vision. DOC will change and adapt these goals over time. The goals set out below in Figure 4 give a clear indication of what DOC's targets are for biodiversity, fresh water, marine protection, historic heritage and tourism and community engagement (Department of Conservation, *pers. comm.* 2018).

Figure 4: The Department of Conservation story

Department of Conservation functions

The functions of DOC are for the most part identified in section 6 of the Conservation Act 1987 and in other Acts listed in the First Schedule of the Act. The Conservation Act 1987 creates a hierarchy of documents to guide DOC in its management. The Conservation Act 1987 is at the top and sets out the statutory purposes for which public conservation lands and waters (PCL&W) is managed; Conservation General Policy is next and provides guidance for administration and management of PCL&W, and below that are conservation management strategies and conservation management plans which implement general policy and provides for integrated management of PCL&W. DOC also administers the Reserves Act 1987, the Wildlife Act 1953 and many other acts (Department of Conservation, *pers. comm.* 2018).

Conservation management strategies

Conservation management strategies are 10-year regional strategies that are a handshake with the community. They provide an overview of conservation issues and give direction for the management of public conservation land and waters, and species for which DOC has responsibility. Their purpose is to implement general policies and establish objectives for the integrated management of natural and historic resources, and for recreation, tourism, and any other conservation purposes (Department of Conservation, *pers. comm.* 2018).

3.2.4 Auckland/Waikato Fish & Game Council

Fish & Game mandate

Fish & Game councils are Crown entities established under the Conservation Act 1987 with powers and functions to, among other things:

> *manage, maintain and enhance the sports Fish & Game resource in the recreational interests of anglers and hunters, and, in particular:*
>
> *(a) assess and monitor populations, user satisfaction, and the trend of ecosystems as habitats.*
>
> *(b) maintain and improve the sports Fish & Game resource*
>
> *- by maintaining and improving access*
>
> *- by ensuring there are sufficient resources to enforce fishing and hunting season conditions*
>
> *- by undertaking works necessary to maintain and enhance habitat*
>
> *(c) promote and educate*
>
> *- by promoting recreation based on sports Fish & Game*
>
> *(d) in relation to planning*
>
> *- to represent the interests and aspirations of anglers and hunters in the statutory planning process*
>
> *- to prepare sports Fish & Game management plans in accordance with this Act*
>
> *- to advocate the interests of the council, including its interests in habitats.*

Management of game bird resource

Game birds are recognised in the First Schedule of the Wildlife Act 1953 and they are managed under Part 2 of the Wildlife Act, with associated regulations and annual Game Gazette Notices. Several of

the principal game birds (grey duck, paradise shelduck, shoveler duck, black swan and pūkeko) are native species (Auckland/Waikato Fish & Game Council, *pers. comm*. 2018).

Sports Fish & Game bird management

Sports Fish & Game Bird Management Plans are prepared and approved in accordance with section 17L of the Conservation Act 1987. Sports Fish & Game Bird Plans must have regard to:

(a) the sustainability of sports Fish & Game in the area to which the plan relates

(b) the impact that the management proposed is likely to have on other natural resources and other users of the habitat concerned.

They must also include such provisions as may be necessary to "maximise recreational opportunities for hunters and anglers".

As statutory management plans, there is a requirement that they be had regard to in the course of preparing plans under the RMA (Auckland/Waikato Fish & Game Council, *pers. comm*. 2018).

The Auckland/Waikato Sports Fish & Game Bird Management Plan 2010

The two goals of the Auckland/Waikato Sports Fish & Game Bird Management Plan 2010 are to:

- manage, maintain and enhance the sports Fish & Game bird resource
- maximise recreational angling and hunting opportunity, subject to the first goal if conflicts occur.

Most species management in the Auckland/Waikato region is undertaken through habitat protection, as it is possible to manage populations through the management of habitat, the species themselves and the extent of recreational harvest.

Certain rivers, lakes and wetlands within the catchment are recognised in the Auckland/Waikato Sports Fish & Game Bird Management Plan 2010 as being of local, regional and national significance to hunters and anglers.

The Sports Fish & Game Bird Management Plan enables engagement in the CMP process to the following extent:

> *"Non-statutory process may also be used to achieve protection of sports Fish & Game bird habitat. Proactive cooperation with other resource management organisations, landowners and managers, iwi, interest groups and individuals in the wider community can be used to realise positive outcomes for Fish & Game management."* (Auckland/Waikato Fish & Game Council, *pers. comm*. 2018).

3.2.5 Waikato District Council

Te Kauwhata Catchment Management Plan

The Waikato District Council's Te Kauwhata Catchment Management Plan (Beca Infrastructure Ltd, 2009) identifies the Te Kauwhata village as an area of future growth of some 200 hectares. New developments are proposed to the northwest (towards State Highway 1) into the Travers Road area; and to the north of the village along Blunt Road towards Whangamarino Wetland.

The Te Kauwhata Catchment Management Plan has several objectives, including:

Social:

- Stormwater treatment and collection areas shall retain and where possible enhance the rural village look and feel.
- Area of new commercial growth be restricted to areas near the existing town centre where existing stormwater reticulation can be utilised.
- Promote the use of low impact design elements and features for areas where social interaction is intended as part of the recreation network or to maximise the use of green open space areas.

Economic:

- Where possible, existing contours shall be used to reduce the amount of earthworks required.
- Encourage the use of a treatment train, including the use of at source stormwater retention to reduce first flush downstream flow volumes.
- Minimise areas of flood inundation on private property by recommending alternative disposal systems, or identify current restrictions in the catchment that have direct impacts on the level of ponding.

Ecological:

- Maintenance and enhancement of ecological corridors and buffer areas, including the use of riparian margins and planted areas in conjunction with stormwater management features as appropriate.
- Ensure that the adverse effects of land use (new development) on water quality and aquatic habitats are avoided, remedied or mitigated.
- Ensure that the natural character and water quality of significant wetlands are protected and enhanced.

Amenity:

- Encourage the use of low impact design methods to achieve amenity enhancement in areas adjoining urban growth.

- Utilise 'soft edge' concepts to retain and enhance amenity associated with wet ponds and created wetlands that are necessary for stormwater detention and treatment within the lower catchment, near the point of discharge.

Cultural:

- Establish methods to improve water quality of the stormwater discharge into Whangamarino Wetland and Lake Waikare to recognise and maintain the cultural significance of the wetland and lake.
- Acknowledge the relationship that tangata whenua, as kaitiaki, have with water and their identified taonga such as waahi tapu (Beca Infrastructure Ltd, 2009).

50 Year Wastewater Strategy

The purpose of this report is to provide a high-level wastewater strategy foundation document for Waikato District Council (WDC) that is framed around understanding the future needs of each community and includes the development of wastewater treatment and disposal infrastructure options to meet the forecast wastewater flows. The strategy leverages from existing information and reviews it holistically from a district-wide perspective to identify options to improve efficiency. This document will be used by Waikato District Council to write up the wastewater aspects of its infrastructure strategy (MWH, 2014).

This strategy includes the wastewater scheme – Te Kauwhata (including Rangiriri) wastewater treatment plant located at Te Kauwhata.

The objective of this strategy is to understand the drivers, responsibilities and future needs for public infrastructure. This enables long term strategy direction in wastewater management. The strategy also identifies the key practices and activities which are required to be implemented and sustained over a short, medium and long term timeframe. These cascade to the district council's 30-year strategy listed within the Waikato District Council Long Term Plan 2015-2025 (Waikato District Council, *pers. comm*. 2017).

3.2.6 Primary Stakeholders Catchment Trust

The Primary Stakeholders Catchment Trust (Inc) (PSCT) is a collective of catchment landowners and primary stakeholders with an interest in the Lake Waikare and Whangamarino Wetland catchment.

The strategic direction for the PSCT is illustrated in Figure 5 below.

Figure 5: Strategic direction for the Primary Stakeholders Catchment Trust

The culture of stewardship is one of the motivators for landowners and primary stakeholders in the catchment. The PSCT identifies this as underpinning the approach that will lead to a successful catchment management plan.

'Stewardship ethic' is one of the foundation stones, linked to self-belief and a culture that leads our thinking. It is a very personal and aspirational model on which many top performing landowners and primary stakeholders model their business on. Stewardship ethic simply describes the long-term relationship one has with the land.

It also is very much part of an intergenerational belief. To the PSCT it is very much about making a living from the land, but while doing so minimising the adverse effects that have occurred from food production. There is an obligation to work together as one and to sustainably manage the valuable resources for future generations. After all, we are all only stewards of the land – borrowing the resource from our children, and their children after them (Primary Stakeholders Catchment Trust, *pers. comms.* 2018).

4. Implementation framework

This section provides an overview and explanation of the implementation framework that underpins the CMP, which is summarised by Figure 6 below.

An overarching CMP purpose has been developed and has been defined through the consultation process undertaken to date. This is defined in Section 1 above, but is repeated below:

"Conserve, enhance and, where appropriate, restore the river, land and wetland environment through effective land, water and resource planning across the Lake Waikare and Whangamarino Wetland catchment; through a coordinated, collaborative approach."

Key catchment issues and opportunities (including those identified through the consultation process) have been developed, which were also informed through a 'state of understanding' process; whereby existing research and initiatives within the catchment were assessed.

Five management areas, which the key issues and opportunities relate to, have been identified. These management areas represent a predominant theme for the catchment and the implementation of the CMP; with some issues and opportunities linking to a number of management areas.

For each management area, a strategic aim has been identified. Each strategic aim sets out a broad aspirational statement (which has been defined through the consultation process undertaken to date) for a given management area for the next 80 years. The Healthy Rivers: Plan for Change/Wai Ora: He Rautaki Whakapaipai uses an 80-year timeframe to meet water quality objectives, and this timeframe similarly was adopted for the CMP. The key catchment issues have helped to inform each strategic aim, and sets out an overarching aim to guide decision making and actions over this timeframe in order to achieve the overall CMP purpose.

For each of the strategic aims, there are a number of objectives which indicate how the CMP will be pursued. The objectives are flexible within the wider aims of the CMP and will be responsive to new information and future changes (e.g. legislative changes).

Part Two of the CMP details an action plan that has been developed to represent achievable steps, actual activities and/or initiatives ("actions") necessary to reach the aspirations set out in the strategic aims and objectives. The actions have, where possible, taken advantage of the key catchment opportunities, and address the key catchment issues.

Ultimately the action plan will achieve the overall CMP purpose and will address the key catchment issues and opportunities which have been identified.

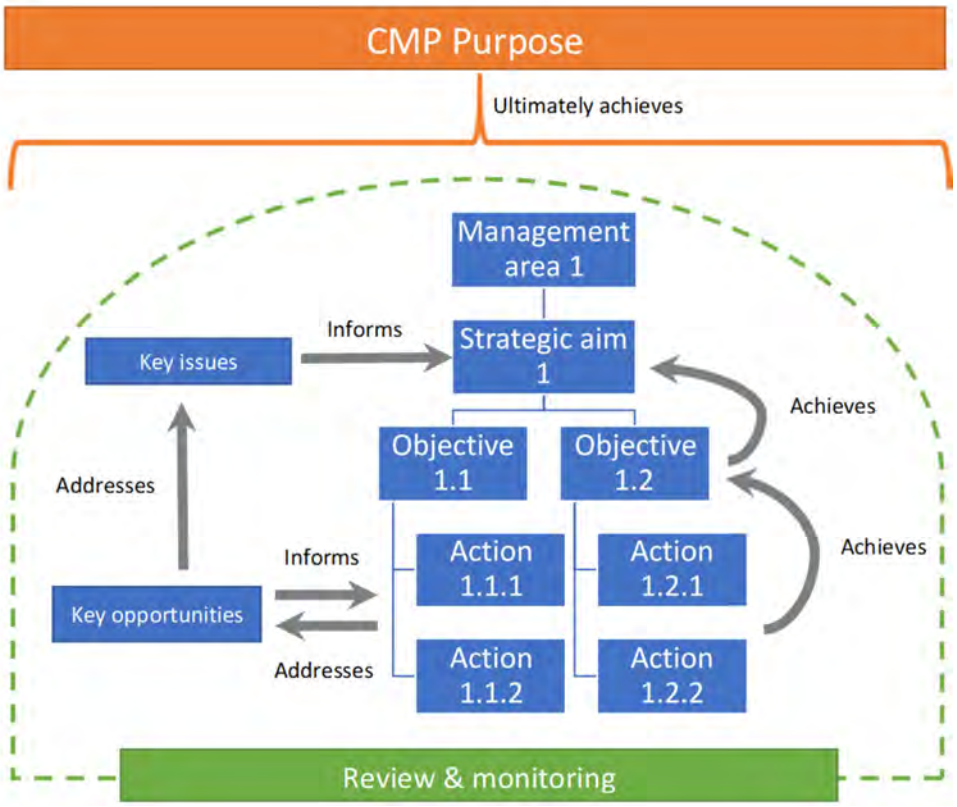


Figure 6: CMP implementation framework

5. Strategic aims and objectives

Five management areas have been identified which represent a predominant theme for the catchment; and the key issues and opportunities (identified in Section 6 below) relate to, in some cases, multiple management areas.

For each management area, a strategic aim has been identified. Each strategic aim sets out a broad aspirational statement (which has been defined through the consultation process undertaken to date) for a given management area for the next 80 years. The Healthy Rivers: Plan for Change/Wai Ora: He Rautaki Whakapaipai uses an 80 year timeframe to meet water quality objectives, and this timeframe similarly was adopted for the CMP. The key catchment issues have helped to inform each strategic aim; and sets out an overarching aim to guide decision making and actions over this timeframe in order to achieve the overall CMP purpose.

For each of the strategic aims, there are a number of objectives which indicate how the CMP will be pursued. The objectives are flexible within the wider aims of the CMP; and will be responsive to new information and future changes (e.g. legislative changes), in accordance with the monitoring and review process outlined in Section 7.

CMP implementation

Strategic aim 1:

To ensure sound implementation of the CMP, giving practical effect to our community's economic, environmental, cultural and social aspirations.

By implementing the following objectives:

1.1 Working together proactively and constructively to make decisions; and to carry out implementation, informed by cultural, environmental and community values and the continuum of history, within the catchment.

1.2 Ensuring a robust governance structure is followed.

1.3 Developing clear implementation policies and actions, using evidence-based (scientific) methodology which yields predictable and reliable outcomes.

1.4 Coordinating research within the catchment.

1.5 Prioritising implementation and action plan recommendations by the largest potential for positive environmental change, balanced against robust economic analysis and responsibility.

1.6 Securing resourcing and building capability to enable implementation, and ensuring robust budgetary processes are implemented and reported against.

1.7 Providing regular and appropriate monitoring, review and dissemination of the effectiveness and implementation of policies.

Explanation

One party cannot achieve the purpose of the CMP alone. There is a need to work together collaboratively with councils, landowners, community groups, businesses, central government agencies, iwi and hapū and non-governmental organisations. A robust governance arrangement and ongoing funding is needed to facilitate this collaborative approach.

Ongoing monitoring and review of the CMP is a vital component of the catchment management process, to ensure the successful implementation of the CMP.

Water management

Strategic aim 2:

To ensure water resources (quantity, quality and flood management) are managed sustainably to provide for the long term wellbeing of the natural environment and community.

By implementing the following objectives:

2.1 Identifying catchment specific water quality issues; and monitoring, evaluating and validating the methodology of maintaining, improving or mitigating water quality and water use.

2.2 Managing sediment, nutrients and microbial pathogens from entering the lakes and wetlands, with a desire to lead to improvements in water quality over time.

2.3 Ensuring the Lower Waikato Waipā Flood Control Scheme meets agreed levels of service.

2.4 Ensuring that there is water available for municipal, irrigation and other uses, while protecting the needs of the natural environment.

2.5 Recognising and promoting wetlands for their values in water management (removing nutrients, settling and filtering water and retaining flood flows).

Explanation

Approximately 1500 hectares of productive farmland around Lake Waikare, and key infrastructure including State Highway 1 and the main trunk railway, is protected from flooding for the majority of the time by the Lower Waikato Waipā Flood Control Scheme (LWWFCS). The LWWFCS and the associated river management works need to be maintained and refurbished to ensure the ongoing protection of confirmed levels of service.

In general, the water quality in the Lake Waikare and Whangamarino Wetland catchment declines from the upper reaches to the lower reaches. Many parts of the catchment are no longer swimmable due to high sediment loads and rising levels of nutrients. This strategic aim seeks to return the waters of the catchment to a level where it is swimmable and visibly clearer than it is currently.

The decline of the water quality in the catchment's shallow lakes and Whangamarino Wetland is also a significant issue, affected by peat subsidence, nutrient and sediment loading resulting from drainage, cropping and the intensive development of surrounding land. This strategic aim seeks to return the water quality to a level where the water is clear enough for native aquatic plants to establish and grow.

Soil and land management

Strategic aim 3:

To ensure soil and land resources are managed sustainably to provide for the long term wellbeing of the natural environment and community.

By implementing the following objectives:

3.1 Promoting sustainable land use.

3.2 Identifying and managing critical source areas and issues of soil loss.

3.3 Supporting and providing opportunities for appropriate soil protection.

3.4 Protecting elite and high quality soils.

3.5 Maintaining and, where possible, improving soil quality through best management practices.

Explanation

Erosion prone soils and unstable areas deliver high loads of sediment (and phosphorus) to Lake Waikare, Whangamarino Wetland and some tributaries (and ultimately to the Waikato River). In addition, new land uses are becoming more intensive and are occurring in areas where that land use does not match the productive capability of the land. This strategic aim seeks that land uses match capability in order to maintain stable and productive soils; and that erosion and associated sedimentation is reduced.

This strategic aim will ensure that agencies and private landowners will undertake land management activities in a sustainable manner.

Biodiversity

Strategic aim 4:

To ensure ecosystem health and resilience is monitored, protected and enhanced throughout the catchment.

By implementing the following objectives:

4.1 Encouraging the enhancement of indigenous habitat and associated species.

4.2 Encouraging the maintenance and enhancement of ecological networks to improve connectivity of habitat.

4.3 Prioritising the protection of threatened species of flora and fauna through effective and appropriate management.

4.4 Ensuring robust control and prevention of pest plant and pest animal species that could impact on catchment biodiversity values.

4.5 Ensuring pest/exotic fish management options are understood, and species (particularly koi carp and catfish) are controlled or eradicated through prioritised responses.

4.6 Recognising and understanding the biodiversity value and building ecosystem resilience of wetlands; and taking shared responsibility to uphold and meet obligations for the Whangamarino Wetland under the Ramsar convention.

Explanation

The Lake Waikare and Whangamarino Wetland catchment is highly modified and contains a variety of significant ecosystems – the most significant being the Ramsar designated Whangamarino Wetland. The remaining habitats are largely fragmented and small; the key to improving ecological health at the catchment scale is to establish comprehensive ecological networks to allow indigenous biodiversity to thrive, and to ensure that the ecological health of the catchment is maintained and, where possible, enhanced.

Economic, social and cultural values

Strategic aim 5:

To recognise and protect people's economic, social and cultural relationships with the Lake Waikare and Whangamarino Wetland catchment.

By implementing the following objectives:

5.1 Increasing cultural and community connectivity with the lake, wetland and other sites of significance, to enhance a sense of connection to place.

5.2 Ensuring all cultures and values within the catchment are recognised and respected.

5.3 Strengthening the diversified economy, social fabric and community relationships within the catchment, including agriculture as an integral part.

5.4 Ensuring taonga species are enhanced, accessible and sustained to ensure intergenerational preservation and future use.

5.5 Ensuring mātauranga Māori and tikanga are shared and part of decision making in natural resource use and restoration projects.

5.6 Acknowledging the recreational value placed on sports Fish & Game resources within the catchment.

5.7 Ensuring water quality and catchment enhancement projects consider aspirations for swimming, fishing, consumption and cultural and recreational values.

5.8 Ensuring nutrient, microbial pathogen and sediment inputs to waterbodies are maintained or reduced, with an aspiration that, over time, waterbodies become safe for swimming and the taking of kai.

5.9 Ensuring robust control and prevention of invasive plant and animal pest species that could impact on catchment economic, social and cultural values.

Explanation

People living in the catchment are reliant on its natural and physical resources for their social, economic, cultural and environmental wellbeing. Strategic aim 5 is seeking that the people and communities within the catchment are thriving and are actively involved in restoring the health and wellbeing of the Lake Waikare and Whangamarino Wetland catchment. The purpose of this aim is to encourage everyone living in the catchment to contribute positively to its overall social, economic, environmental and cultural wellbeing.

Strategic aim 5 also recognises that catchment management must acknowledge and take into account tāngata whenua and the wider community's environmental and social aspirations, as well as their historical, cultural, spiritual and customary connections with the catchment.

Tāngata whenua values are a collective understanding of the traditional and contemporary Maori world view which encompasses the cultural, spiritual, economic and environmental wellbeings of the iwi, hapū and whanau. Tāngata whenua is a common term relating to people of the land. In regard to iwi, hapū and whanau specific to a geographic area (rohe), tāngata whenua is replaced with mana whenua.

Mana whenua exercise their rangatiratanga, kaitiakitanga and manaakitanga responsibilities over their geographical area or rohe. Mātauranga Māori is a transferred body of oral and applied traditional knowledge which encompasses the Māori world view. The Māori world view is the holistic intergenerational relationship between Māori and the spiritual, physical and natural world.

6. Key issues and opportunities

This section provides a summary of the key catchment issues and opportunities (including those identified through the consultation process). These issues and opportunities have also been informed through a 'state of understanding' process where existing research and initiatives within the catchment were assessed and specific issues identified for each strategic aim identified in Section 6 below.

These issues and opportunities are not listed in any particular priority order.

Five management areas have been identified, as above, which the key issues and opportunities relate to. These management areas represent a predominant theme for the catchment, and the overall implementation of the CMP; with some issues and opportunities linking to a number of management areas.

The five management areas are further explained in Section 5 above, and include (in no particular priority order):

- CMP implementation
- water management (including quantity, quality and flood management)
- soil and land management
- biodiversity
- economic, social and cultural values.

In addition to the 'state of understanding' process, several maps were developed which assisted with identifying the key catchment issues and opportunities, listed below. These maps are included in the Maps section in this document for reference.

Map 10: Biodiversity terrestrial properties

Map 11: Overview of key catchment sites and assets

Map 12: Environmental monitoring sites

Map 13: Nitrogen generation score

Map 14: Phosphorus generation score

Map 15: Environmental and restoration projects

Map 16: Property land titles

Map 17: Erosion risk score

Map 18: Combined water quality score

Map 19: Waikato Regional Council recorded flood hazard

6.1 Catchment issues and opportunities

Catchment issues

Issue no.	Issue	Current state/problem description	Links with key management area(s)
I1	Increased terrestrial and aquatic animal pests.	Aquatic pests such as koi carp and catfish impact upon the indigenous biodiversity of the catchment, and also contribute to the resuspension of sediment within the lake. A framework for pest management and control has been developed to guide the delivery of actions over the next three years by Waikato Regional Council and DOC (Archer, et al., 2018)	Biodiversity Water quality Cultural values Social values
I2	Increased aquatic and terrestrial pest plant species.	Pest plants such as alligator weed and yellow flag iris impact on the indigenous biodiversity of the catchment by smothering indigenous vegetation. In 2009, NIWA undertook weed surveillance within the Whangamarino catchment (Bodmin, et al., 2009). In addition to alligator weed and yellow flag iris, there were a number of additional weeds designated as surveillance weeds in Whangamarino Wetland. These include alder, Manchurian wild rice, purple loosestrife, Senegal tea, tradescantia (also known as wandering willie), Japanese honeysuckle, Spanish heath, water celery, African feather grass, moth plant, mignonette vine, cathedral bells, blue morning glory and evergreen buckthorn.	Biodiversity Water quality Cultural values Social values
I3	Lack of data and information within the upper sub-catchments of the catchment area, including the source of sediment.	There is a general lack of data and information, particularly in relation to the key issues affecting headwater streams, the upper sub-catchments and areas of the catchment outside of Lake Waikare and Whangamarino Wetland (e.g. the effects of contaminants on lakes Ohinewai, Kopuera, Rotokawau and Penewaka Lagoon, as well as catchment streams).	CMP Implementation Land and soil Water quality Biodiversity Cultural values Water management Social values
I4	No measurable water quality targets set to guide catchment management.	Historically there have been no measurable water quality targets set to guide management of the lacustrine, stream and wetland receiving environments.	Water quality Land and soil
I5	Lower Waikato Waipā Flood Control Scheme (LWWFCS) operating levels.	Information presented during the LWWFCS Section 128 hearings for the operation of the Northern Outlet Control Gate (NOCG) has shown that there is uncertainty amongst experts regarding the interaction of the LWWFCS in terms of operating water levels and the effect that a change in water level has on the health of Lake Waikare and the Whangamarino Wetland.	Water management
I6	Importance of the water supply dams (and Waikato River) for Auckland water supply.	The Mangatangi dam, within the CMP catchment, covers an area of approximately 185 hectares and provides a capacity of 35.3 gigalitres for Auckland. This dam and other rainwater reservoir dams provide approximately 80 per cent of Auckland's water supply.	Water management
I7	Land drainage to create economic farming areas.	Historic land drainage has lowered water levels in the current recognised Whangamarino Wetland causing peat subsidence (in those areas of peat wetland) and changes to vegetation. Also links to issue I4.	Water management Biodiversity Water quality

Issue no.	Issue	Current state/problem description	Links with key management area(s)
I8	Unstable and erosion prone land in the upper catchments.	The Waikato Regional Council 2015 Prioritisation Study identified that upper Matahuru and upper Waerenga catchments are within the top 10 priority catchments for soil conservation. A study was undertaken in 2011 which evaluated 482 (1ha) samples from the year 2002 and 500 (1ha) samples for the year 2007. Sixty-five per cent of the 2007 samples and 62 per cent of the 2002 sample points were identified as unstable (historic erosion, freshly vegetated or active erosion) (Taylor, 2016)	Land and soil
I9	Accelerated stream channel erosion from increased stormwater peak flow rates.	Clearance of native bush and conversion to pasture can alter catchment hydrology and increase the volume and rate at which stormwater runs off the land (changes the hydrological regime). This in turn leads to accelerated stream channel erosion in small headwater streams and subsequent deposition of these sediments in lower catchment areas. Stream bank erosion in flood plain locations (alluvium) are also recorded. Refer to Map.	Land and soil Water quality
I10	Sediment deposition in the lower catchment areas of Lake Waikare and Whangamarino Wetland.	A study undertaken by NIWA (Gibbs, 2009) investigated the likely sources of sediment in the Whangamarino Wetland and found that the steep hill country of the Hapuakohe Range at the headwaters of Whangamarino River was one of the three main sources. In addition, accelerated stream channel erosion, and unstable and erosion prone land primarily driven by land use change and agricultural practices, increase the sediment loads of headwater streams for deposition in lower catchment areas. Also, water flowing from Lake Waikare during flood events is known to contribute downstream sediment.	Land and soil Water quality
I11	Peat subsidence.	Ongoing peat subsidence leads to drainage issues, results in carbon loss through oxidation and can impact on agricultural productivity.	Land and soil
I12	Threats to the economic and environmental viability of agricultural land uses.	In 2015, the economic value-added by land protected in the Whangamarino sub-catchment was estimated to be $157 million (based on current prices and value-added multipliers, or about 0.7 per cent of Waikato gross domestic product). This does not include the non-market values within the catchment (e.g. from recreational use, biodiversity, etc). These values can be very high, e.g. in a meta-analysis study published in 2012, the value derived from wetlands was estimated to be approximately $66,000 per hectare per year. The issues identified in this table, along with potential future options for management, could be inconsistent with current agricultural production-focused land uses in parts of the catchment. These threats to the status quo result from competing catchment values, as well as risks to land from existing and future flooding, as well as stream erosion and land instability.	Land and soil Biodiversity Water quality Water management Cultural values Social values
I13	Intensified land use, and land use changes.	Intensified land use and land use changes, particularly for agricultural activities, have impacted on a range of values within the catchment. An example of this is the change in land use from forested catchments to agriculture in the upper Matahuru and upper Waerenga catchments, which has resulted in an increase in sediment discharges to water (Waikato Regional Council , 2015).	Land and soil Biodiversity Water quality Water management Cultural values Social values
I14	Effects on the receiving environment as a result of urban growth.	Significant growth is planned for Te Kauwhata. Stormwater and wastewater discharges from new urban areas could lead to increased water quality and water quantity effects on the receiving environment.	Land and soil Water quality Biodiversity

Issue no.	Issue	Current state/problem description	Links with key management area(s)
			Social values Cultural values
I15	Land contamination.	Information suggests that contamination issues from historical horticultural and agricultural activities (sheep dips and agrichemicals), lead buck shot and mining activities may exist; and nutrients and sediment from farms which abut wetlands/feeder/headwater streams. There is knowledge that some contaminants transfer via sediment attachment.	Land and soil Water quality Biodiversity Cultural values
I16	Decreased habitat for eel (tuna).	Habitat for eel (tuna) has been greatly impacted by land use, water quality issues and the increase of pest fish (e.g. koi carp) within the catchment, leading to a decline in eel numbers.	Biodiversity Cultural values
I17	Further fragmentation of indigenous vegetation and associated impacts on both flora and fauna.	Land use changes have led to a further fragmentation, conversion/changes to species assemblages or complete loss of indigenous vegetation such as forest or wetland fragments, with associated impacts on flora and fauna and community structures.	Biodiversity Land and soil
I18	Livestock access to waterways and remnant indigenous ecosystems.	Pastoral land use in the catchment has led to livestock grazing and access to waterway, wetlands and remnant indigenous ecosystems. Where waterways and ecosystems are unfenced, this has impacted on a number of values in the catchment.	Biodiversity Land and soil Water quality Cultural values Social values
I19	The lack of macrophyte growth in Lake Waikare.	Macrophyte growth requires a suitable light climate for aquatic plant growth. Light attenuating sediments, turbidity and resuspension within Lake Waikare (due to wave action and the shallowness of the lake) all reduce light within the water column, making macrophyte growth difficult.	Water quality
I20	'Blackwater' DO events within Lake Waikare, and some of its tributaries.	Heavy rainfall generated by cyclones Debbie and Cook in March and April 2017 caused major flooding in the Waikato region and dissolved oxygen flat-lined at 0 per cent saturation for long periods (>7 weeks at some sites), leading to 'blackwater events'. The sensors revealed the extent and duration of these blackwater events which ultimately resulted in widespread mortality of tolerant native and invasive fish. Blackwater events are caused when water inundates a flood plain and picks up carbon from the land (from plants, effluent, crops, etc). This large input of carbon break downs and leaches into the water, turning it black. Concurrently, the breakdown of this carbon by bacteria consumes oxygen and can quickly reduce the oxygen to extremely low levels. Blackwater events are natural occurrences; however, flood protection schemes can intensify the effects of these events, leading to longer durations of low oxygen sags due to the altered hydrology. In addition, the loss of the natural vegetation (trees and wetland), together with drain ditches, can streamline the transport of high nutrient water and carbon. Pump stations are necessary in these schemes to pump the standing water and blackwater backups. As peat subsidence continues, and with climate change, we can assume that these periods of low dissolved oxygen conditions may increase in the future.	Water quality

Issue no.	Issue	Current state/problem description	Links with key management area(s)
I21	Discharge of sediments and nutrients, and high E.coli levels.	The discharge of sediments, nutrients and E.coli has led to water quality within the catchment being extremely degraded (particularly in Lake Waikare and Whangamarino wetland). Water quality in Lake Waikare, based on the annual chlorophyll-a, cyanobacteria, annual total nitrogen median and annual total phosphorus median, is severely non-compliant with the National Policy Statement for Freshwater Management (2017) over the entire evaluation period (1997-2016). All four attribute states are well within the D band (i.e. below the national bottom line). Median total nitrogen and chlorophyll-a concentrations have increased substantially and rapidly over the last 19 years, showing that water quality in the lake is deteriorating at an alarming rate.	Water quality
I22	The shallow bathymetry and large size of Lake Waikare.	The bathymetry and size of Lake Waikare is an obstacle to restoration as it is a large, shallow lake. This means the lake is prone to wind-wave fetch causing resuspension of sediments and reduced light within the water column.	Water quality
I23	High algal levels in Lake Waikare (algal NOF band rating of D).	As for Issue I21.	Water quality
I24	Resuspension of sediment in Lake Waikare.	As for Issues I1 and I22.	Water quality
I25	Water allocation an emerging issue.	General water allocation rights for the community, including iwi rights and interests to fresh water, is a significant issue to consider within the Waikato region and lower Waikato. Iwi have identified that Te Mana o te Wai (the power and prestige of water) is the priority, and tools to achieve this include an allocation of fresh water to iwi for their specific purposes, included providing for their economic, social, environmental and cultural values. The catchment provides water to locals, for farming and cropping and to urban areas (including Auckland). Water is diverted to support maintaining peat near Motukaraka and Whangamarino Wetland.	Water management Cultural values
I26	Existing threats to ecosystem services, social and recreational values in the catchment (such as duck hunting, kayaking, etc.).	The economic value of the Whangamarino Wetland was estimated at approximately NZ$18.6 million (in 2015 terms) (Waikato Regional Council , 2016), the majority of which was non-use value. The wetland provides for carbon storage and a range of ecosystem services, the most significant of which are biodiversity and flood protection. It also provides recreational values for hunters and kayakers. Issues identified in this table (such as Issues I10-I14 and Issues I16-I22) threaten this economic, social and recreational value of the wetland. Whilst not quantified, similar threats to Lake Waikare and other freshwater resources in the catchment are likely to exist, albeit at a smaller scale.	Social values
I27	Limited access to the lakes, wetland and other significant sites.	People are disconnected from the streams, lakes and wetlands to enable social and cultural activities and practices from being undertaken.	Social values Cultural values

Issue no.	Issue	Current state/problem description	Links with key management area(s)
I28	Existing threats to the mauri of water, cultural values and how future options could impact on waahi tapu.	Lake Waikare, Whangamarino and the surrounding lands are of high cultural significance to iwi, hapū and marae. The diminished soil and water quality has impacted the relationship between the people and its natural resources. Subsequently, the mauri, or life essence, of the area has declined. This limits the ability of the waters to create and sustain all the living things reliant on these taonga taiao (natural treasures). The waters have not died, but much is required to improve the mauri of these taonga. These taonga also hold sacred sites, important to iwi, hapū and marae. Future works to improve the mauri of the waters must consider and weigh the possible impacts on waahi tapu.	Cultural values
I29	Biosecurity threats to catchment values	The biosecurity threat to the catchment is real. Alligator weed, velvetleaf and *Mycoplasma bovis* are examples of pests and diseases which reduce crop growing capability, pastoral agriculture, irrigation and recreation. The impact of pests and diseases like these may mean that landowners will be forced to change land use or may need to change the way they manage the land.	Economic values Social values Cultural values Land and soil Water quality Water management Biodiversity
I30	CMP implementation	There is a need to ensure there is a robust and effective monitoring programme, resourcing, funding and priority for CMP implementation. This includes ability to build on community capacity and the ability to provide educational initiatives as part of the implementation programme.	CMP implementation

Catchment opportunities

Opp'ty no.	Opportunity	Current state/problem description	Links with key management area(s)
O1	Development of a strategic pest plant management plan.	Develop a catchment specific pest plant management plan to complement existing pest plant management regimes, and to ensure a coordinated approach is undertaken to pest plant management and funding.	Biodiversity Social values Cultural values Land and soil Water quality Water management
O2	Development of a strategic animal pest management plan.	Develop a catchment specific animal pest management plan to complement existing animal pest management regimes, and to ensure a coordinated approach is undertaken to animal pest management and funding. A framework for pest management and control has been developed to guide the delivery of actions over the next three years by Waikato Regional Council and DOC (Archer, et al., 2018).	Biodiversity
O3	Review of ICM river management and land drainage activities.	A review of ICM activities, including an economic analysis of the current LWWFCS levels of service vs. alternative options and the development of a catchment hydrological model to better understand how the LWWFCS operates and how changes in the scheme can affect water levels in the lake and wetland.	Land and soil Water quality Water management

Opp'ty no.	Opportunity	Current state/problem description	Links with key management area(s)
O4	Development of pilot sites for demonstration, trial and educational purposes within the catchment.	Implementing pilot sites within the catchment to demonstrate best practice catchment management, which will assist with information and data collection, and continued community education regarding effects of land use and resources.	Land and soil Water quality Biodiversity Social values Cultural values CMP implementation
O5	Implementing basic catchment management works.	Implement basic catchment management works (e.g. fencing, soil conservation works and planting/riparian planting programmes) in areas identified as high risk/high priority; and in a progressive manner from the upper catchments towards the lower catchments.	Land and soil Water quality Biodiversity Social values Cultural values
O6	Economic analysis of alternative land uses.	As there are threats to the economic viability of traditional agricultural land uses, an economic analysis of alternative land uses (e.g. mānuka planting, etc) will assist in decision making for matching land use with the land suitability within the catchment.	Land and soil Water quality Biodiversity Social values
O7	Investigate merits of constructed wetlands.	Constructed wetlands can treat sediment and nutrients. Investigate whether constructed wetlands are feasible within this catchment, and/or the enhancement of existing wetlands.	Land and soil Water quality Biodiversity
O8	Development of a Watercourse Management Framework.	The development of a Watercourse Management Framework for headwater streams to holistically set out a plan for progressive catchment works and deal with erosion, contaminants and pest plant issues.	Land and soil Water quality Biodiversity
O9	Consideration of land use options (to ensure land use matches land suitability) in particular the upper catchment location.	Areas of the upper catchment which are unstable, erosion prone and/or is currently unsustainable for its current land use (e.g. dairy farming). Alternative land use to be considered.	Land and soil Water quality Biodiversity
O10	Identify existing key areas for high priority protection and/or enhancement.	Identify key areas for high priority protection/enhancement (e.g. spawning or nesting areas, streams/lakes where water quality is salvageable, high value existing habitat). The following large biodiversity targets (>100ha) within the Lake Waikare and Whangamarino Wetland catchments have been identified: - Whangamarino Wetland - Mangatangi – extensive stands of kauri-podocarp-broadleaved-beech forest - Kohukohunui – tawa kohekohe forest and rimu-tawa forest - Pouraurewera Stream (Mangatawhiri) – kauri-podocarp-broadleaved-beech forest - Hapuakohe Range (southwestern) – kauri-podocarp-broadleaved-beech forest - Ohinewai wetlands The following areas have been identified within the top 10 biodiversity priorities (greater than 5ha in size) for the Waikato Region.	Land and soil Water quality Biodiversity Social values Cultural values

Opp'ty no.	Opportunity	Current state/problem description	Links with key management area(s)
		- Upper Mangatawhiri – Taraire-tawa-podocarp forest - Matahuru – Kauri-podocarp-broadleaved forest	
O11	Offsite mitigation options.	Where values cannot be maintained, explore the potential for offsite mitigation options within the catchment to ensure other areas are maintained, enhanced and/or protected.	Land and soil Water quality Biodiversity Social values Cultural values
O12	Focused sub-catchment management.	Determine whether any lakes/wetlands/headwaters in the catchment has the potential for a focused catchment management regime at a reduced scale to promote improved catchment management and to monitor improvements of water quality and other values. This can also be linked with the pilot sites for educational purposes.	Water quality Biodiversity Land and soil Cultural values
O13	Investigate contaminant inputs in all lacustrine and freshwater receiving environments.	Undertake a 'whole of catchment' approach to investigating and understanding contaminant inputs causing degraded water quality in all lacustrine and freshwater receiving environments.	Water quality Land and soil
O14	Utilisation of parallel technical processes/projects/data.	There are several technical processes and projects occurring in parallel to the development and implementation of this CMP. This information and data will assist with informing (supporting or discounting) future actions and technical work in relation to catchment management. Examples of technical processes/projects include (but are not limited to): - technical work undertaken by the regional council's Science and Strategy Directorate - technical work in relation to the Northern Outlet Control Gate and the Lower Waikato Waipā Flood Control Scheme (s.128 review process) - Waikato and Waipā River Restoration Strategy.	Water management
O15	Existing water take review.	Review of existing water takes within the catchment, to analyse what the catchment can sustain into the future with regards to water abstraction and how that impacts upon other catchment resources.	Water management
O16	Growing New Zealand and Waikato tourism market.	An opportunity to showcase Whangamarino Wetland (and other significant sites within the catchment), which may lead to additional funding sources/resources.	Social values
O17	Develop an understanding of the catchment ecosystem services potential.	The catchment ecosystem services potential can be linked to the economic analysis of farmland as well as economic value of the receiving environments.	Social values
O18	Develop areas for better access or connectivity to and interaction with streams, lakes and wetlands in the catchment.	Supporting projects/initiatives which allow the general public to have better access to and interaction with the freshwater environment. For example, developing eco-reserve areas, creating boardwalks or walkways, and facilitating access points to the freshwater environment.	Social values Cultural values
O19	Identify key cultural sites for enhancement and protection.	With the support of the marae, significant sites should be appropriately managed with the approval of marae and landowners. Sites may be protected, enhanced or celebrated for public awareness.	Cultural values

Opp'ty no.	Opportunity	Current state/problem description	Links with key management area(s)
O20	Statutory requirements related to water quality (and other) targets.	Historically, there have been no measurable water quality targets set to guide management of the lacustrine, stream and wetland receiving environments. There is an opportunity to use regulatory processes, such as Healthy Rivers PC1 or the outcomes from other statutory or policy processes, to set measurable and achievable water quality targets for all freshwater resources in the catchment.	Water quality
O21	Development of an 'On Farm Biosecurity' strategic plan.	Develop a catchment specific 'On Farm Biosecurity' strategy to complement existing regional regimes, and to ensure a coordinated approach is undertaken to biosecurity management and funding. The opportunity is to undertake this strategic plan alongside the Regional Pest Management Plan review.	Social values Cultural values Land and soil Water quality Water management Biodiversity
O22	Engagement with the Te Kauwhata Wastewater Treatment Consultation Group (TKWTCG) regarding Lake Waikare information and environmental enhancement/restoration initiatives.	Waikato District Council holds the resource consent in relation to the Te Kauwhata wastewater discharge into Lake Waikare. As a requirement of the resource consent, TKWTCG consists of several representatives interested in this discharge and the receiving environment. There is potential to engage with this group to share information, initiatives and funding/resourcing.	Social values Cultural values Water quality Water management

7. Monitoring and review

Ongoing monitoring and review of the CMP is a vital component of the catchment management process. Under the management of the governance structure, reviews at appropriate timescales have been recommended to ensure that all partners and participants concerned with the implementation activities are involved as appropriate.

The monitoring and review process is described below.

7.1 Monitoring and results

Monitoring of the CMP objectives and the progress towards the overall CMP purpose will be ongoing, and will focus on the following key aspects:

- Environmental outcomes demonstrating the effectiveness, or otherwise, of the implementation of this CMP. This will, where possible, coincide with existing environmental monitoring programmes within the catchment (e.g. those undertaken by Waikato Regional Council's Science and Strategy Directorate and the Department of Conservation); and will take into account the findings of the technical projects and processes which have been identified in the action plan.
- Consideration and inclusion of any new information and/or changes (such as shifting economic, policy, statutory and physical pressures).
- The completion of the actions identified within the action plan to measure the degree of uptake and success of this CMP.

The results of this monitoring will be reported annually to the governance structure of the CMP. The annual monitoring reports will be used to inform the reviews of the CMP.

7.2 Annual works programmes

The development of a catchment annual works programme is proposed. The purpose of the annual works programme is to review the action plan priorities against the required resourcing (e.g. funding and labour) and partnerships. This will help to ensure the action plan is delivered upon in accordance with the identified priorities. Importantly, the regional council will develop work plans (three-year and annual) stating what it will undertake to achieve over the following period. This is illustrated in Figure 7 below.

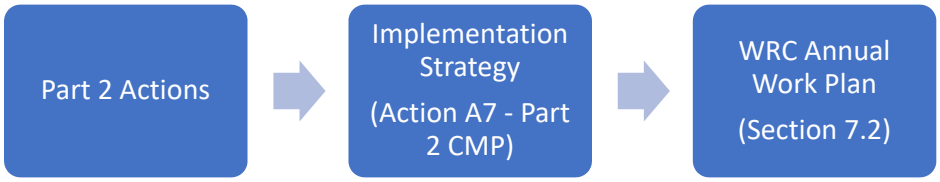


Figure 7: Annual work programme process

The development of the annual works programme will take into account the results of the monitoring undertaken and will ensure implementation is dynamic and responsive to these environmental outcomes and also any outcomes as a result of the CMP review process.

7.3 Reviews

It is anticipated that Part One of the CMP is unlikely to change remarkably over the short-medium term, therefore, it is recommended to review the full CMP (including both Part One and Part Two of the CMP) every 10 years (i.e. commencing in the 2026/27 financial year). This will allow for updated knowledge on the identified management areas (e.g. water management), catchment state and any statutory/policy changes to be fully captured within the updated CMP document and Waikato Regional Council's 2027-2028 Long Term Plan (LTP).

For Part Two, the implementation actions presented in this CMP are not set in stone. As some actions are achieved, others will be changing (due to new information and/or other changes), ensuring a truly responsive and dynamic process. This process is summarised in Figure 8 below.

It is recommended to undertake a review of Part Two every three years, to be timed with the Waikato Regional Council's LTP review process, commencing in the 2020/21 financial year.

The review of the CMP will focus on the following key aspects:

- The results of environmental monitoring.
- Any new information and/or changes (such as shifting economic, policy, statutory and physical pressures).
- Priorities within the action plan are re-examined.
- Additional actions (or any changes) are included where appropriate.
- Key funding requirements are identified.

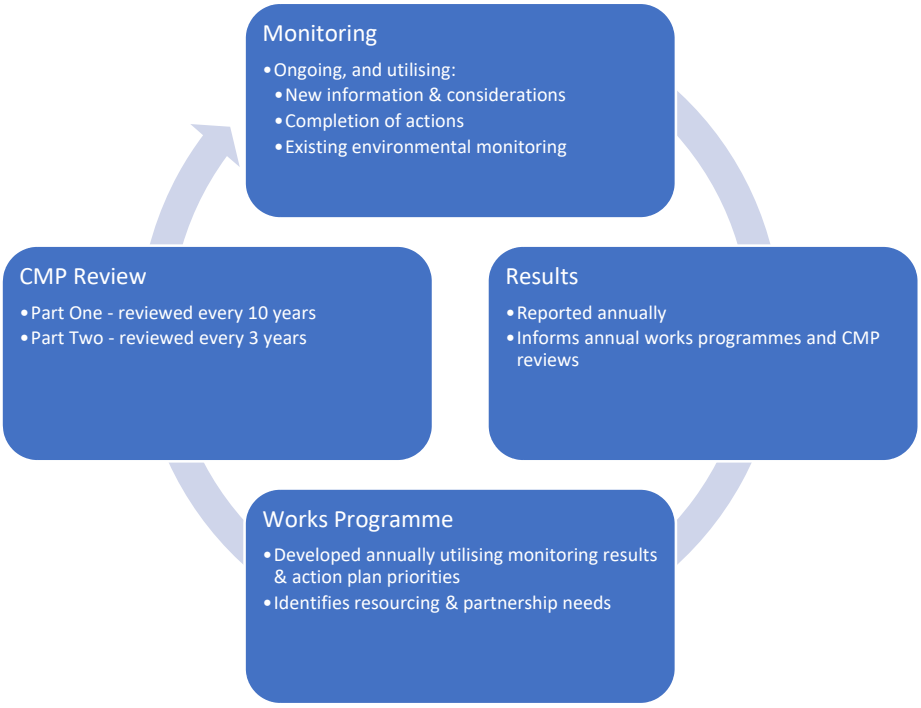


Figure 8: CMP monitoring and review process

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Maps

A full size of the maps referred to with Part One of the CMP are as follows:

Map 1: CMP catchment area

Map 2: CMP cultural and archaeological sites

Map 3: CMP sub-catchments

Map 4: Government and council owned/administered land

Map 5: CMP AgriBase land use activities

Map 6: CMP key assets and infrastructure

Map 7: CMP flood protection assets

Map 8: CMP land drainage districts

Map 9: Healthy Rivers: Plan for change priority catchments.

Map 10: Biodiversity terrestrial properties

Map 11: Overview of key catchment sites and assets

Map 12: Environmental monitoring sites

Map 13: Nitrogen generation score

Map 14: Phosphorus generation score

Map 15: Environmental and restoration projects

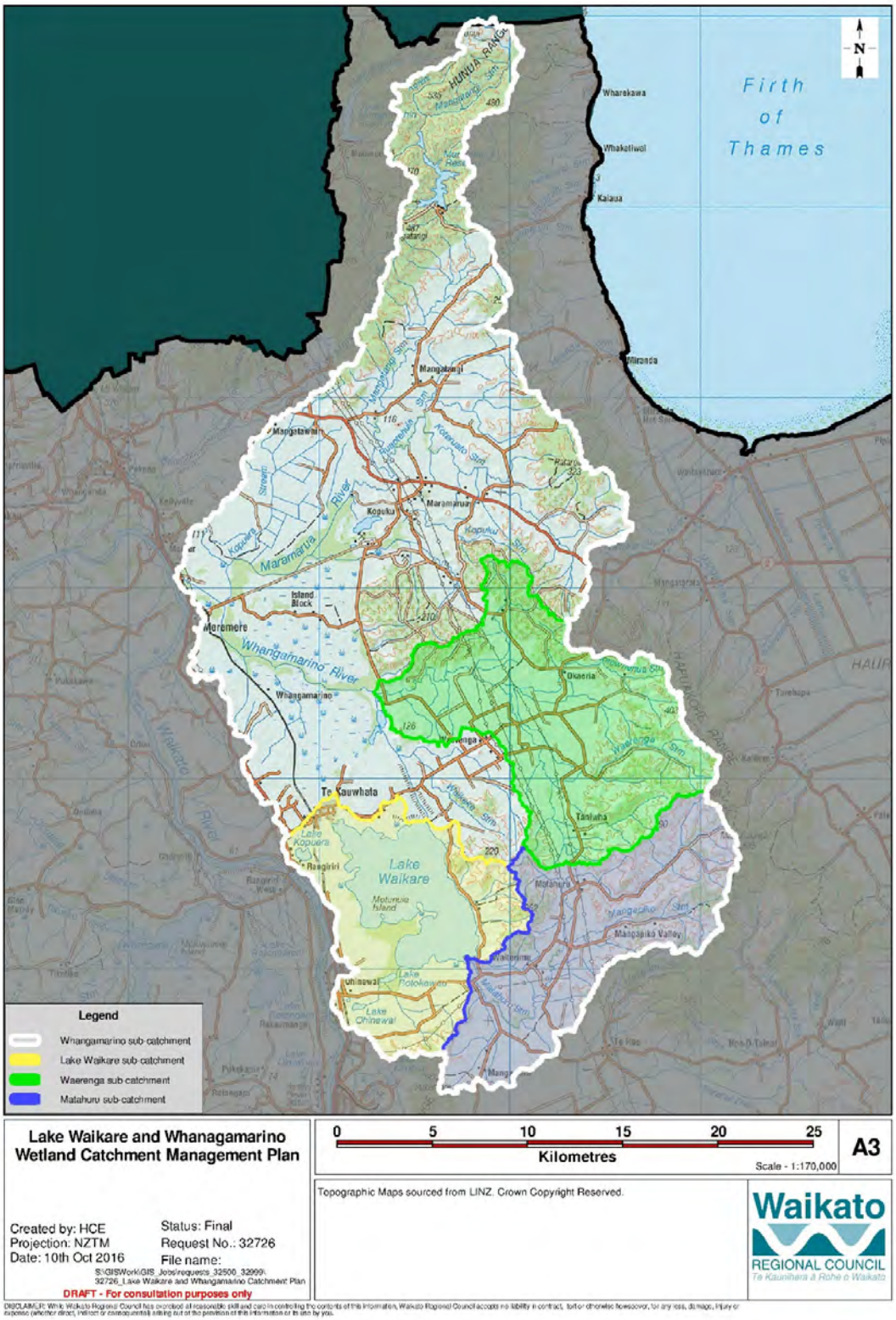
Map 16: Property land titles

Map 17: Erosion risk score

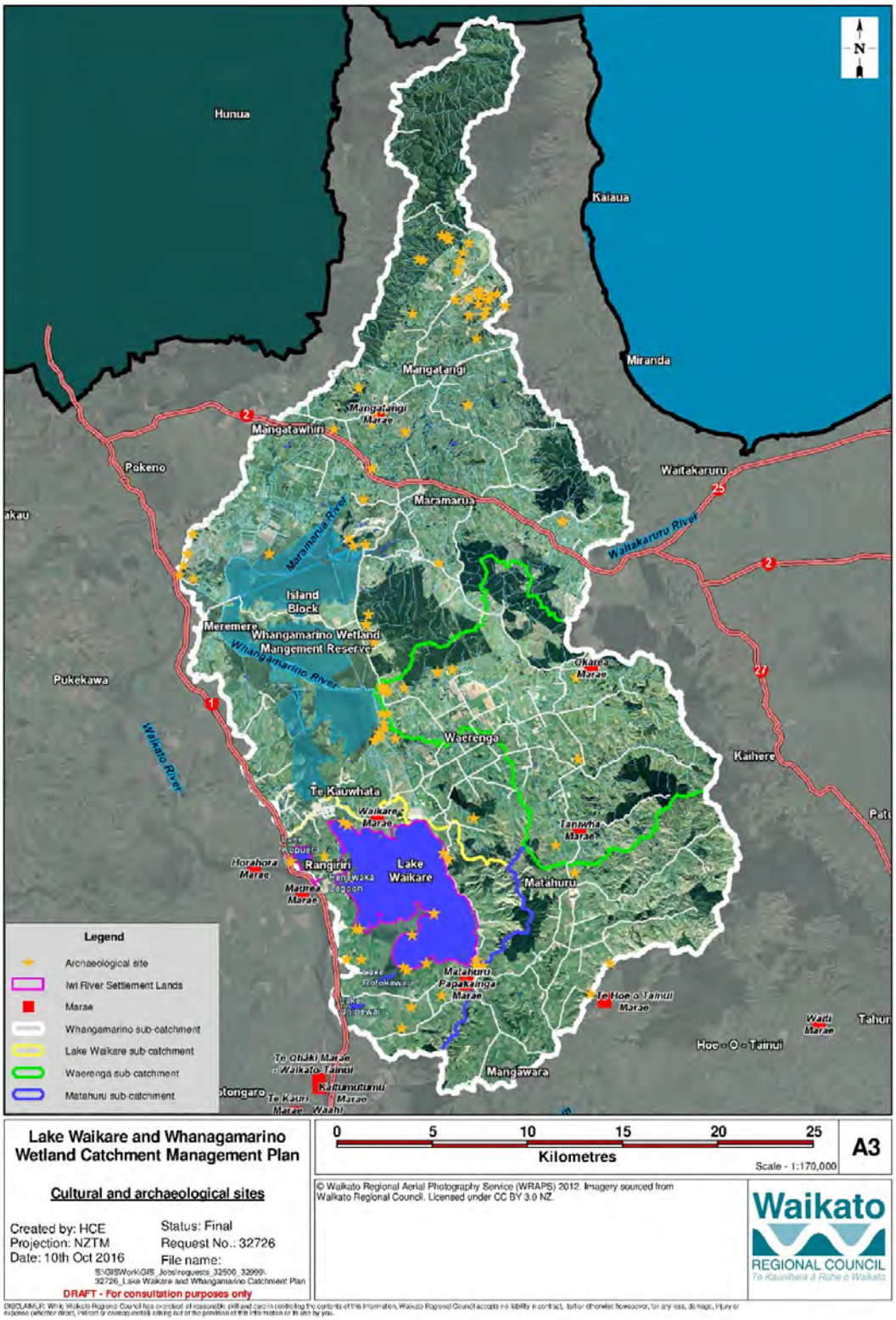
Map 18: Combined water quality score

Map 19: Waikato Regional Council recorded flood hazard

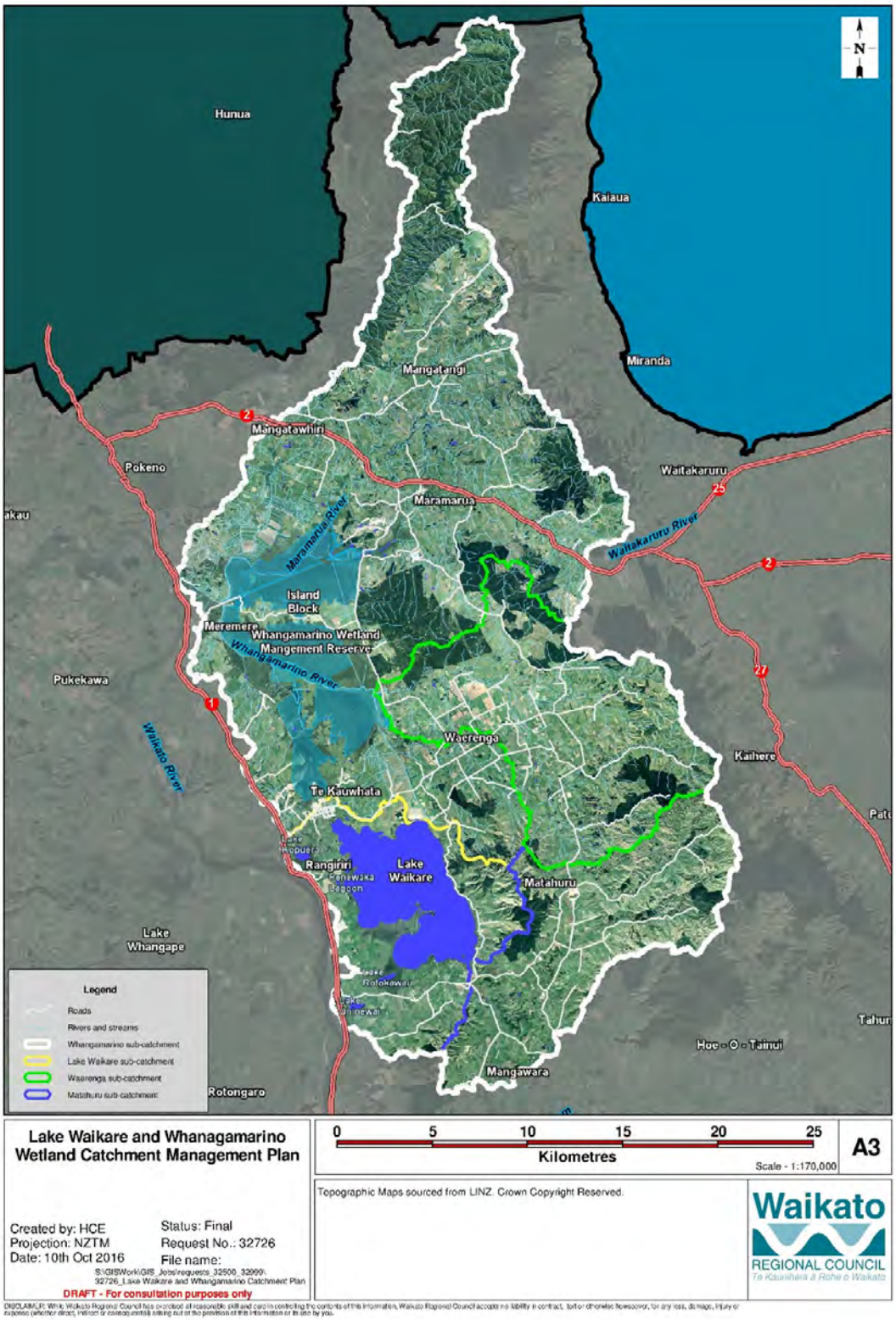
Map 1: CMP Catchment Area



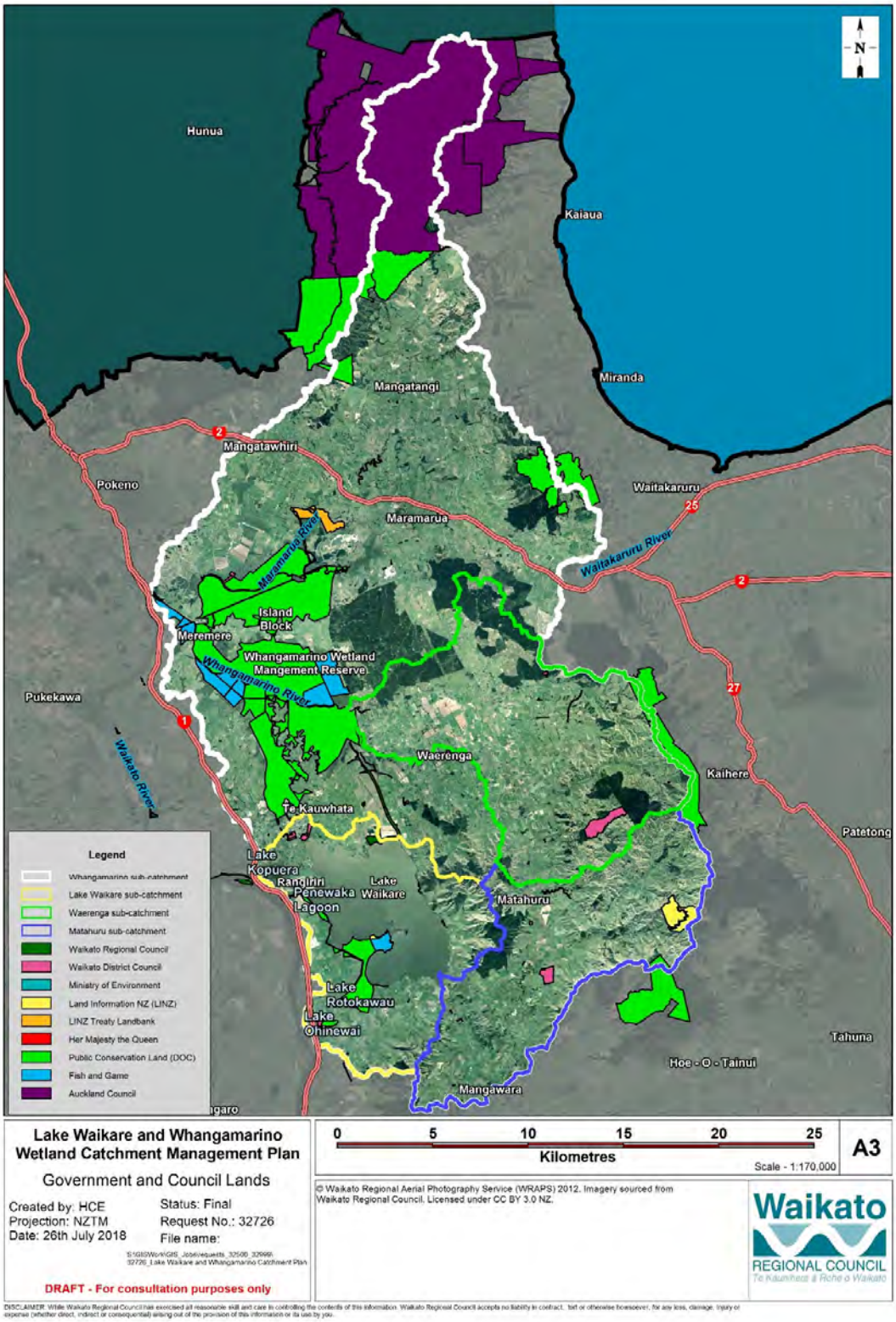
Map 2: CMP cultural and archaeological sites



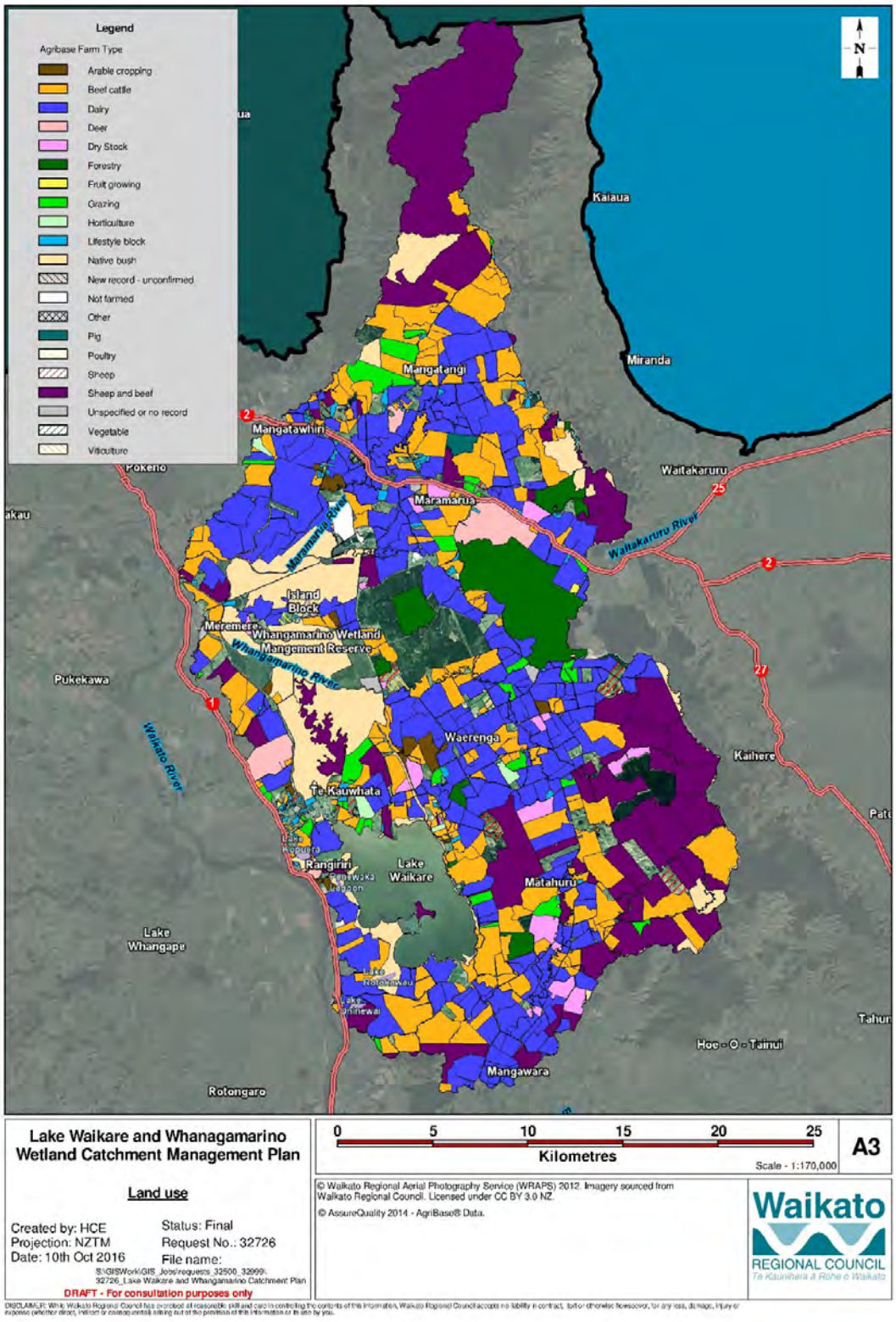
Map 3: CMP sub-catchments



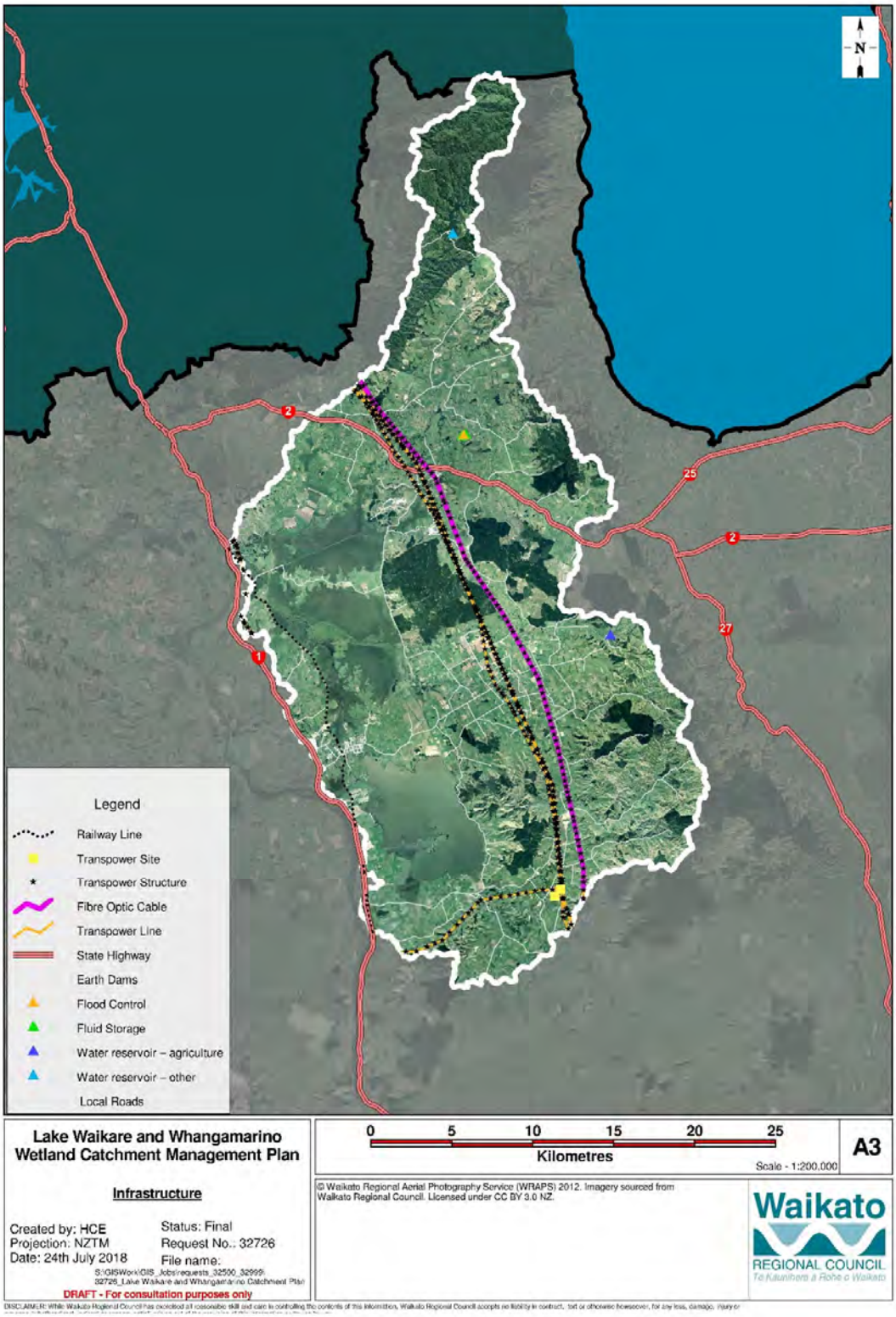
Map 4: Government and council owned/administered land



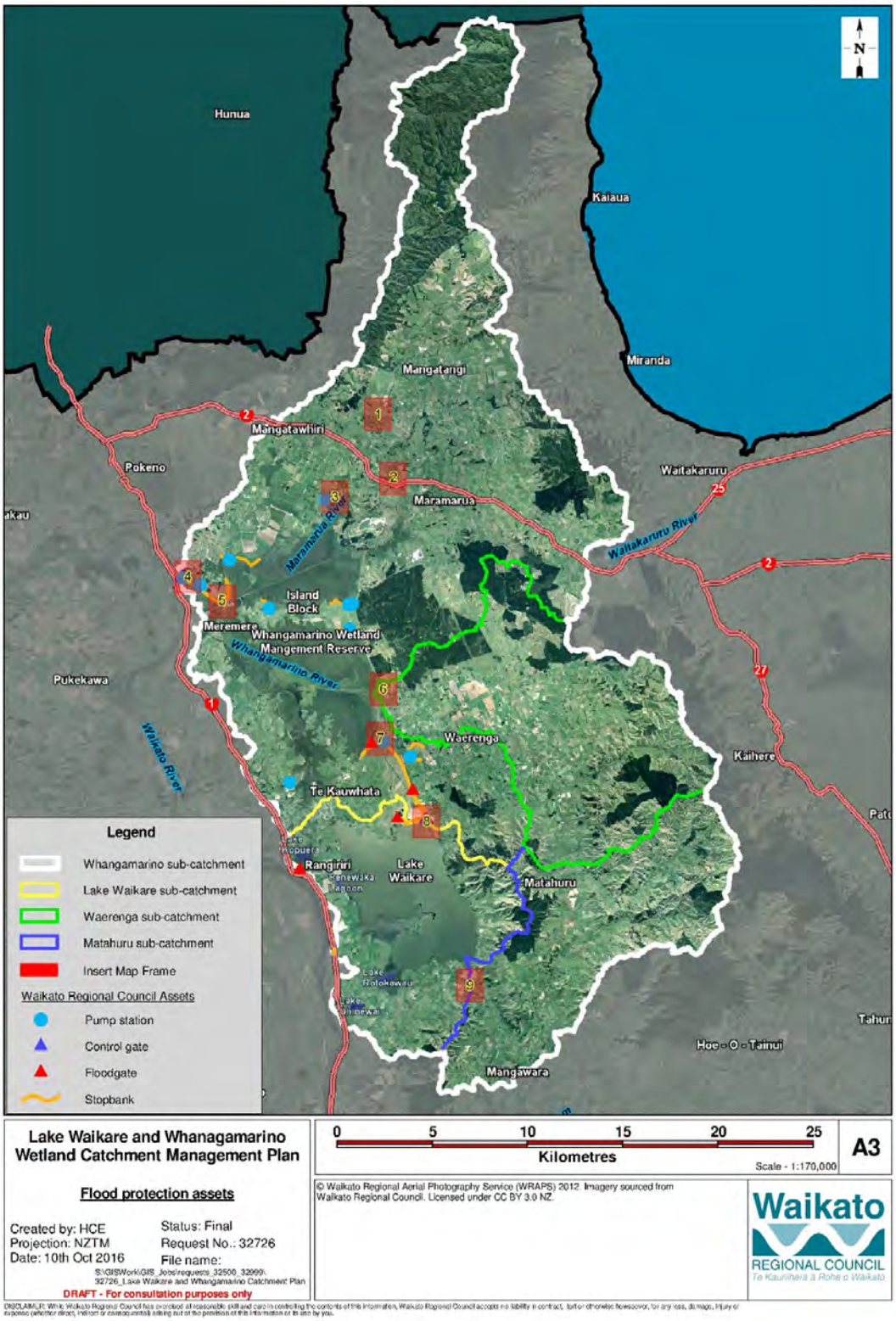
Map 5: CMP AgriBase land use activities



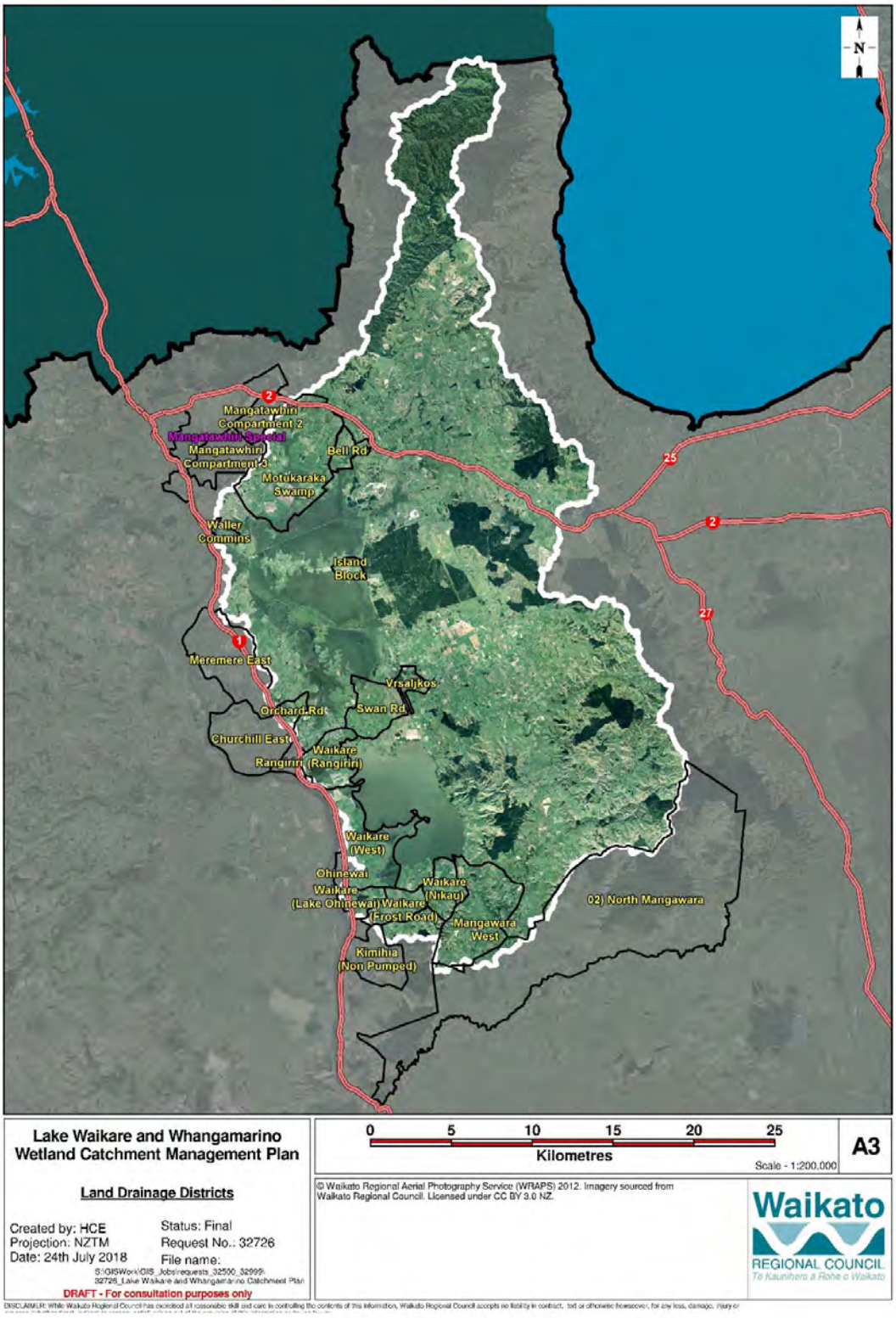
Map 6: CMP key assets and infrastructure



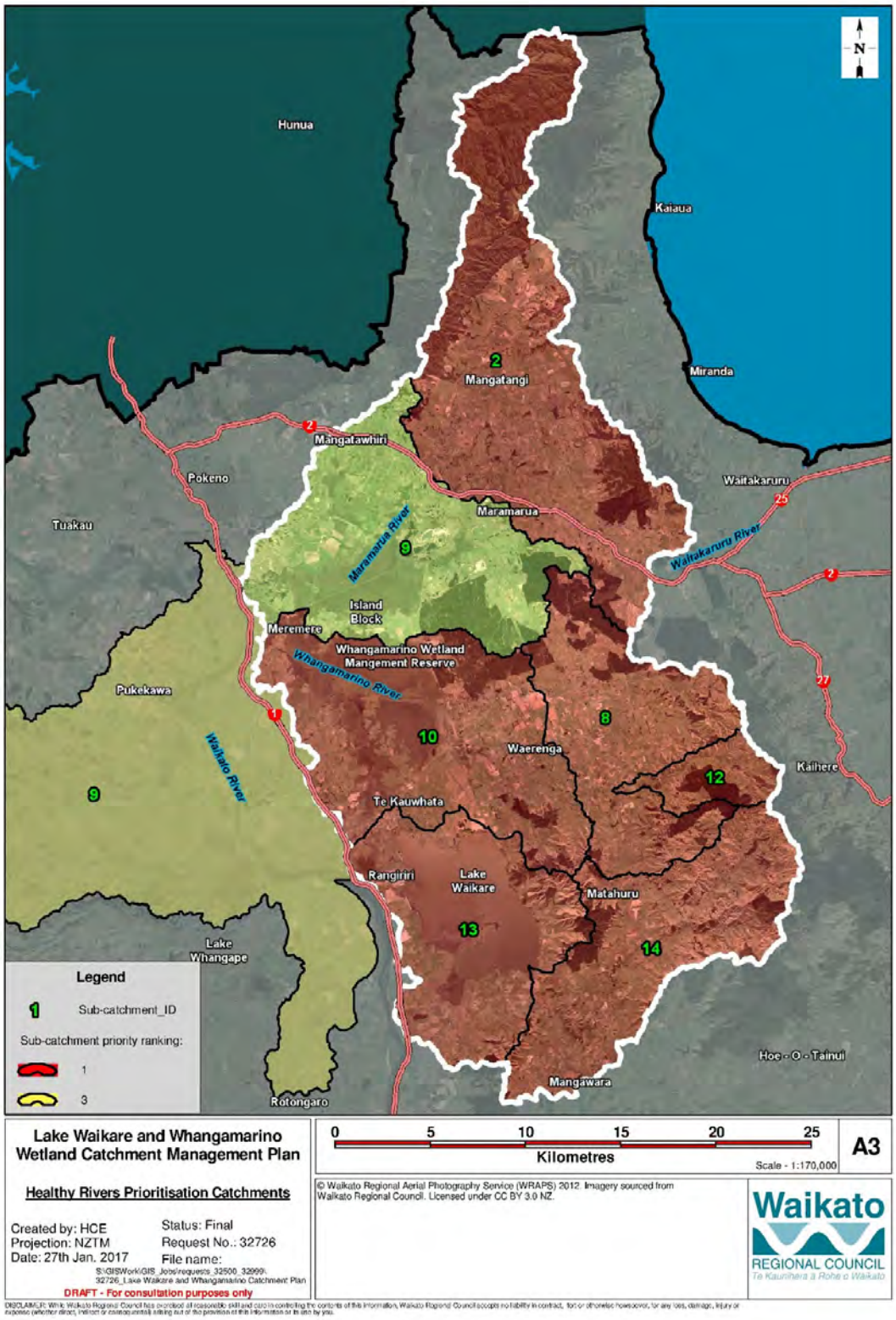
Map 7: CMP flood protection assets



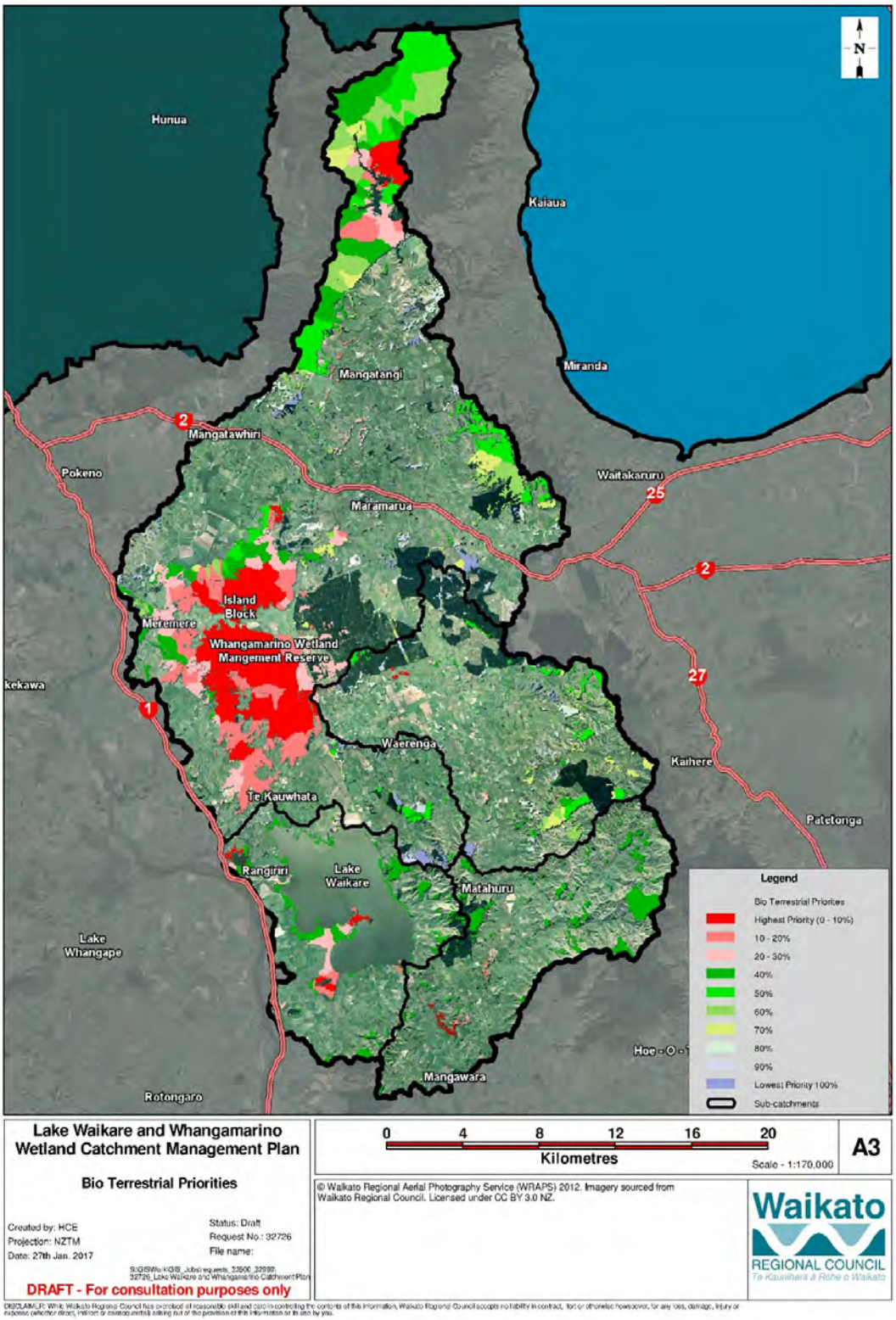
Map 8: CMP land drainage districts



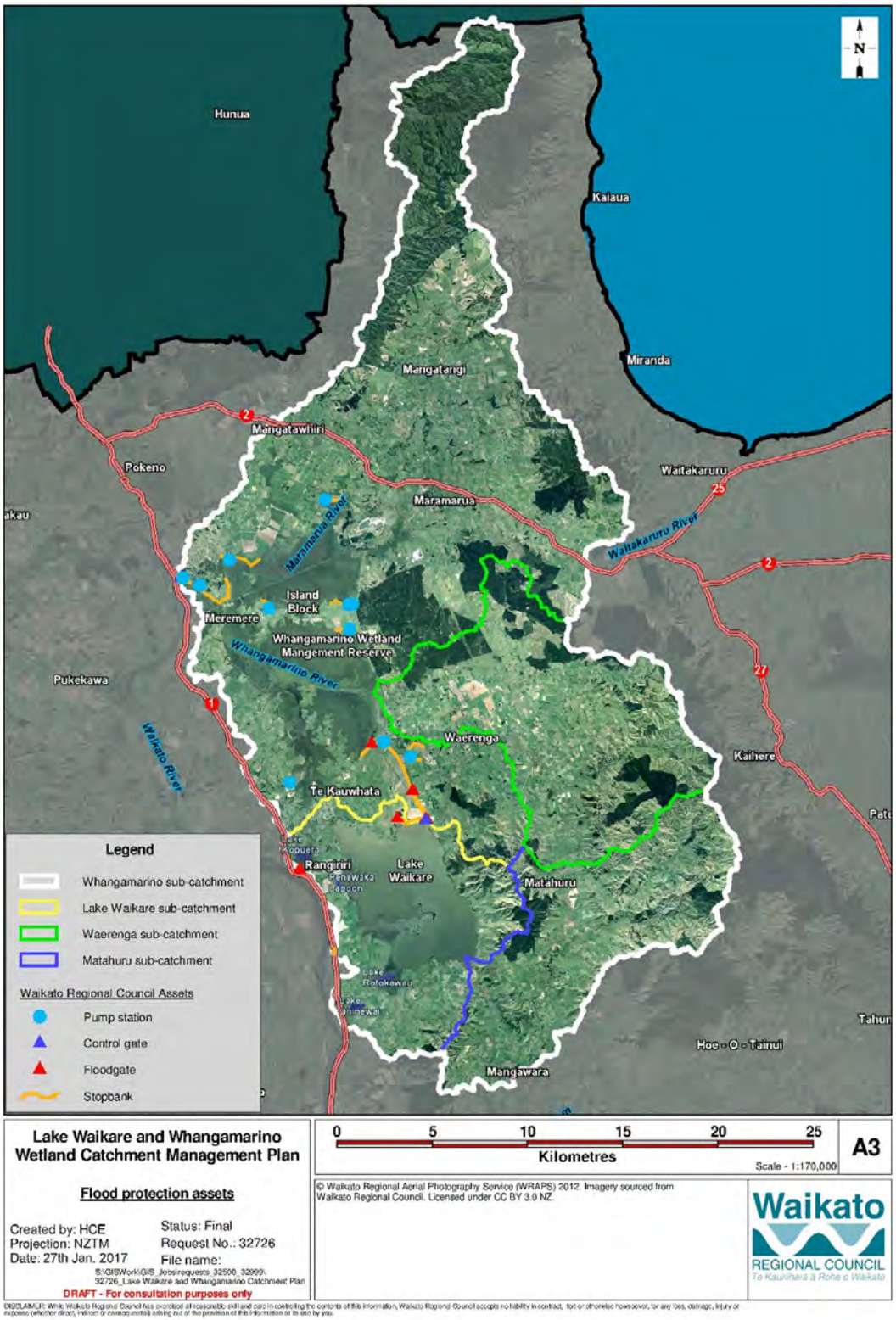
Map 9: Healthy Rivers/Wai Ora: Plan for change priority catchments



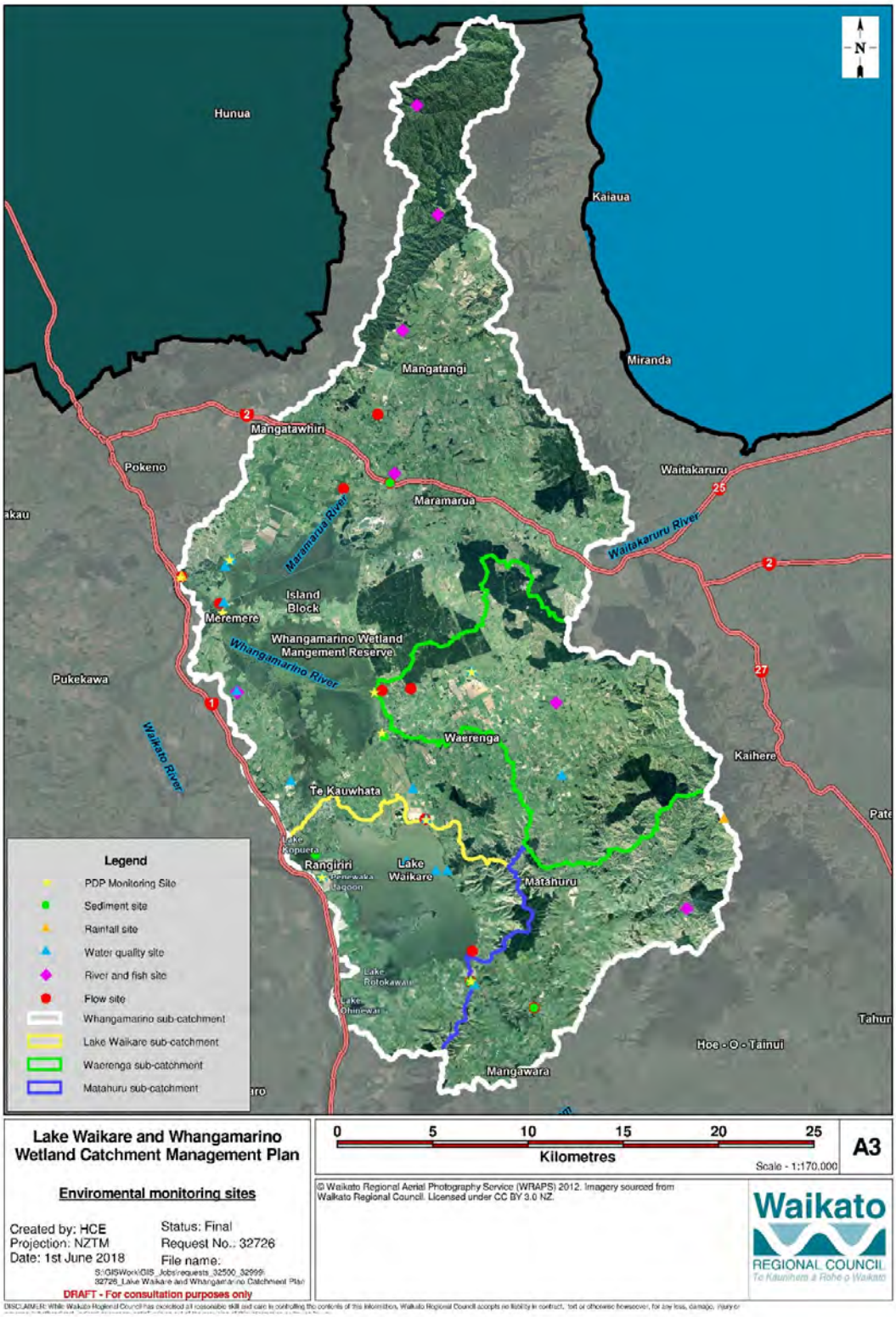
Map 10: Biodiversity terrestrial properties



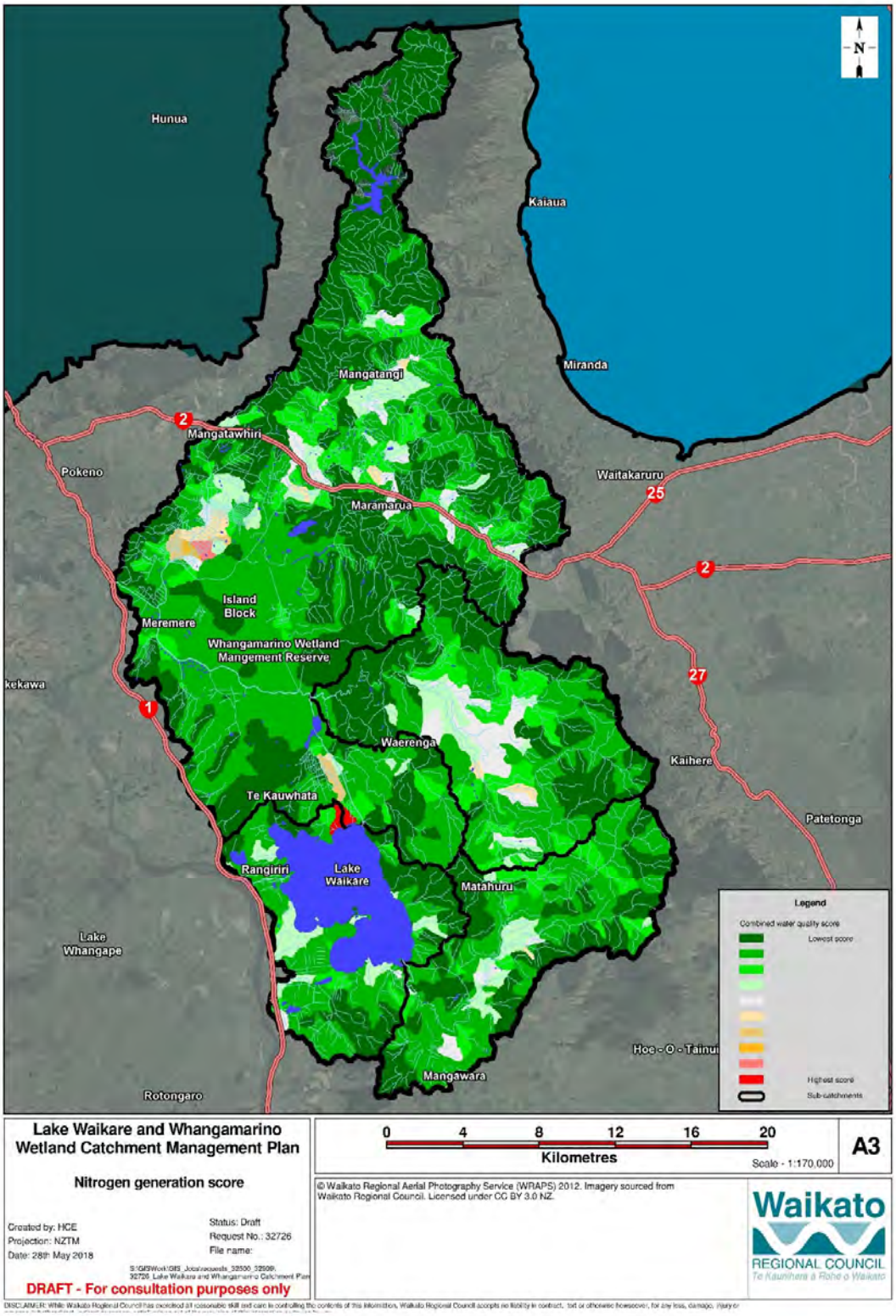
Map 11: Overview of key catchment sites and assets



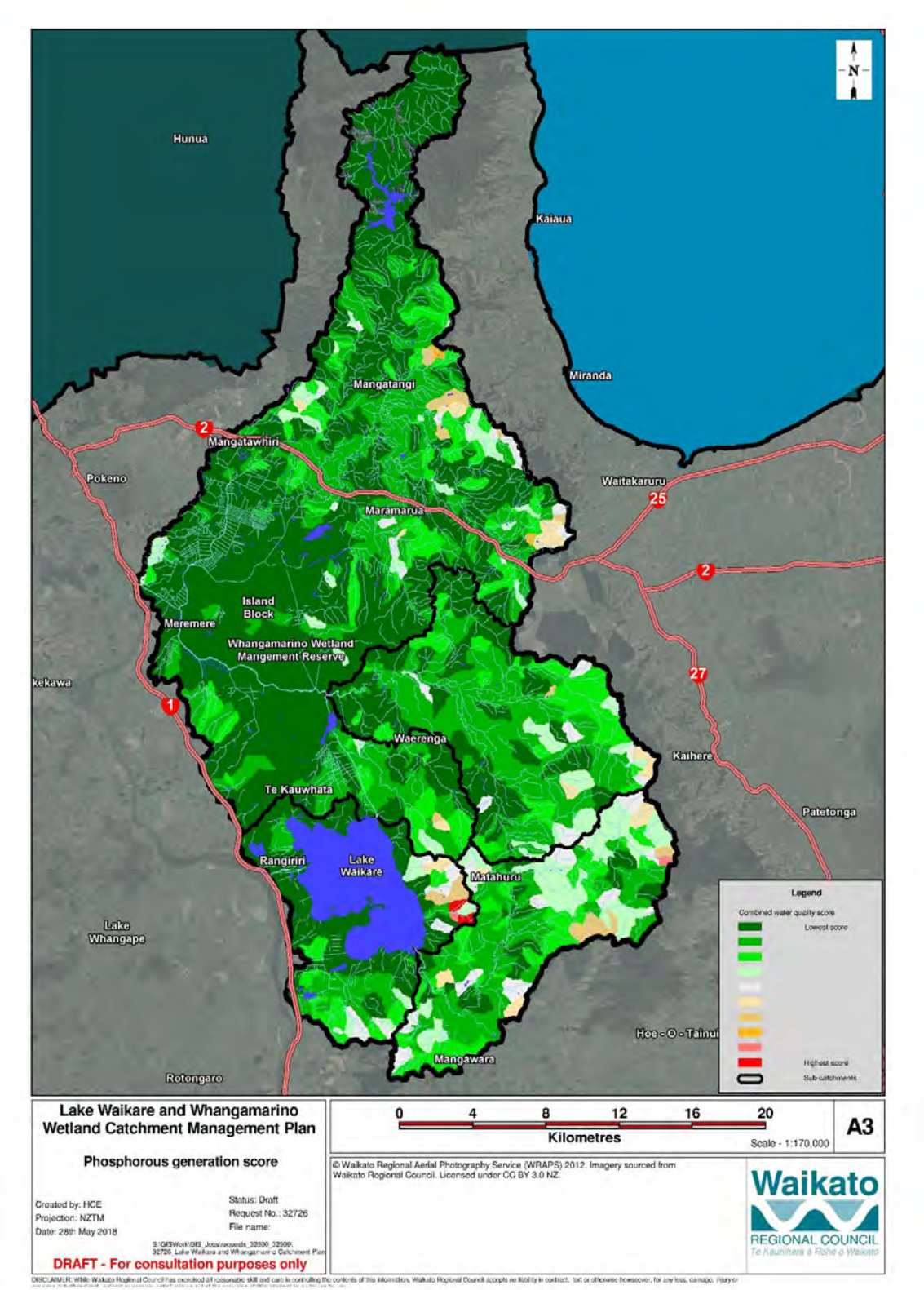
Map 12: Environmental monitoring sites



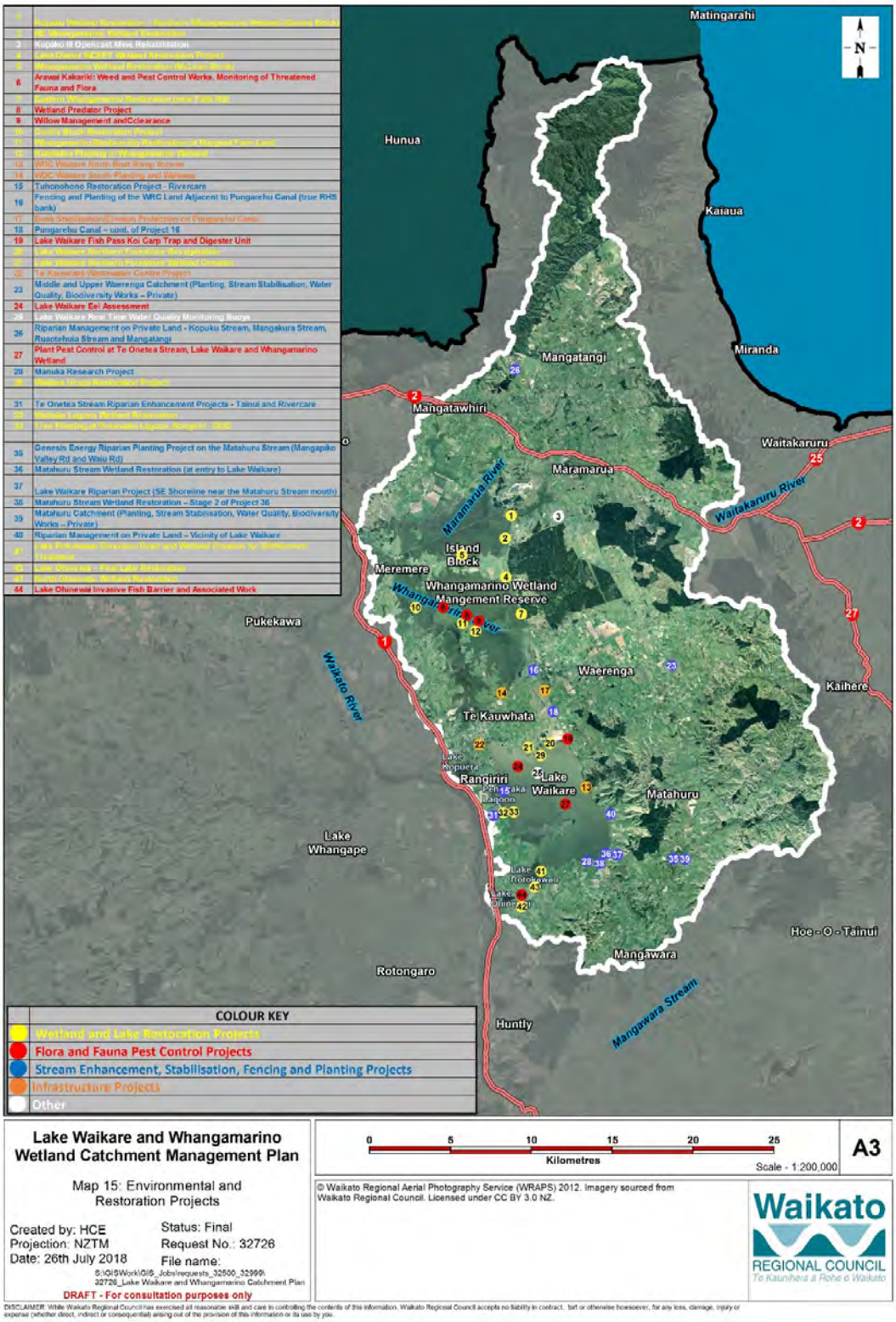
Map 13: Nitrogen generation score



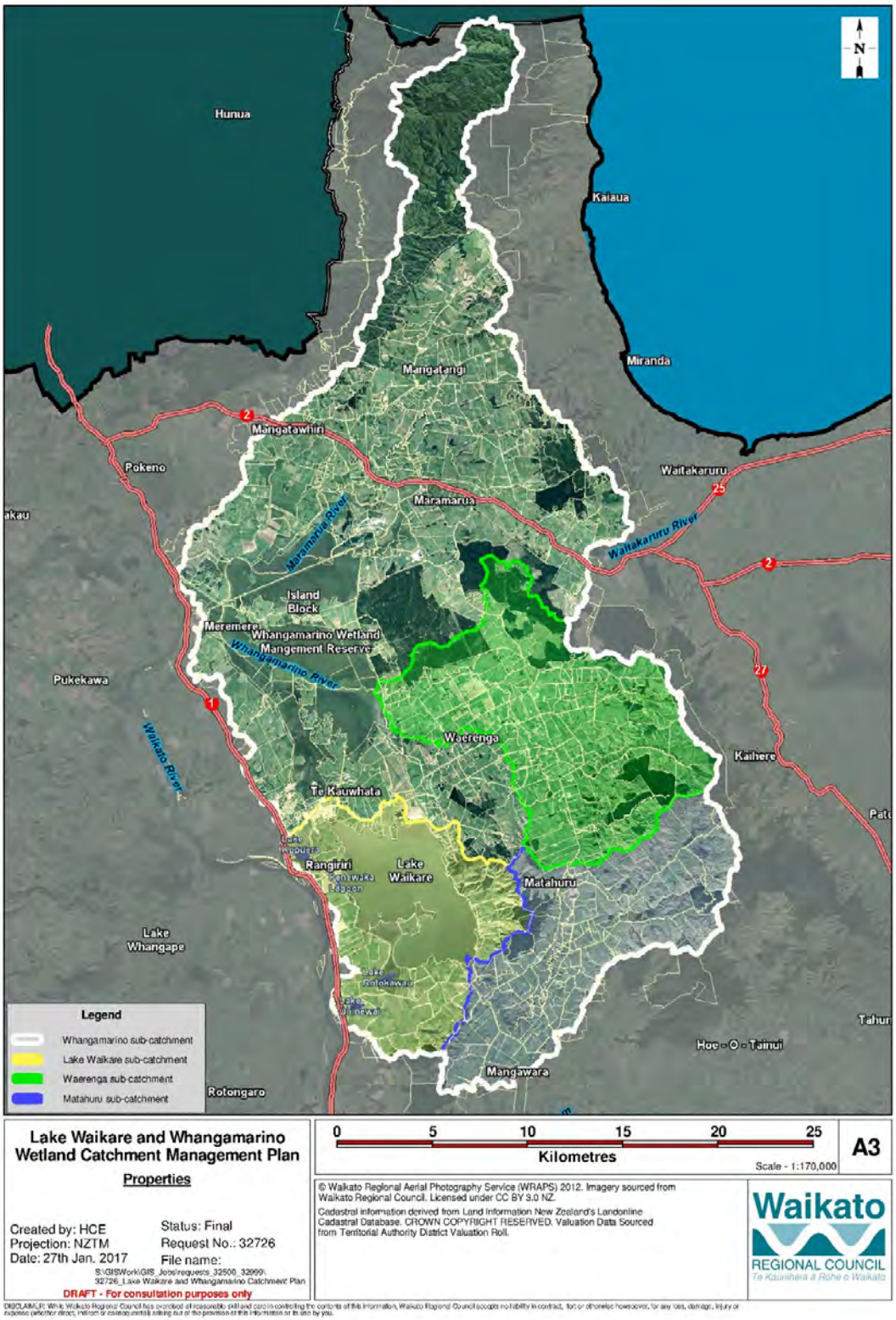
Map 14: Phosphorus generation score



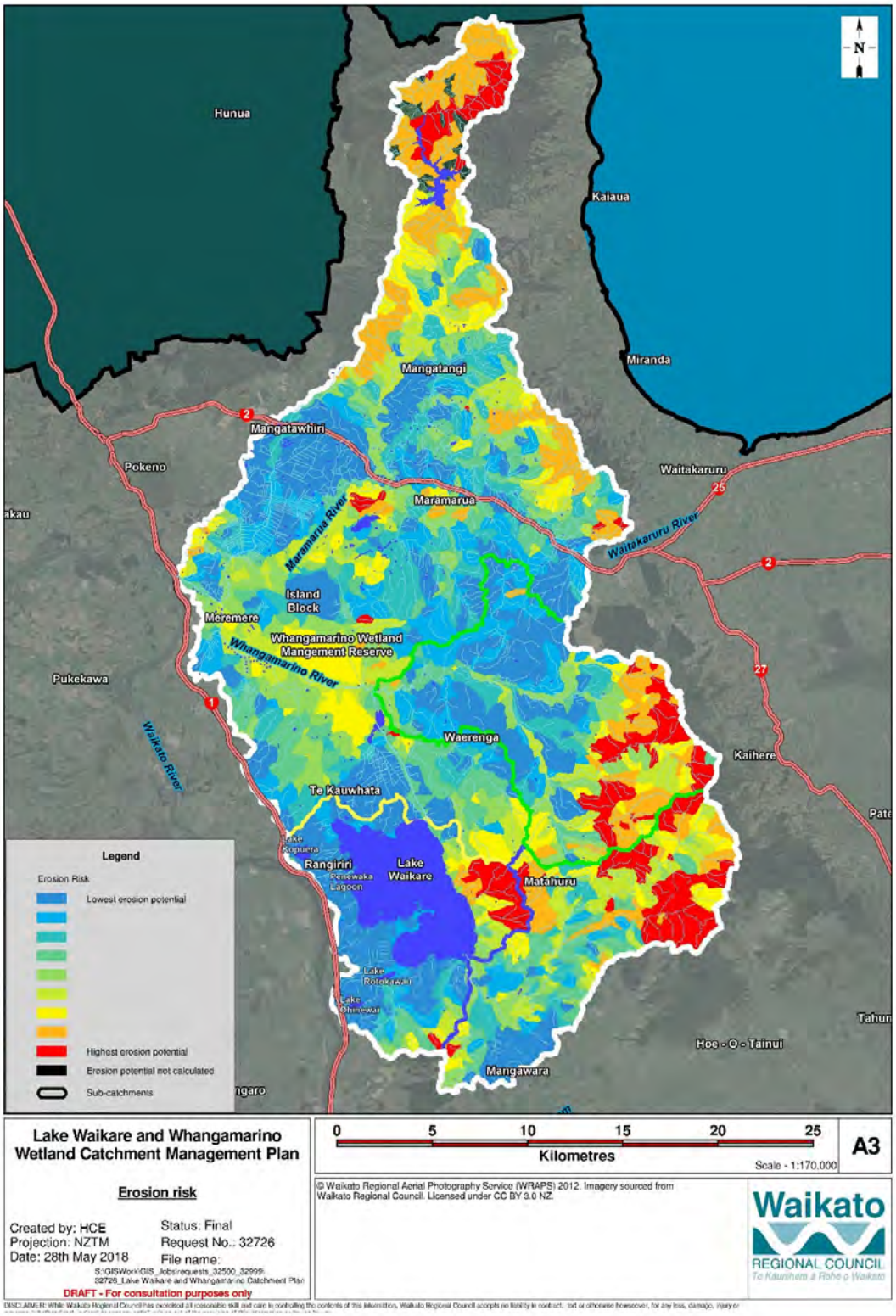
Map 15: Environmental and restoration projects



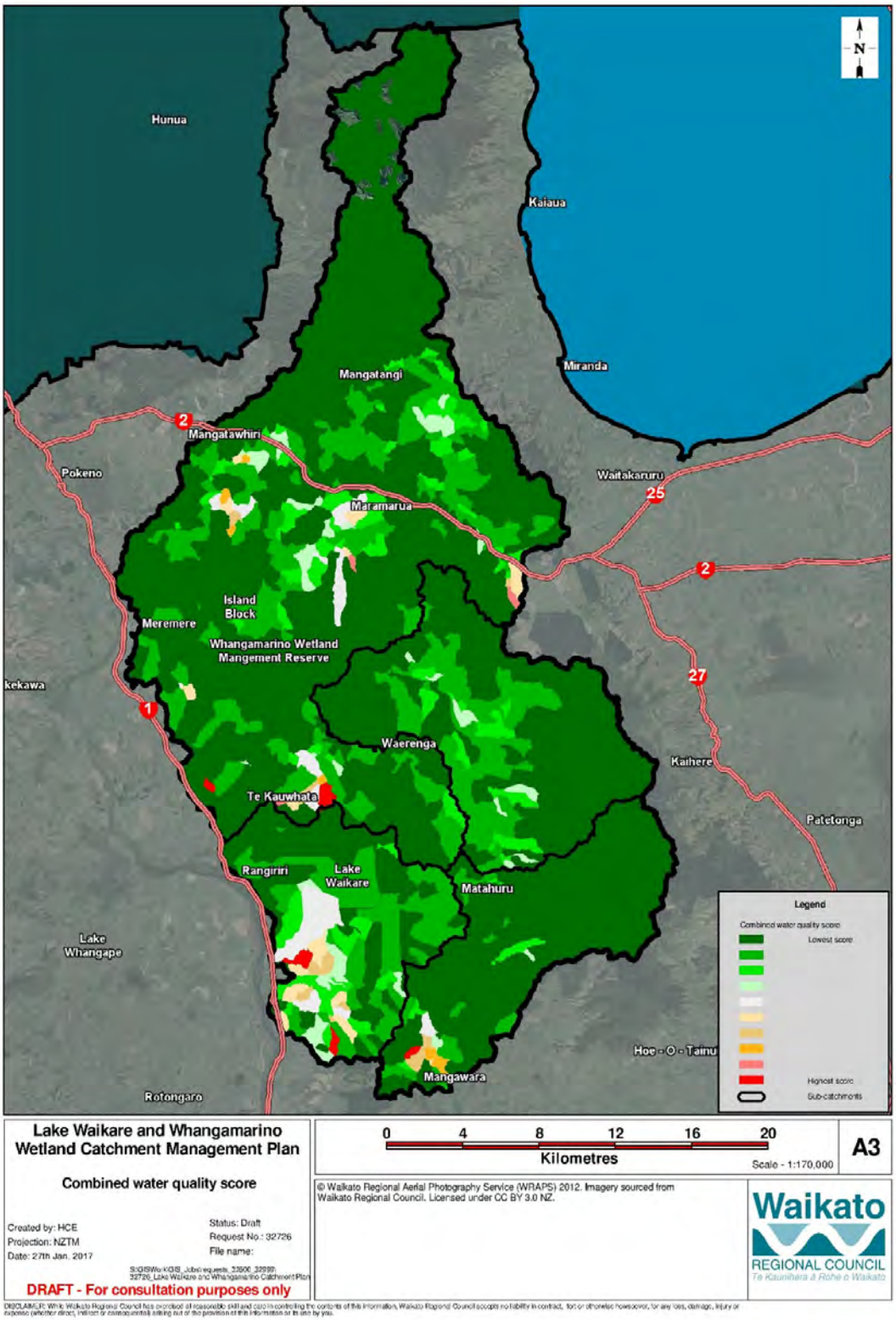
Map 16: Property land titles



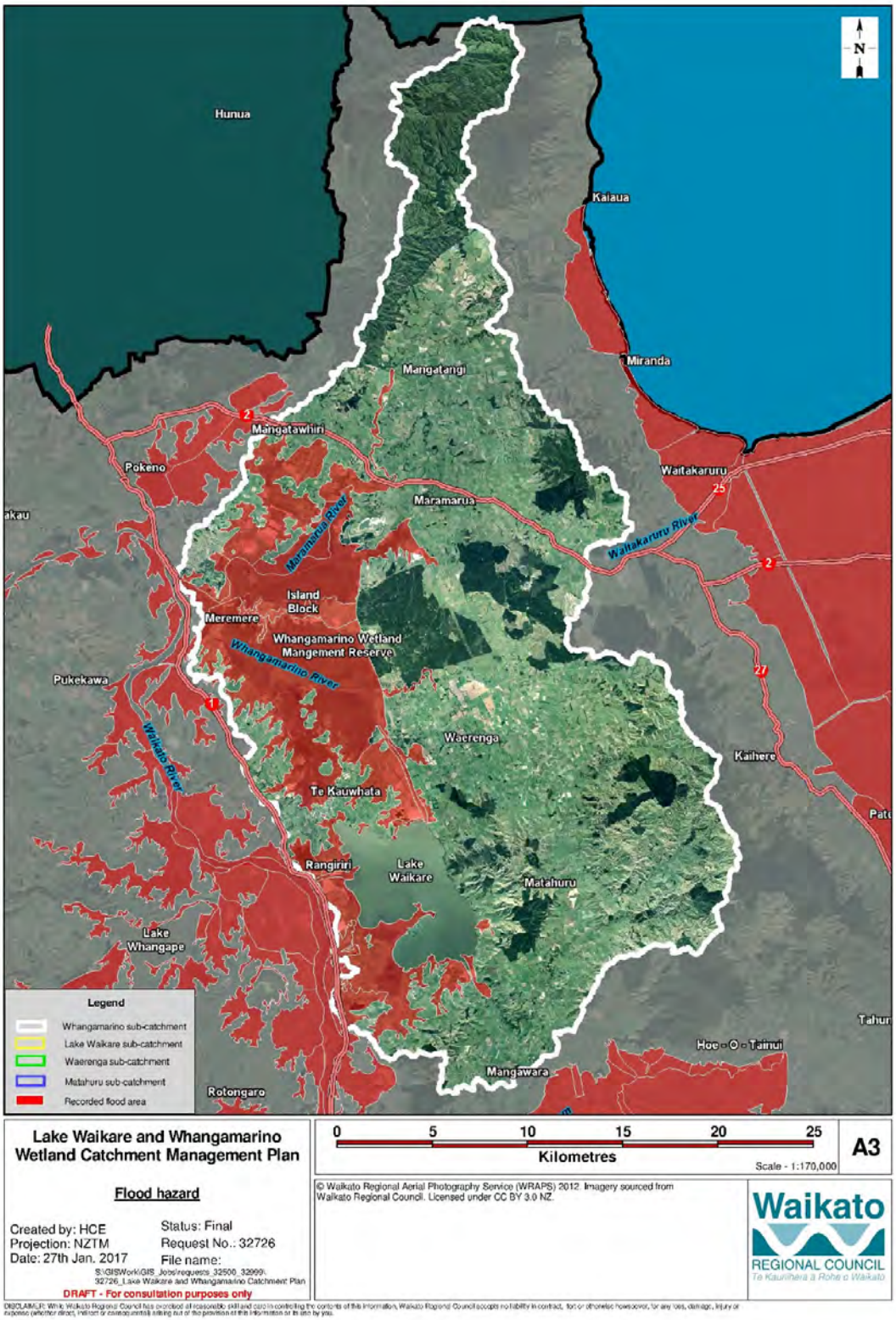
Map 17: Erosion risk score



Map 18: Combined water quality score



Map 19: Waikato Regional Council recorded flood hazard



Appendix 1 Primary Stakeholders Catchment Trust report

Background

The report, authored by Dr Doug Edmeades, and appended to the Lake Waikare and Whangamarino Catchment Management Plan (CMP) is an independent report, procured on behalf of the Primary Stakeholder Catchment Trust (PSCT). The PSCT is one party to the CMP and the views expressed within Dr Edmeades' report, while were informed from a range of sources, are the independent views of the author. The report is acknowledged by Council as an independent perspective and as such it has no status within Council, nor should it be inferred as conveying a shared view of any other party to the CMP

agKnowledge
"The Independent Fertiliser Experts"

Lake Waikare & Whangamarino

Catchment Plan

A report prepared for

Primary Stakeholders Catchment Trust

By

Dr D C Edmeades & Mr F Philips

BRIEF

A trust (Primary Stakeholders Catchment Trust (PSCT) has been established by landowners in the Lake Waikare-Whangamarino catchment to facilitate their involvement in the development of a Catchment Management Plan (CMP).

The Trust has asked agKnowledge Ltd to:

1. Liaise with the Waikato Regional Council and obtain, digest and distil the information they have already collected in relation to the preparation of the Lake Waikare Whangamarino Catchment Management Plan.

2. Liaise with the Waikato River Authority (WRA) to obtain and digest information related to the Waikato Waipa River Restoration Strategy.

3. Translate the information into a digestible format and filtered for relevance to farmers.

4. Identify problems, gaps and limitations in the available information.

DESCRIPTION OF CATCHMENT

The Lake Waikare-Whangamarino Catchment comprises 7 sub-catchments and within the catchment there are five Waikato Regional Council (WRC) water quality monitoring sites (Table 1 and Figure 1).

Table 1: Sub-catchments within the Lake Waikare-Whangamarino catchment

Sub-catchment	Area (ha)	Area monitored (ha) [1]
Mangatangi	19,454	19,452
Maramarua/Kopuera	13,106	0
Matahuru	10,806	10,653
Waikare	10,688	0
Waerenga	2,032	1,951
Whangamarino Jefferies	9,705	9,602
Whangararino Island block	14,723	14,723
Total	*80,652*	*56,382 (70%)*

Note 1) area upstream of the monitoring site

All the sub-catchments, except for Maramarua/Kopuera and Mangatangi, drain through the monitoring site at Whangamarino (Island Block) and the whole catchment drains into the Waikato River prior to the Mercer Bridge.

CATCHMENT MANAGEMENT PLAN

The Waikato Regional Council (WRC) has commenced the process to develop a Catchment Management Plan (CMP) for the Lake Waikare-Whangamarino catchment.

To-date three documents have been prepared:

5. The "Lake Waikare & Whangamarino Wetland Catchment Management Plan: Part One – Catchment Over View – Draft for Consultation, March 2017." This report documents the resources in the catchment.

6. A data-base (Excel spreadsheet) listing all known Projects (64 on-ground activities such a riparian planting), Studies (72 Research Reports), and Monitoring programs, completed or in progress in the catchment, as at the end of 2016.

7. Based on this data-base, a further report "Lake Waikare & Whangamarino Wetland Catchment Management Plan: State of Understanding report – draft for consultation, March 2017", assesses this body of work in the catchment and identifies important gaps in the current knowledge.

THE WRC 'STATE OF UNDERSTANDING' REPORT

It is made clear that this report is a 'work in progress' and importantly, it is noted that the Landowners are key stakeholders and that their input "needs to be incorporated" in the ongoing development of the CMP.

After reviewing all the work in the catchment up to the end of 2016, the report notes that, "a significant amount of research and on-the ground projects have occurred to date within the catchment, however many of these have tended to focus on the Lake Waikare and the Whangamarino wetland and not the wider catchment subject to the CMP. " In other words the focus has not been directed to issues related to agricultural activities in the catchment.

Despite the large body of research and activities in the catchment the report identifies 19 issues/gaps in the state of current knowledge. Leaving aside those relating directly to the internal management of the Whangamarino Wetland and Lake Waikare, there are a number that relate to land use and farming activities in the broader catchment. These can be condensed down as follows:

8. Farming effects on the wetlands where farms abut the wetlands and feeder streams.

9. Management and rehabilitation of land in the headwaters of the catchment.

10. Management and mitigation of the stream-channel erosion in the lower reaches of the catchment.

11. Quantification of the sediment and nutrient input and outputs within the catchment.

12. Defining measurable water quality targets for the sub-catchments within the catchment.

There are some issues relating to the internal management of the Lake Waikare, and Whangamarino Wetland, which may indirectly influence land management and farming, in the wider catchment. Of particular importance are:

13. The effect of pests (koi carp and catfish) on the re-suspension of sediments in the lower reaches of the lowland streams and in the Whangamarino Wetland and Lake Waikare.

14. The ongoing management of the control gate on Lake Waikare and the Whangamarino Wetland weir.

The report concludes by listing 23 "potential investigations" identified to fill the gaps in the preparation of a CMP. Three of these are relevant to the issues/gaps identified above and in fact should be condensed into one overarching investigation.

15. Summarise all the water quality (nitrogen, phosphorus, pathogens and sediments) monitoring data collected by the WRC and the Department of Conservation (DOC) with a view to developing a Catchment Nutrient Plan (CNP) as a subset within the CMP.

THE WAIKATO RIVER AUTHORITY

The Waikato River Authority (WRA) was established in 2010 as a result of the Treaty Settlement between Waikato-Tainui and the Crown. The WRA is the sole trustee of the Waikato River Clean-up Trust and is responsible for administering a $220m fund over a 30 year period. The Trust generally has up to $7m available each year to support river restoration activities throughout the Waikato and Waipa River Catchments. The Trust will not fund activities explicitly required by the Healthy Rivers Plan Change (see next section) unless they go beyond the minimum standard e.g. through fencing wider set back of streams.

In the recent 2017 funding round the WRA priorities relevant to farmers and farming in the Lake Waikare – Whangamarino Catchment include:

16. Projects that improve water quality in streams, wetland and lakes and drains that flow into the Waikato River and its catchment.

17. Restoration of catchment headwaters of the Lower Waikato, in particular the Matahuru and Mangawara sub-catchments.

18. Projects that improve the health of the Whangamarino wetland.

19. Habitat and water quality enhancement of high priority lakes including Lake Waikare.

20. Retirement and restoration of wetlands associated with lakes including the Matahuru and Awaroa wetlands.

21. Projects that protect and restore currently existing wetland and the creation of new wetlands throughout the catchment.

The WRA has already funded a number of activities in the catchment over recent years. These are captured in the WRC data-base, noted earlier.

THE WAIKATO AND WAIPA RIVERS RESTORATION STRATEGY

The Waikato Regional Council, Waikato River Authority and DairyNZ will be jointly releasing a forward-looking strategy in 2018 entitled "Waikato River & Waipa River Restoration Strategy." This will set out funding and restoration priorities for "a wide-range of non-regulatory activities related to the restoration and protection of the Waikato and Waipa Rivers. Huka Falls to Port Waikato and the Waipa River." The focus is broad and covers the whole catchment and includes consideration of iwi cultural priorities, erosion and sedimentation, water quality, biodiversity, fish, and access and recreation

HEALTHY RIVERS: PLAN CHANGE ONE

Plan Change One (PC1) is a Regional Plan change now in a statutory process, details of which, including timeline, can be found on the WRC website. It is not clear at this stage when hearings before the Commissioners will be heard, or importantly, when the finalized plan will be ready for implementation.

In the context of this report it is emphasized that, relative to the CMP and the WRA, the PC1 has a narrow focus – it is solely concerned with water quality as expressed by the four contaminants: nitrogen, phosphorous, pathogens and sediments.

WATER QUALITY

Trends

Based on the data from the five water-quality monitoring sites in the catchment, the trends in the water quality are summarized in Table 2 (page 8).

22. There has been deterioration in the physical quality of the water (turbidity and clarity) in 3 of the 5 sub-catchments reflecting an increase in sediments in the water.

23. There have been some improvements in total nitrogen in some sub-catchments (3 of 5) and deterioration in others (2 of 5). All five catchments, have improved with respect to ammonia.

24. There have been no practically important or statistically significant trends in phosphorus.

Current Situation

The water quality (median values, 2010 to 2014 incl. WRC Technical Report 2015/15) at each of the monitoring sites is summarized below (Table 3). To give some perspective to the data, the water quality in the Waikato River at Huntly, Mercer and Tuakau is also provided (*in italics*).

Table 3 Water quality attributes in the five sub-catchments (2010-2014). The water quality attributes at three of the monitoring sites in the lower Waikato River are provided to given some perspective to the data.

Site	Median Clarity (m)[1]	Median total nitrogen (mg/m^3)	Median total phosphorous (mg/m^3)	Median ecoli (n/100ml)
Mangatangi	0.50	490	72	380
Matahuru	0.27	1310	98	600
Waerenga	0.75	1120	46	500
Whangamarino (Jefferies)	0.39	1090	89	600
Whangamarino (Island Road)	0.20	1830	152	180
Huntly Tainui[2]	*0.9*	*562*	*45*	*Not known*
Mercer Bridge[2]	*Not measured*	*631*	*52*	*80[3]*
Tuakau[2]	*0.6*	*571*	*53*	*Not known*

Notes 1) the higher the number the clearer the water.
2) figures are the 10 year goals from Plan Change One
3) 95 percentile not median.

25. All the sub-catchments have poorer clarity than the three sampling sites in the lower reaches of the Waikato River.

26. The median total nitrogen concentrations of the water in four of the five sub-catchments are higher than in the lower reaches of the Waikato River.

27. The total phosphorus concentrations are higher within the catchment than in the lower reaches of the Waikato River

28. The clarity of the water entering the Whangamarino wetland from the Matahuru and Jefferies catchments is better than in the water leaving the wetland at Island Road.

29. The total phosphorus and nitrogen concentrations in the water entering the Whangamarino wetland from the Matahuru and Jefferies catchments are lower than in the water leaving the wetland at Island Road. The reverse is true for e coli.

30. The total phosphorus concentrations are higher within the catchment than in the lower reaches of the Waikato River

31. The clarity of the water entering the Whangamarino wetland from the Matahuru and Jefferies catchments is better than in the water leaving the wetland at Island Road.

32. The total phosphorus and nitrogen concentrations in the water entering the Whangamarino wetland from the Matahuru and Jefferies catchments are lower than in the water leaving the wetland at Island Road. The reverse is true for e coli.

Table 2 Trends in water quality (1993 to 2012, WRC Technical Report 2013/20) in the six tributary streams in the Waikare-Whangamarino Catchment.

Tributary	Attribute							
	Temperature	Dissolved oxygen	Turbidity	Visual clarity	Total nitrogen	Ammonia	Total phosphorus	E coli
Mangatangi	ns[1]	ns	deterioration	deterioration	improvement	improvement	ns	-
Mangatawhiri	ns	ns	ns	ns	improvement	improvement	ns	-
Matahuru	ns	ns	deterioration	deterioration	ns	improvement	ns	-
Waereanga	ns	ns	deterioration	deterioration	deterioration	ns	ns	ns
Whangamarino (Jefferies Road)	ns	ns	ns	ns	improvement	improvement	ns	-
Whangamarino (Island Block)	ns	ns	improvement	ns	deterioration	ns	ns	-

Note 1) ns = not statistically significant or not of any practical importance

Plan Change One Targets

It is not possible to discuss the development of a CMP for this catchment without being cognizant of Plan Change One (PC1) – the now notified plan to 'clean-up' the Waikato and Waipa Rivers. PC1 is focused on enhancing water quality (i.e. reducing the concentrations of nitrogen (N), phosphorus (P) pathogens and sediments).

It is noted that PC1 specifically identifies the Whangamarino Wetland for its international significance and accordingly it is has been given a high priority in terms of restoration.

PC1 has set water quality targets or each of the 5 sub-catchments to be achieved in 10 years and 80 years. These are set out in Table 4 together with the current situation. Note that there are **no targets in respect to phosphorus**.

33. For nitrate N the current concentrations in all the sub-catchments, except Whangamarino, are the same as the targets set for years 10 and 80. A modest reduction is required in 10 years in the Whangamarino.

34. There are **no targets set for total** N (as distinct from nitrate N) in these sub-catchments although there are targets for total N in the Waikato River. (This is so for all the sub-catchments in the Waikato-Waipa catchment).

35. The goals set for e coli in year 10 require modest reductions in the Waerenga and the two Whangamarino sub-catchments. However over 80 years large reductions are required in all sub-catchments.

36. The changes in clarity required to meet the 10-year targets appear to be modest, but larger improvements are required over 80 years.

37. It follows that of the 4 contaminants (nitrogen, phosphorus, pathogens and sediments) the main focus in this catchment as far as PC 1 is concerned should be on reducing sediments and e coli, noting that reducing sediment loads (and hence improving clarity) will have a concomitant effect on reducing P concentrations (see also para 40 and 41).

Table 4 Current water quality measurements and the targets required in Plan Change One (PC1) in 10 and 80 years for five sub-catchments.

Sub-catchment	Attribute	Current	PC 1 (10yr)	PC1 (80 yr)
Mangatangi	Nitrogen (median nitrate, mg/m³)	110	110	110
	Ecoli (95th percentile, n/100 ml)	6125	5567	540
	Clarity (m)	0.5[1]	0.5	1.0
Matahuru	Nitrogen (median nitrate, mg/m³)	720	720	720
	Ecoli (95th percentile, n/100 ml)	6770	6147	540
	Clarity (m)	0.3[1]	0.4	1.0
Waerenga	Nitrogen (median nitrate, mg/m³)	820	820	820
	Ecoli (95th percentile, n/100 ml)	5605	5098	540
	Clarity (m)	0.8[1]	0.9	1.0
Whangamarino (Jefferies)	Nitrogen (median nitrate, mg/m³)	650	620	620
	Ecoli (95th percentile, n/100 ml)	5175	4712	540
	Clarity (m)	0.4[1]	0.6	1.0
Whangamarino (Island Road)	Nitrogen (median nitrate, mg/m³)	750	750	750
	Ecoli (95th percentile, n/100 ml)	668	655	540
	Clarity (m)	0.2[1]	0.3	1.0

Note 1) from Table 3 and rounded up to be consistent with the PC 1 targets.

Phosphorus load

From a land management perspective it is valuable to consider not only the concentrations of the contaminants but also their loads at various locations within the catchment. We have attempted to do that for P, focusing on the sources of the P load passing the Whangamario Island Road monitoring site.

The total P load (tonnes/year) is estimated to be about 49 t/yr. This includes the inflows from the Waikato River into Lake Waikare, which occurs as part of the flood control scheme and from rainfall.

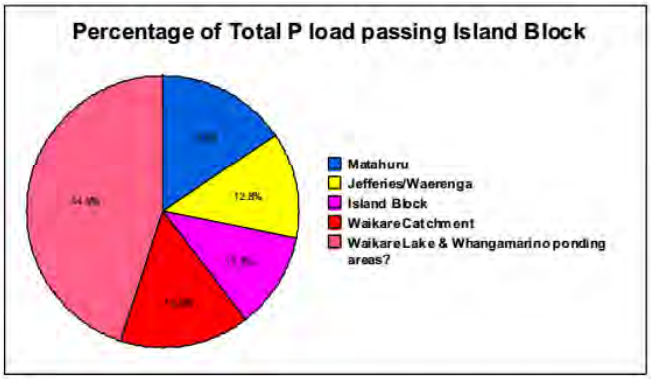
Table 5 and Figure 2 show the estimated P loads from the various sources contributing to the total load, in both absolute and relative terms.

Table 5 Estimates of the phosphate loads from various sources to the Whangamarino Island Road monitoring site.

Inflows of P from land and rainfall to Whangamarino Island Road	Tonnes P/year[1]	Proportion (%)
Matahuru	7.6	15.5
Whangamario Jefferies including Waeranga	6.3	12.8
Lake Waikare excluding Matahuru	7.6	15.5
Whangamarino Island Road	5.5	5.53
Total P accounted for	26.9	55.1
Balance from non-land activities	21.9	44.9

Note 1) These are 'best estimates' given the currently available data. The absolute numbers depend on what assumptions are made but this should not greatly affect the proportions.

Figure 2 Sources of the Total P at Whangamarino Island Road monitoring site.



38. The total P load discharged at Island Road into the Waikato River is about 49 tonnes/year representing about 5% of the total P loading in the Waikato River at Mercer (964 tonnes/year).

39. About half of the P leaving the catchment at Whangamarino Island Road is from agricultural land use and the balance from within the Waikare Lake and Whangamarino Wetland.

Conclusions: Water Quality

Notwithstanding the limitations in the data, several conclusions can be drawn from this analysis:

40. Sediments, ecoli and P (indirectly - see 41 below) appear to be the major contaminants limiting water quality in this catchment.

41. There are no goals set for managing P in this catchment. However P concentrations and sediment loadings in waterways are linked because most of the P is particulate P (i.e. attached to soil particles). For this reason reducing sediments will also reduce P concentrations.

42. Reducing N losses in this catchment is not a high priority.

43. The current evidence suggest that about half of the P leaving the catchment at Whangamarino Island Road is from agricultural land use and the balance from within the Waikare Lake and Whangamarino Wetland.

Limitations of the Information

There are some limitations in the available data that need to be acknowledged:

44. The water quality data is gathered monthly from five sites, which represent about 70% of the overall catchment. Two catchments are not sampled at all (Lake Waikare and Maramarua/Kopuara).

45. The frequency of sampling, and the fact that flow rates are only recorded at 2 sites, means that the accuracy in the mass flow calculation of the contaminants is unlikely to be better than +/- 15%.

IMPLICATIONS FOR THE CMP

The Regional Council's CMP should logically be informed by the requirements of PC1 and the priorities in the Waikato and Waipa River Restoration Strategy. Conceptually the situation can be envisaged as Figure 3 showing how the three components overlap and interact. From the farmers perspective the endpoint should provide sufficient information to prepare a well-informed, farm-specific Farm Plan.

The WRC "State of Understanding Report" identified 19 issues/gaps in the current state of knowledge, which were condensed down earlier in this report (see Para 8-12) to 5 topics of relevance to farmers. It is useful to restate these:

1. Farming effects on the wetlands where farms abut the wetlands and feeder streams.

2. Management and rehabilitation of land in the headwaters of the catchment.

3. Management and mitigation of the stream-channel erosion in the lower reaches of the catchment.

4. Quantification of the sediment and nutrient input and outputs within the catchment.

5. Defining measurable water quality targets for the sub-catchments within the catchment.

Points 1, 2, and 3 above overlap with a subset of the activities identified as funding priorities in the (yet to be released) 2017, Waikato and Waipa River Restoration Strategy (see Points 16, 17, 18, 19, 20 and 21). It is sensible therefore to encourage support for these activities as a component of the CMP.

Quite independent from the CMP process, a set of water quality targets has been developed for the 5 sub-catchments via PC1. These may be modified as PC1 goes through the hearing stages but it is assumed that these targets will take precedence over any goals that the WRC may wish to include in their CMP, unless they desire a higher standard. In other words point 5 above is completed.

The limited analysis in this report on the sources and flows of P in this catchment highlights the importance of this type of forensic investigation. Thus point 4 above is an important initial step in the development, prioritization and implementation of a robust CMP.

RECOMMENDATIONS FOR PSCT

The analysis above identifies two gaps in the existing knowledge and proposed activities within the catchment.

Recommendation 1: It is suggested that the PSCT should seek funding to implement a catchment-wide, robust, water-quality monitoring system.

From this information the movements and loadings of the contaminants in and through the 7 sub-catchment catchments can be determined. This will not only inform the CMP about the priority activities for the catchment but, once in place, an ongoing monitoring system will also enable the effectiveness of any mitigation options implemented by the CMP to be measured.

It is acknowledged that the CMP is a 'work in progress' and that there is a need to seek input from farmers.

Recommendation 2: It is suggested that the PSCT seek funding to hold meetings with the farmers in this catchment to seek their input into the ongoing development of the CMP. This report could be used as the background document for this purpose.

ACKNOWLEGMENTS

The technical input from Drs Bill Vant and Eloise Ryan of Waikato Regional Council and the assistance from Dr Keri Neilsen of the Waikato River Authority are gratefully acknowledged.

Figure 1: The Whangamarino Catchment

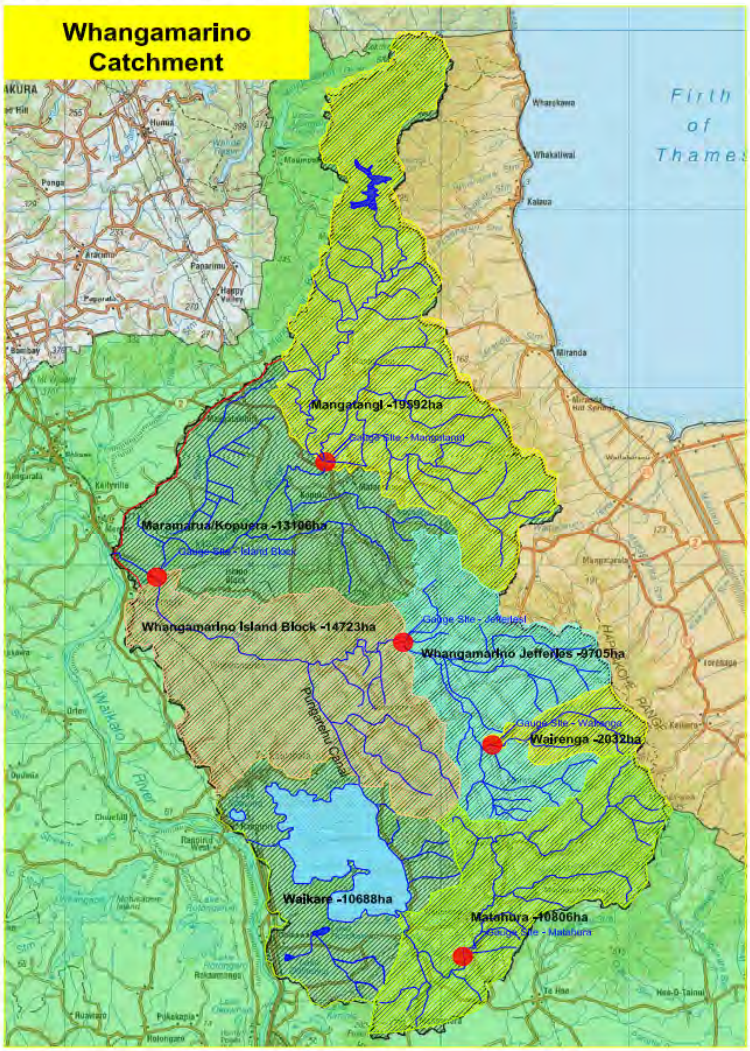


Figure 3: The Catchment Management Plan will be informed in part by Waikato and Waipa Restoration Strategy and the requirements of the Healthy River Plan.

HE TAIAO MAURIORA HEALTHY ENVIRONMENT

HE ŌHANGA PAKARI STRONG ECONOMY

HE HAPORI HIHIRI VIBRANT COMMUNITIES

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