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Water Management REPORT

FRESHWATER CONSTRAINTS TO ECONOMIC DEVELOPMENT

PREPARED FOR
Bay of Plenty Regional Council

WL18016

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Background

The Bay of Plenty (BOP) Regional Growth Study identified fresh water as an enabler for economic growth. A key action stemming from the water work stream was to prepare a 'Water Strategy' to help support sustainable economic growth.

Bay of Plenty Regional Council (BOPRC) contracted Aqualinc Research Ltd to complete a study that assessed regional freshwater-related opportunities and barriers to sustainable economic growth.

The study was needed to support the Regional Growth Strategy, to inform the community and BOPRC understanding of the region's freshwater resources, and assist with implementing the National Policy Statement for Freshwater Management 2014 (NPS-FM).

The problem

Fresh water uses include extractive uses for irrigation, municipal supply, rural and domestic water supply, stock water, industry and commercial use. Fresh water also has in-situ 'uses' linked to ecosystems, cultural values, recreation and hydro power. Freshwater resources are subject to quantity and quality pressures that vary across the region.

Currently, it is not known whether fresh water is a constraint to economic growth or will be in the future. The current and future quantity and quality pressures have not been assessed regionally. Therefore, there may or may not be a need for water infrastructure projects to meet the pressures.

While allocation limits have been set for a range of surface water and groundwater resources, a comparison of water supply and demand had not been completed.

If there is a shortfall of fresh water to meet potential water demand, a range of measures, including water infrastructure, will need to be considered to enable the water demand to be met.

What we did

A comparison of freshwater supply and demand for the region's Water Management Areas (WMAs) was completed and a range of development scenarios were modelled for 'case study' catchments. Several of these scenarios were presented to tangata whenua and stakeholders in a series of workshops at the regional and sub-regional level.

Feedback on the case studies and on opportunities and barriers to the use of fresh water was provided by tangata whenua and stakeholders.

This study does not presume any particular outcome and does not pre-empt any formal consultation and planning processes under the Resource Management Act 1991 (RMA).

What we found

We found that under the current allocation limits, there would be either a surplus of surface water, or groundwater, or both, to support growth opportunities in most of the WMAs/catchments examined in the study, if irrigation and frost protection consents are based reasonable use.

In some cases, surface water resources are fully allocated or over allocated, but sufficient groundwater allocation is available to cater for potential needs for fresh water, or vice versa.

The exception is in the Pongakawa & Waitahanui catchments, where potential future need cannot be met by the amount of water available from surface water or groundwater.

In general, the availability of fresh water is not expected to be a major constraint to economic growth in BOP.

We found that there is potential to reduce current allocation by applying “reasonable use” methods to refine consented flows and volumes. The high flows and volumes allocated for frost protection in particular need to be rationalised.

There is significant potential to support economic growth through increased fresh water use. The economic growth opportunity created from fresh water, including through more efficient allocation and use, is likely to be primarily generated from irrigation, particularly irrigation of high value horticultural crops. Should that occur, the benefits to the local districts and regions in terms of revenue generated, local employment and downstream benefits are significant.

There is a potential negative effect in terms of increased nutrient leaching but, under horticultural development, this is unlikely to be a road block to development. However, water quality limits have not yet been set for most of the region; therefore the significance of this constraint cannot be confirmed at this point.

Commercial and industrial enterprises are not generally large net consumers of water. While municipal use can be significant, most districts have plans in place to deal with supply needs over the long term.

Feedback from the workshops was generally positive with respect to increasing irrigated area and intensifying land use through horticultural development. Increased use of fresh water will lead to increase employment, social well-being and improve social infrastructure, especially housing, schools and healthcare.

However, concerns around getting access to additional fresh water in specific locations (even if it is available at a WMA or catchment scale and groundwater in sufficient quantity and quality) and the effect of increased freshwater use were also raised. These included impacts on the environment, utilisation of existing infrastructure, and increased stresses on the community.

Part of the concern arises from insufficient robust information in several areas such as on water needs (for irrigation), locations and accessibility of groundwater, the effects of growth on the community, and Treaty settlements and how they relate to water. The potential effect of climate change on the availability and use of water was also raised.

The workshop participants recognised that there are wider opportunities for freshwater use. This included opportunities to develop the Māori economy, new industries such as aquaculture and aquaponics, added value from processing, tourism, recreation and micro-hydro.

Given that there is sufficient water generally available to support increased use of fresh water, consideration was given to why more development around freshwater use has not occurred. Barriers to development include lack of “champions” to get things started, access to information and capital, risks (such as in the cost of finding and proving groundwater supplies), regulation, concerns around effects on the environment, public opposition and the lack of supporting community infrastructure.

What it means

Because overall water availability generally exceeds current and foreseeable future water demand if irrigation and frost protection consents are subject to reasonable use tests, there is not a need for large-scale water infrastructure. Infrastructural projects will tend to be relatively small-scale and localised, or carried out on an individual basis. An example is irrigation for the proposed horticultural development at Raukōkore, in the East Coast WMA. Other possibilities are small piped distribution systems to supply water to locations without riparian access to surface water.

The use of surface water needs to be improved through allocating water on the basis of reasonable use, implementing water user groups, and irrigation rostering.

While, in general, surface water resources are over-, fully allocated or close to fully allocated in most catchments based on current allocation limits, groundwater is not, and much of the new development will need to be supplied from groundwater. However, feedback from the workshops indicated that access to groundwater in sufficient quantity and quality is a major concern. Community wells and piped water may be a solution to this problem, which could be addressed through small scale infrastructure projects.

Where to next

Given that the quantity of fresh water that is available for allocation in the catchments we have investigated is not in short supply (noting that there could be individual sub-catchments that have localised access issues), the barriers to future development need to be better understood and addressed.

Lack of information in key areas is a significant concern.

With irrigation development, this is primarily about irrigation crop water needs, the economic and productive benefits of irrigating (given that irrigation in the region is largely dry-year insurance and not required every year), and the costs of developing irrigation infrastructure.

Regardless of what water is used for, the high costs associated with deep groundwater development are a concern, with the risk of not finding sufficient quantity and quality of groundwater high in potential users' minds.

Efficient allocation (i.e. consistent with reasonable use for specific purposes) underpins the conclusions of this study. BOPRC already assesses reasonable use for new consents (including renewals). However, there are a large number of older consents which are 'locking up' water for economic growth. Mechanisms to review consent conditions during their term to ensure allocations are efficient should be explored.

1 INTRODUCTION

1.1 Background

The Bay of Plenty (BOP) Regional Growth Study identified fresh water as an enabler for economic growth.

A key action stemming from the BOP Regional Growth Study water work stream was to prepare a 'Water Strategy' to help support sustainable economic growth. Across New Zealand, various Water Strategies have been prepared, which are focussed more on how fresh water will be managed in the future, with links to economic development.

Bay of Plenty Regional Council (BOPRC) contracted Aqualinc Research Ltd to complete a study that assesses regional freshwater-related opportunities and barriers to sustainable economic growth. This study supports the Regional Growth Strategy and has an economic development focus. It also helps to inform community and BOPRC understanding of the region's freshwater resources and assists with implementing the National Policy Statement for Freshwater Management 2014 (NPS-FM).

Freshwater uses include both extractive uses for irrigation, municipal supply and industry as well as in-situ 'uses' linked to ecosystems, cultural values, recreation and hydro power. Freshwater resources are subject to quantity and quality pressures that vary across the region.

The quantity and quality pressures may or may not result in a need for water infrastructure projects to address the pressures.

A range of development scenarios were required to be modelled for 'case study' catchments. These scenarios required guidance and road-testing with tangata whenua and stakeholders in a series of workshops at the regional and sub-regional level.

This study does not presume any particular outcome and does not pre-empt any formal consultation and planning processes under the Resource Management Act 1991 (RMA).

1.2 Objectives

This project stems from the Bay of Plenty Regional Growth Strategy and aims to answer the following questions:

- Is fresh water (quantity) a constraint to economic growth?
- What is the economic growth opportunity created from fresh water, including through more efficient allocation and use?
- Subject to the extent of any such constraints and opportunities, is there a need for irrigation infrastructure in the region and if so where and for what purpose?
- Are there other opportunities and barriers to economic growth?

The project has been funded by Ministry for Primary Industries (MPI) and by BOPRC. MPI's interest was in a study that provided the following:

- Identified key potential water infrastructure projects throughout the BOP region for further investigation;
- The reasons why they may be worth pursuing;
- The nature of the costs that could be involved; and

- The nature of the benefits possible for the primary sectors, the community and the environment.

1.3 Expected outputs

The deliverables included in this freshwater study include:

- A summary of fresh water availability, and current and potential demand in the region;
- Identification of areas where shortfalls of fresh water could constrain development;
- Credible future scenarios for development using fresh water (at a granular spatial level), including major landowner initiatives and documented assumptions; and
- Opportunities for meeting water shortfalls (including water user groups, reliability of allocation, efficiency of allocation, setting of limits, priority of allocation, achievement of multiple outcomes from water infrastructure development, commercial and financing).

1.4 Dissemination/ workshops

An initial regional high-level analysis of supply and demand was completed and presented to representative community groups and stakeholders. This enabled community and stakeholder feedback to be incorporated into future scenarios.

1.5 Planning context

BOPRC is improving how it manages fresh water, implementing the NPS-FM through a 2-stage process. The first stage, delivered through the region-wide Water Quantity Plan Change (Proposed Plan Change 9), sets default water quantity allocation limits, minimum flows and levels. It also introduces stronger rules about metering, addressing unauthorised takes and registration of permitted takes, amongst other provisions.[1]

The second stage will progressively set objectives, limits and methods for both freshwater quality and quantity in each of the nine Water Management Areas (WMAs), illustrated in *Figure 1*. These objectives, limits and methods will provide for tangata whenua and community freshwater values. The process to set these WMA-specific provisions has started for the Rangitāiki and Kaituna-Pongakawa-Waitahanui WMAs (Plan Change 12).

[1] BOPRC notified the proposed Plan Change on 9 October 2018. As of 21 November 2018, the Environment Court has received fourteen appeals on a wide range of aspects of the Plan Change. This report is based on the interim allocation limits set by the proposed Plan Change. However, these interim limits and BOPRC's NPS-FM implementation programme may change as a result of the appeals.

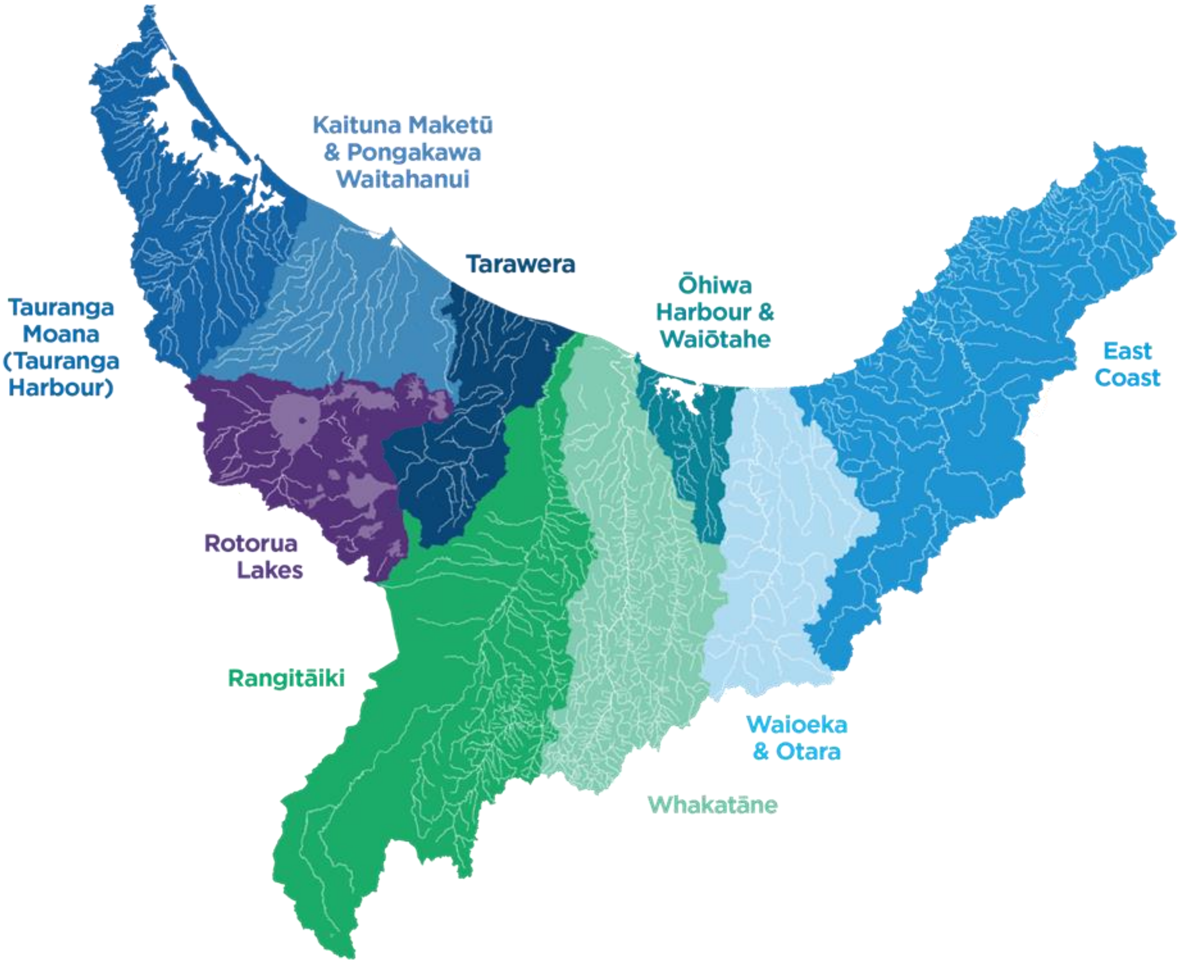

Figure 1: Bay of Plenty Water Management Areas

The analysis presented in this report is based on the interim, default and conservative allocation limits set by proposed Plan Change 9. The focus is water quantity. However, water quality limits, to be set through WMA-specific processes, will be significant constraints to land use intensification. In the absence of water quality limits for most of the region, no assessment of the extent of those constraints is possible. Nonetheless, nutrient loss estimates of the future land use scenarios evaluated are included, as an indicator of potential environmental impacts.

2 METHODOLOGY

The project was divided into three parts:

- Phase 1: A high-level regional overview of the water status at a Water Management Area (WMA) scale; essentially a comparison of water supply and potential water demand at WMA level to indicate whether the region, and individual WMA's, were likely to be water-short or not.
- Phase 2: Case studies at a catchment scale within individual WMAs to identify whether individual catchments were water-short or not, and to identify potential opportunities or constraints to freshwater–based economic development in those catchments.
- Phase 3: Workshops to get tangata whenua and community feedback on a range of freshwater future options for selected catchments, focusing on water availability, its potential economic uses and impacts from those uses.

Phase 1 and Phase 2 were desktop analyses based on the best available information, but which has known limitations. This part of the study was also based on current planning provisions that may change as freshwater limits are progressively set throughout the region under the NPS-FM.

The outcomes of Phase 1 and Phase 2 were discussed at the workshops.

2.1 Phase 1 Methodology– Regional overview at WMA scale

2.1.1 Potential water demand

The most significant water uses in BOP are:

- Urban & municipal
- Commercial & industrial
- Irrigation & frost protection
- Unconsented or permitted use

The greatest potential water use supporting regional development was assumed to be for irrigation.

Commercial and industrial enterprises are not generally large net consumers of water. Municipal use can be significant, and while existing and future demands on water for municipal supply need to be accounted for, most districts have plans in place to deal with supply needs over the long term. The emphasis, therefore, was on irrigation.

Assessing water supply and demand for each WMA required the following:

- Determining potential irrigable area (includes current actual irrigated area);
- Calculating potential irrigation demand;
- Determining surface water and groundwater availability from allocation limits and current allocation;
- Allocating potential demand to either surface water or groundwater;
- Comparing supply with demand to identify surpluses or shortfalls.

Once the supply-demand comparison was completed, observations were made on:

- Conclusions, including issues that needed to be addressed;
- Opportunities;
- Constraints;
- Recommendations for how the opportunities might be assessed in more detail.

2.1.2 Potential irrigable area

For this high-level initial assessment, potentially irrigable land was assumed to be:

- Land with slope less than 7 degrees, noting that some horticultural crops could be grown and irrigated on steeper slopes;
- Land below 600 metres elevation;
- Land that was not constrained by poor drainage, high water tables or unsuitable for other reasons;[2]
- Land that was not currently used for other purposes such as urban, industrial, commercial, roads, parks, reserves, native bush and similar.

An underlying assumption was that irrigation would be viable within the current environment.

2.1.3 Water allocation for irrigation

Future irrigation demand in litres per second for surface water (representing peak flow rate) and cubic metres per year for groundwater (representing annual demand) was estimated for each WMA.

Regional Councils typically allocate water for irrigation to meet full irrigation demand in 9 out of 10 years. That means that actual use of water and the amount allocated for that use are different. In most years, actual irrigation demand (or need or use) is lower than allocated amounts. Likewise, on this basis, allocated amounts may be insufficient to fully meet crop needs in 1 year out of 10.

As irrigation demand depends on crop type, soil type and climate, and there will be land use changes associated with conversion from dryland to irrigation, the following assumptions were made for Phase 1.

- Existing forestry on potentially irrigable land would remain as dryland forestry;
- Sheep & beef farms on potentially irrigable land would be converted to kiwifruit on deep[3] soils, and dairy farms on the shallower soils;
- All farms on potentially irrigable land that were currently mapped as arable, vegetable and horticultural properties would be fully irrigated.

For the initial high-level overview, peak flow rate on a per hectare basis was obtained from Irricalc modelling for the area using pasture as a representative crop. Peak flow rate was 5 mm/day or about 0.6 litres per second per hectare. This is a high estimate, and will exceed the rates needed for deep rooted crops on deep soils. Peak irrigation demand should not exceed this value.

[2] These are areas used for roads, urban and municipal, or otherwise not able to be irrigated.
[3] Deep soils are silt or clay loams generally considered to allow unimpeded root development to greater than 600 mm depth. Rooting depth on shallow soils is assumed to be generally less than 600 mm.

2.1.4 Supply-demand comparison

Water supply was based on water allocation limits taken from a report published by BOPRC (Kroon, 2016, "the Availability Report"[4]). The limits identified in this report are interim limits, subject to Environment Court appeals and will be revised by BOPRC as part of the current NPS-FM implementation programme. In general the interim limits are conservative.

The total surface water allocation limits within each WMA were obtained by taking the allocation limits on individual streams and rivers in the WMA and summing them. Streams without consented allocation are not included in the availability report, and represent an additional opportunity, although it should be noted that most often these will be in areas that have low suitability for development.

Groundwater management zones have been defined by BOPRC[5], based on assessments from GNS Science, but in many cases cross WMA boundaries. Allocation limits were proportioned based on the relative area of the management zone under each WMA, or WMA's were grouped to align with management zone boundaries as much as possible.

Potential irrigable area was allocated on either surface water or groundwater. Where there was a choice between surface water and groundwater, the surface water was assumed to be taken up first, because it would be expected to be a lower cost and more certain source of water than groundwater.

Finally, irrigation demand was compared to available supply on a WMA basis to identify surpluses or shortfalls.

2.2 Phase 2 Methodology– Case studies at WMA or catchment scale

A key finding of the Stage 1 study was that more detailed assessments were best tackled at the WMA or catchment level. On that basis, the following WMAs or catchments were selected for further analysis:

- Waioeka/Otara WMA;
- Wairoa catchment (Tauranga Moana WMA);
- Tarawera WMA;
- Whakatāne & Ohiwa/Waiotahe WMAs;
- Lower Rangitāiki and Mid-Upper Rangitāiki (Rangitāiki WMA);
- Kaituna/Waiari and Pongakawa/Waitahanui catchments (Kaituna-Pongakawa-Waitahanui WMA).

Because irrigation demand for the Rotorua Lakes WMA is minimal and because the catchment is water-rich, a high-level review of water supply and demand was carried out for that catchment. Likewise, because there are no detailed assessments for water availability for the East Coast WMA, only a high level review was completed for that area.

For the other WMAs and catchments, the general approach taken to address the issues raised in Phase 1 was:

- Determine current consented surface water and groundwater allocation for the catchment.
- Compare current consented allocation with current supply (allocation limits) to determine headroom or over-allocation.

[4] Kroon, G. (2016). Assessment of water availability and estimates of current allocation levels, October 2016 (version 1.1). Bay of Plenty Regional Council.
[5] Ibid

- Determine potential irrigable area expansion.
- Determine future water demand (this was usually dominated by irrigation expansion).
- Adjust the balance between surface water and groundwater takes to obtain an overall water balance.
- Calculate gross economic benefits of expansion, including employment.
- Determine change in nutrient losses from the root zone from land use.

2.2.1 Current consented surface water and groundwater

A record of all consented water takes was obtained from BOPRC. These records included takes for the following uses:

- Irrigation;
- Frost protection;
- Domestic/ urban/ municipal;
- Industrial;
- Commercial.

The consents were separated into surface water takes and groundwater takes. The information extracted from the consents information included:

- Consented flow rate (peak flow rates in litres per second);
- Consented annual volumes in cubic metres per year;
- What the water was used for (primary use);
- Source of water (surface water or groundwater);
- Irrigated area for irrigation takes, where available.

There was little information available to compare actual use with allocation, although there is some evidence of low or non-usage of some consents, particularly for many old pre-RMA consents with 35 year terms. There is an opportunity for improvements to allocation efficiency.

With respect to annual volumes, we note that when consents themselves don't specify an annual maximum, the annual maximum volume specified in the consents information held by BOPRC is derived from daily amounts.

Ongoing work on improving the BOPRC water accounts has found that for several consents, the extrapolation from daily amounts to annual volumes is excessive, which will, in some cases, be inflating allocated amounts.

The differences for irrigation and frost protection have been addressed through the reasonable use test, but for many industrial, commercial and municipal groundwater consents, that issue still exists. This is a limitation of this study and a constraint to growth.

Where irrigated area was not specified on consents, it was estimated using other sources of information, such as land use maps and aerial photos.

2.2.2 Potential irrigable areas

The following criteria were used to define potential irrigable area for all WMAs.

- Land Use Class (LUC) 1-4;

- Less than 15 degrees slope;
- Land below 250 m elevation for kiwifruit;
- Land that was not constrained by poor drainage or unsuitable soils[6];
- Land that was not currently used for other purposes such as urban, industrial, commercial, roads, parks and similar.

These criteria were provided by BOPRC.

For Kaituna-Pongakawa-Waitahanui and Rangitāiki WMAs, their future land use scenarios were provided by BOPRC, based on scenarios being considered in the limit-setting process that is underway for those areas.

While the percentage of land irrigated varies across regions, currently the majority of dairy farms and some kiwifruit/avocado properties are not irrigated. Most often this is due to landowners choosing not to irrigate and land uses being viable without irrigation; this is not generally influenced by water availability.

2.2.3 Existing land use

Current land use in each of the study areas was obtained from the BOPRC land use maps[7]. Our understanding is that the maps contained the best available information on land use in the region.

The land use information was divided into the following categories:

- Arable;
- Dairy;
- Dairy support;
- Deer;
- Sheep and beef;
- Orchard or permanent horticulture;
- Kiwifruit;
- Exotic forest;
- Native forest;
- Scrub;
- Water;
- Lifestyle or mixed land use;
- Parks & reserves;
- Urban/ road/ rail;
- Wetlands;
- Other;
- Not confirmed.

For the analysis, several land uses were combined. Orchard and permanent horticulture was grouped as “Avocado/ horticulture”, as a component of permanent horticulture is avocado. The non-agricultural uses and native forest and scrub were combined into “Other”. The following sub-groups were analysed in further detail.

- Kiwifruit;
- Avocado/ horticulture;
- Dairy;
- Deer;
- Sheep & beef;

[6] Poor drainage and unsuitable soils were identified using soil classifications in S-Map soil polygon data. (Available at https://smap.landcareresearch.co.nz/)
[7] Available at http://boprc.maps.arcgis.com/apps/webappviewer/index.html?id=53e38e0f72b94ed582e5a50e57756b66.

- Arable;
- Lifestyle/ mixed;
- Exotic forestry;
- Other.

Land use for existing irrigation areas was extracted from the consents database and cross-checked against the existing land use maps.

2.2.4 Future land use

An initial assumption was made that where current land use is anything other than lifestyle blocks, orchard or permanent horticulture, kiwifruit, exotic forest, native forest, water, parks and reserves, urban/road/rail, wetland and outside of DOC land, that land use could be changed to other agricultural uses such as kiwifruit, horticulture and pastoral enterprises, subject to the conditions below.

Land use in areas outside of potentially irrigated areas was assumed to remain the same. In some catchments, small adjustments were made to urban areas to reflect projected urban growth.

Existing land uses within the potentially irrigable area were mapped.

Where the land was not currently irrigated, potential changes in land use were guided by the projections given in the report by Rob van Rossen (2015)[8].

The assumptions in that report were that there would be large increases in horticulture, a decrease in dairy and sheep and beef, and minor increases in arable.

Commercial forestry was also predicted to increase, but that did not impact on irrigation demand.
These changes were generally applied to the land uses within each catchment and refined.

Additional conditions were applied to the case study catchments, as follows:

Land suitable for new kiwifruit

- Allophanic or pumice soils only (not on gley, raw, podzoil, or organic soils – as per SMAP NZSC Order Description);
- Below 250 m above mean sea level;
- Good soil drainage.

Land suitable for new horticulture (such as avocados)

- Good soil drainage.

2.2.5 Current Supply and Demand

Allocation limits

The current allocation limits for surface water and groundwater for each WMA or catchment were extracted from the Availability Report. Note that some groundwater limits have been modified by BOPRC since the report was produced, reflecting a more recent review by GNS Science. The most recent values have been used for the analysis.

[8] "Land-use Intensification Risks in the Bay of Plenty Region: An assessment of current use, capability and drivers for change" by Rob van Rossen in January 2015.

For surface water, the streams and rivers located within each catchment were identified and allocation limits summed to provide a catchment total allocation. If streams did not have allocation limits specified in the availability report, they were not included.

Although a default value of 10% of Q5 7 day flow[9] at the point of assessment could be applied, it is likely that there is insufficient flow data to determine the allocation limit. This approach is likely to understate the total surface water availability for a catchment, but the streams without flow data (and therefore without specific allocation limits) tend to be small or in areas with very low demand.

In some cases, surface water take consents allowed abstraction of water from streams that did not have specified allocation limits. While the take totals were included in current consented demand totals, no allowance for the take was made in the allocation limits.

Reliability of supply of surface water takes was not considered, but it is currently understood to be very high by national standards. BOPRC intends to identify an appropriate level of reliability in future WMA-specific plans changes.

For groundwater, the management zones delineated in the availability report often traversed catchment or WMA boundaries. The management zone area underlying the catchment or WMA as a percentage of total management zone area was determined and multiplied by the management zone allocation limit to estimate the available groundwater volume for the catchment or WMA.

The groundwater allocation limits in the Availability Report are reported in litres per second and are based on 35% of estimated residual annual aquifer recharge. These were converted to cubic metres per year by assuming that the flow was available for 365 days per year. The basis for this was that the allocation limits were based on a percentage of average annual rainfall recharging the aquifers and protecting base flows in streams.

Current water demand

The list of current[10] consents for water takes in each catchment or WMA supplied by BOPRC were divided into surface water takes and groundwater takes.

Surface water consents that were non-consumptive were excluded from further analysis. Examples included flood control and hydroelectric generation.

Consented flow rates for surface water and annual volumes for groundwater were summed to determine current consented flows and volumes.

Permitted use and non-consented activities

Not all water demand can be specifically quantified, as some takes are permitted under the RMA and the BOPRC’s Regional Natural Resources Plan (RNRP) that may be difficult to trace, or not currently required to be notified to the Regional Council. In some areas, this could represent a substantial proportion of the total takes.

The RMA allows for water to be taken without a consent for reasonable domestic and stock drinking water use provided that the use does not, or is not likely to have, an adverse effect on the environment. The operative RNRP rules allow small takes for any purpose such as dairy shed wash-down, horticultural spray makeup, and irrigation of garden/small glasshouse operations.

These rules allow:

- Take and Use of Groundwater up to 35 m^3/day per property. (Rule 38) [11]
- Take and Use of Surface Water up to 15 m^3/day per property. (Rule 41)

[9] Five year seven day low flow or the low flow that has a 20% chance of happening in any one year, or, on average, once every five years.
[10] We have assumed that current consents are active, but recognise that some may not be used to their full extent.
[11] Note that Proposed Plan Change 9 reduces the permitted volume of groundwater from 35 m^3 per day per property to 15 m^3 per day per property for small properties.

In general, many dairy farmers do not currently hold consents for dairy shed water use, but on many occasions, use may exceed the permitted activity provisions. Also, some horticultural properties do not have the necessary resource consents for the volume of water used.

Estimates of permitted use and non-consented takes for domestic, stock drinking water and dairy shed use for the BOP region were completed by Helen Rutter in a study carried out in 2015[12]. The estimates were carried out based on a per animal, or per person basis, with stock numbers[13] and population numbers[14] used to obtain a total estimate for each secondary or tertiary catchment or aquifer zone in the BOP region.

A high level approach was taken for this study, where estimates were carried out on a per property or area basis using BOPRC land use data. In the case-study catchments, there are a high number of lifestyle block properties, which may or may not have livestock, but often have water uses for crops, small orchards or other uses. Assessing these on a per property basis will provide a realistic estimate of water use.

For land uses that are likely to have permitted water use, the number of properties in each catchment was estimated by dividing the land use areas by an estimated average property size as follows.

Table 1: Relationship between land use and property size

Land use 2016	Estimated property size (hectares)
Arable	100
Dairy	200
Dairy support	100
Deer	Equal to land use
High intensity beef or dairy grazing	Equal to land use
Kiwifruit	8
Lifestyle block or mixed land use	8
Orchard or permanent horticulture	8
Sheep and beef	250

Where the area of land use for a particular activity was small (this was the case for deer and high intensity beef), the property area for that activity was used as the default property size.

While the RNRP rules set quantities for maximum permitted use, applying these values to all properties results in unrealistic volumes of water assigned to unconsented (permitted and Section 14(3)(b)) use. To obtain realistic numbers, the following was assumed.

[12] Rutter H, 2015. Assessing unconsented or permitted water use in the Bay of Plenty Region, Bay of Plenty Regional Council. Aqualinc Research Limited.
[13] From Agribase™ 2013
[14] From Census 2013

Table 2: Assumed unconsented (permitted and S 14(3)(b)) water use per property

Land use	Estimated water use
Arable	5 m^3/day/property
Dairy 3 cows/ha @140 litres/cow/day	0.42 m^3/day/ha
Dairy support 2.6 cow equivalents/ha @ 70 litres/cow.equivalent./day	0.182 m^3/day/ha
Deer	5 m^3/day/property
Beef/ dairy grazing 2.6 cow equivalents/ha @ 35 litres/cow.equivalent./day	0.091 m^3/day/ha
Lifestyle	1.5 m^3/day/property
Kiwifruit	10 m^3/day/property
Horticulture	10 m^3/day/property
Sheep & beef 10 ewes/ha @ 5 litres/ewe/day	0.05 m^3/day/ha

Volumes of water use and stocking density were guided by the values given in Rutter (2015).

Where the estimated water use was a volume per day per property, the daily volume was multiplied by the estimated number of properties to determine permitted water use for that land use.

Where the estimated water use was a volume per day per hectare, the daily volume was multiplied by the area of land associated with that land use to determine permitted water use.

Current headroom or over-allocation

For both groundwater and surface water, the sum of current consented takes (all uses) plus permitted use and non-consented estimates were subtracted from current allocation limits to determine current headroom or over-allocation. This provided the amount of water available for expansion without further adjustments (litres per second for surface water and cubic metres per year for groundwater), or the extent of current over-allocation. In the case of over-allocation, no further expansion would be possible unless the allocation limits were revised or water was released by applying reasonable use tests to existing consents.

2.2.6 Reasonable use allocation

The flow rates and volumes of water allocated through existing consents varied according to location and use. For irrigation, the flows and annual volumes of water allocated on a per hectare basis spanned a wide range, and were often combined with frost protection.[15]

Typically, reasonable use rates for irrigation are the flows and volumes of water that would reasonably be needed to be allocated to fully meet irrigation demand in a 1 in 10 year drought.

If actual allocation rates or volumes exceed this amount, water could, in theory, be released for other users with no impact on existing users. If actual allocation rates or volumes were lower than the reasonable use needs, water could not be released for other uses without having an impact on existing users.

In addition, reasonable use allocation rates need to be used for proposed irrigation on future land uses to determine water demand.

Specific reasonable use rates for irrigation were determined using soil water balance modelling, as described below.

Reasonable use rates for frost protection were taken as the lowest of:

a) Current frost protection allocated volume, or

[15] About half of the water consents in the BOP region are pre-RMA and are not as specific as post RMA consents with respect to flows, volumes and uses.

b) Volume required to apply 2.5 mm/hour for 7 hours per day, 26 days/year over the protected area.

For the development options, the current ratio of existing frost protected area to the total kiwifruit/horticultural crop area for each case study was applied to future scenarios. The volume of water for future frost protection was determined using the "reasonable use" volume as defined in b) above.

2.2.7 Future Supply and Demand

Demand for water comes from the following uses:

- Irrigation;
- Frost protection;
- Domestic/ urban/ municipal;
- Industrial/ commercial;
- Permitted and non-consented use;
- Hydro Electric Power generation.

Future irrigation demand

For Phase 1, the Irricalc soil water balance model[16] was used to determine irrigation rates. Irricalc treats the soil water reservoir as a single entity with a specified soil moisture holding capacity over the rooting depth of the crop. It does not allow for water movement from underlying water tables or from deeper soil below the crop root zone. In the BOP region, soils tend to be deep, with underlying water tables that contribute to crop water needs.

For Phase 2, irrigation demand flow rates and volumes were refined using Hydrus[17], which is a public domain Windows-based modelling software package for analysis of water flow and solute transport in variably saturated soils. It is able to account for water movement from below the crop root zone.

Daily irrigation was simulated using Hydrus for various soil textures for a range of crops under relevant climatic conditions (rainfall and evapotranspiration), with shallow and deep water tables to determine reasonable use rates for irrigation.

Generally, the Hydrus modelling resulted in both lower peak flow rates and annual volumes for deep rooted crops such as kiwifruit or avocados than had been obtained from the Irricalc modelling.[18]

It needs to be recognised that there is a degree of subjectivity involved in setting irrigation supply rates (litres per second per hectare) for different crops. This relates to the risk that growers are willing to take in not being able to meet full irrigation demand for short periods in some years. Some growers will install systems with high flow rates to minimise the risk, while others will install systems with lower rates (to reduce cost) and be willing to accept some risk. The supply rate for irrigation has very minimal effect on the volume of water required on an annual basis. However, it is very important for surface water allocation calculations because the regional council estimates total allocation by tallying up rates of take. For example, if the available flow in a stream is 10 litres per second, a 4 ha block requiring 160 m^3/day for irrigation could take all of the available flow if the allowed rate of take was 10 l/s. It would complete the irrigation in less than 2 hours, but because Council does not know the timing of irrigation, it does not allocate additional water to another user. Alternatively if the rate of take was 2.5 l/s the same stream could supply water for 16 ha without an increase in reported allocation.

[16] ©2014-2015 Aqualinc Research Limited - PO Box 20-462, Bishopdale, Christchurch, New Zealand
[17] Šimůnek, J. and M. Th. van Genuchten, Modelling non-equilibrium flow and transport with HYDRUS, Vadose Zone Journal, doi:10.2136/VZJ2007.0074, Special Issue "Vadose Zone Modelling", 7(2), 782-797, 2008
[18] For example, irrigation requirements for kiwifruit were reduced from 5 mm/day to 2 mm/day.

Future irrigation demand was determined by multiplying the proposed future irrigated areas by the reasonable use rates and/or volumes of irrigation determined using Hydrus.

The percentages of irrigated area in each land use were determined for current irrigation consents. These percentages were then applied to the potential future land use in the potential irrigable areas to determine future potential irrigated area, recognising that all potentially irrigable area will not be actually irrigated. For example, if only 10% of dairy farms are irrigated, then any increase in the dairy farming area was assumed to also only irrigate 10%.

The basis of this approach, i.e. maintaining the current percentages of irrigation for the future, is that irrigation in BOP is primarily used for drought insurance, and is less frequently required than for higher demand irrigated areas such as Hawke's Bay. Relative to other regions, BOP farmers and growers are generally less affected by droughts and the benefits of irrigation are lower; they also have options other than irrigation to manage droughts.

Future irrigation demand was specified in litres per second for surface water and cubic metres per year for groundwater.

Other future water demands

No specific allowance has been made for increases in water demand for uses other than for irrigation and frost protection. The justification for that approach is that there is surplus or currently unused capacity in many consents held for municipal use. While some City/District councils may have capacity for expanded industrial/commercial use, they may be saving excess capacity for future domestic use. Detailed analysis of potential future increase in demand is not justified at this stage for a high level study.

With groundwater, access to water and the associated infrastructure required to use it (e.g. bores), is more likely to be a constraint. (This may not be a valid assumption in the Kawerau district where the combination of geothermal heat and the continued development of wet industries maybe the main driver of growth).

Future supply and demand comparison

The balance between surface water and groundwater was determined by assuming that surplus surface water would be utilised first, meaning that surface water resources became fully allocated, and the balance was taken from groundwater.

Current water demand has been compared with current water supply (allocation limits) to provide a surplus or shortfall of water. The comparison has been completed separately for surface water and groundwater.

Expansion of demand has the options of being supplied by surface water, or groundwater, depending on what is available and on the location of the take.

By preference, future demand is assumed to first be supplied by surface water, and then by groundwater, if there is insufficient surplus surface water to meet future demand. For irrigation, the area of irrigation expansion was adjusted so that the majority of surplus surface water was allocated. The remaining area was allocated to groundwater. This assumes that water from either source would always be accessible, if available.

This approach was taken because surface water, if available, would be more certain and less costly than groundwater. While a sufficient allocation of groundwater may have been available to meet the needs of all water demand expansion, the uncertainty around finding groundwater and the high cost of drilling deep bores would tend to favour a surface water supply.

2.2.8 Potential impacts

The impact of potential irrigation expansion on gross earnings and earnings before interest and tax (EBIT) was estimated. Also estimated was the potential impact on employment.

Earnings

Gross farm gate revenue and EBIT were determined based on the rates given in *Table 3*.

Table 3: Orchard/farm gross revenue and gate return multipliers:

Land Use	Gross Revenue ($/ha/yr)		EBIT ($/ha/yr)	
	Irrigated	Dryland[19]	Irrigated	Dryland[19]
Green kiwifruit[20]	69,300	57,750	23,400	19,500
Avocado[21]	97,000	81,000	52,000	43,500
Dairy[19]	6,700	5,900	2,100	1,800

Gross Revenue from irrigation expansion was determined by multiplying the change in irrigated area for each land use by the Gross Revenue "Irrigated" values in *Table 3* and summing those values for all land uses. Where there was no change in irrigated area or a particular land use was not irrigated, the change in gross revenue was zero.

EBIT from irrigation expansion was determined by multiplying the change in irrigated area for each land use by the EBIT "Irrigated" values in *Table 3* and summing those values for all land uses. Where there was no change in irrigated area or a particular land use was not irrigated, the change in gross revenue was zero.

Employment

Changes in employment were determined based on the full time equivalent (FTE) rates given in *Table 4*.

FTE's include direct, indirect and induced employment, as follows.

- Direct employment occurs on the farms/orchards themselves.
- Indirect employment covers industries servicing farms/orchards.
- Induced employment is created in the wider regional economy as a result of increased activity in farms/orchards and service industries.

Table 4: Multipliers for changes in employment due to irrigation expansion[22]

Land Use	$/FTE
Average kiwifruit	125,000
Avocado/ horticulture	125,000
Dairy/Dairy support	200,000

The change in employment from irrigation expansion was determined by dividing the change in gross revenue for each land use by the $/FTE values in *Table 4* and summing those values for all land uses.

[19] Derived from Economic and contaminant loss impacts on farm and orchard systems of mitigation bundles to address sediment and other freshwater contaminants in the Rangitāiki and Kaituna-Pongakawa-Waitahanui Water Management Areas. Perrin Ag Consultants Ltd & Manaaki Whenua Landcare Research, August 2018.
[20] Assumes new development will be 100% green, irrigated 20% above dryland.
[21] Dryland gross returns based on 15 tonnes.ha x 5.5 kg/tray x $30/tray, irrigated 20% above dryland
[22] Sourced from: The Opuha Dam, an ex post study of its impacts on the provincial economy and community. Harris Consulting, Butcher Partners, University of Auckland.

Where there was no change in irrigated area or a particular land use was not irrigated, the change in FTE's was zero.

Nutrients

Intensifying land and growing crops generally results in increased leaching of nutrients relative to what occurs on unimproved land. Under irrigation, the quantity of leaching tends to increase (because soil is wetter for longer).

Different rates of nutrient leaching occur under different land uses, and converting from one land use to another may or may not result in increased nutrient leaching.

Baseline nutrient leaching rates were obtained from Williamson Water Advisory (WWA) data. This data has been used for the analysis of the impact of land use change on water quality in the Kaituna-Pongakawa-Waitahanui and Rangitāiki WMAs. The Kaituna-Pongakawa-Waitahanui and Rangitāiki data was averaged to provide indicative nutrient leaching values for other catchments (*Table 6*).

Table 5: Indicative baseline nutrient leaching values due to irrigation expansion[23]

Land use	Current (kg N/ha/yr)	Future (kg N/ha/yr)
Dairy	76	86
Kiwifruit/ horticulture	24	27
Sheep & Beef	30	35

Loss of phosphorus into water ways is expected to be low, as the primary mechanism for phosphorus loss is overland flow of water. Under properly designed and managed irrigation, overland flow is minimal.

Phosphorus leaching was assumed to be 1 kg P/ha/yr under all land uses for both dryland and irrigated properties. This means that overall, when considering dryland and irrigated land use together, there would be no change in P leaching. However, because P leaching values are presented for irrigated land use only, reported changes in P leaching will reflect changes in irrigated area only.

It is important to note that the estimates of nitrogen and phosphorus loss reported are only indicators of likely environmental impacts but are insufficient to estimate the actual impact on receiving freshwater environments or the likely extent of water quality constraints.

2.3 Phase 3: Workshops

The desktop analysis discussed at the workshops is based on the best available information, which has known limitations. It is also based on current planning provisions which may change as freshwater limits are progressively set throughout the region under the NPS-FM.

Workshops to discuss the findings from Phase 2 were completed for the following catchments.

- Waioeka/Otara WMA - held in Ōpōtiki on 6 June 2018
- Wairoa catchment (Tauranga Moana WMA) – held in Bethlehem on 7 June 2018
- Tarawera WMA – held in Kawerau on 12 September 2018
- Whakatāne & Ōhiwa/Waiōtahe WMAs – held in Whakatāne on 13 September 2018

[23] Unpublished data supplied by WWA to Aqualinc

- Kaituna-Pongakawa-Waitahanui WMA – held in Pongakawa on 25 October 2018
- Rangitāiki WMA – held in Whakatāne on 23 October 2018

The format of the workshops consisted of:

Pre-circulation of information for attendees to consider. This consisted of a current land-use map of the relevant catchment, and a description of the key findings of the technical analysis.

An introductory presentation by BOPRC outlining:

- The reasons for the project
- Links with the Regional Growth Strategy
- The desire to find out if water quantity is a constraint to economic growth.
- Proposed Plan Change (PC9); the region-wide plan change that formalises default surface and groundwater allocation limits, and monitoring requirements
- The impact of catchment specific limits on water users and future development.

A technical presentation by Aqualinc (except for Kaituna-Pongakawa-Waitahanui and Rangitāiki, where BOPRC staff led the presentation) including:

- Current water demand based on consented and non-consented water takes
- Current ground and surface water resource, and any water surpluses (or deficits) relative to the PC9 allocation framework, and the (limited) scope for efficiency gains via a 'reasonable use test'
- Potential irrigable area, and potential land uses within that area
- Potential impacts from the new irrigable area, including economic, employment and nutrient loss impacts.

Workshop feedback (pro's, cons and information gaps) from the introduction and technical presentations. Key points from the presentations were summarised, to focus discussion. Participants were asked to comment on whether they considered the estimates to be reasonable, with respect to:

- Access to fresh water (e.g. new sources, proximity to demand, access to groundwater, reliability of supply, etc.);
- Viability of suggested new irrigated land uses in the area; and
- Access to capital, land, labour, etc.

Broader workshop feedback considering potential opportunities for and barriers to economic development using water at a wider catchment or WMA level.

3 PHASE 1

3.1 Potential irrigable area

The first stage of Phase 1 was to determine the potential irrigable area in each WMA.

These have been mapped in *Figure 2*.

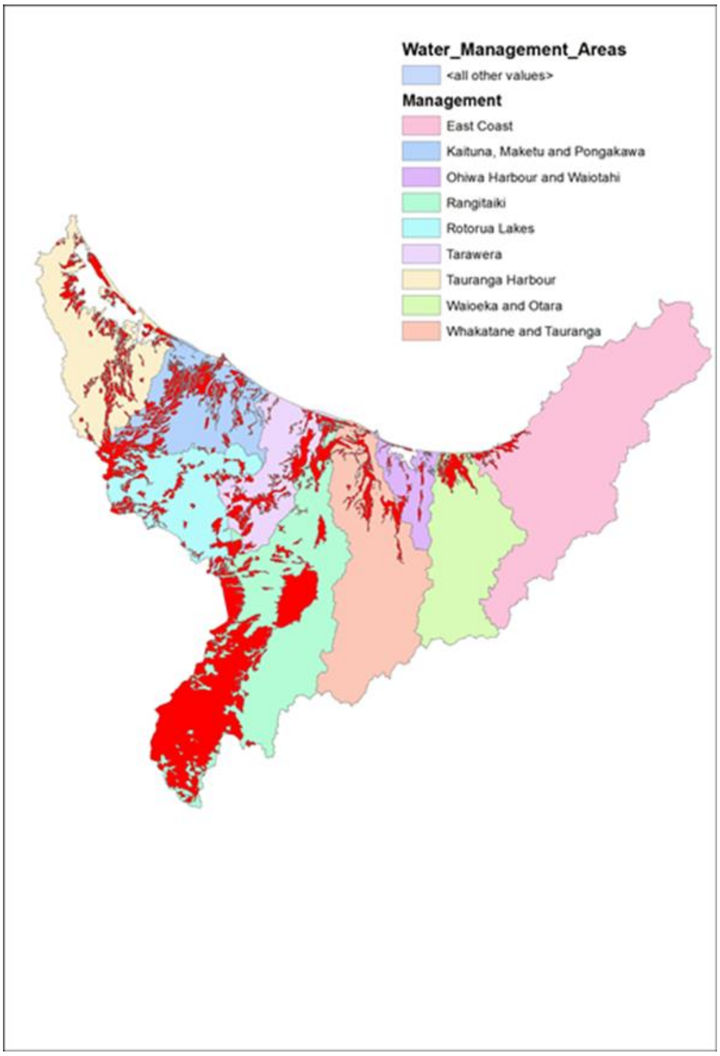

Figure 2: Potential irrigable areas (shown in red) in each Water Management Area in Bay of Plenty

Note that these areas include both currently irrigated land and land that could potentially be irrigated based on the criteria used in Section 2.1.2 to define irrigable area.

The total land area in the region is 1,334,062 hectares. The initial high-level assessment of irrigable area found that 18% of this area, or 238,448 hectares could be irrigated.

The initial assessment did not take into account present land use or constraints other than those listed in Section 2.1.2, and therefore would significantly overstate the potential for irrigation.

A more conservative assessment was taken, by applying the criteria described in Section 2.1.3. Based on the reassessment, the area in each WMA was then tabulated. See *Table 6*.

Table 6: Potential irrigable areas in each WMA

Water Management Area	WMA area	Irrigable area	% irrigable
East Coast	275,418	0	0
Kaituna-Pongakawa-Waitahanui	107,357	3,140	3
Ohiwa Harbour and Waiotahe	34,196	0	0
Rangitāiki	295,584	3,482	1
Rotorua Lakes	109,990	7,725	7
Tarawera	79,606	1,782	2
Tauranga Harbour	129,416	5,958	5
Waioeka and Otara	123,112	0	0
Whakatāne	179,383	0	0
TOTAL	**1,334,062**	**22,087**	**2%**

3.2 Supply-demand balance

Irrigation demand in litres per second (representing peak flow rate) was estimated for each WMA. Surface water and groundwater allocation limits were sourced from the Availability Report.

The respective potential irrigable areas in each WMA were assigned a water source – surface water or groundwater, based on proximity to the source, and the flow rates and volumes applied to each area to determine a demand from the source. Where groundwater management zones traversed WMA boundaries, WMA areas were grouped together to represent the potential water demand from the management zones.

A realistic assessment was taken, by applying the criteria described in Section 2.1.3, with the results shown in *Table 7*.

Table 7: Realistic supply – demand balance

Water Management Area	Irrigation Demand (l/s)	SW allocation limits (l/s)	GW allocation limits (l/s)
East Coast	-	7	
Kaituna-Pongakawa-Waitahanui	1850	4797	1261[4]
Whakatāne, Ohiwa Harbour and Waiotahe	-	889	3798
Rangitāiki	2090	5593	2375[3]
Rotorua Lakes	4547	549	115[2]
Tarawera	1077	2234	793
Tauranga Harbour	3455	705	4,473
Waioeka and Otara	-	638	489[1]
TOTAL	**13,019**	**15,428**	**13,303**

Note 1: Includes East Coast

Note 2: Includes part of Tarawera

Note 3: Includes part of Rotorua Lakes, Tarawera, Whakatāne.

Note 4: Includes part of Tarawera

Table 7 shows that a realistic potential irrigated area in the BOP region could be about 22,000 hectares and require up to 13,000 litres per second of water. Total allocation available is about 28,500 litres per second, which means that, overall, there is sufficient water in the BOP region overall to meet a realistic irrigation demand (not accounting for other uses).

In addition, some areas such as Rotorua Lakes are unlikely to have high irrigation demand due to sufficient rainfall being available in most years.

While there is sufficient overall availability to meet a realistic potential demand, availability and accessibility to the resource in individual WMAs and with surface water and groundwater differs at the WMA level. *Table 8* shows the availability of surface water by WMA.

Table 8 : Surface Water Allocation by WMA (allocation in litres/sec)

Water Management Area	Total Remaining Allocation	Total Over Allocation
East Coast	0	-24.7
Kaituna, Maketu and Pongakawa	1969.5	-2098.2
Ohiwa Harbour and Waiotahi	0	-28.8
Rangitaiki	1299.9	-1531.8
Rotorua Lakes	63.9	-439.4
Tarawera	126.6	-3404.2
Tauranga Harbour	224.5	-1395.9
Whakatane	28.8	-3.1
Waioeka and Otara	340.5	-26.3

Note: Excludes rivers and streams for which no allocation limit is listed in availability report.
Also excludes rivers and streams from which consented takes are prohibited.

The availability of groundwater is shown in *Table 9*.

Table 9: Groundwater allocation by WMA (allocation in litres/sec)

Water Management Area	Total Remaining Allocation	Total Over Allocation
East Coast + Waioeka and Otara	481.9	0
Kaituna, Maketu and Pongakawa	308.1	-159.3
Kaituna, Maketu and Pongakawa+Tarawera	82.3	0
Ohiwa Harbour and Waiotahe	1335.2	0
Ohiwa Harbour and Waiotahe + Waioeka and Otara	2041.1	0
Rangitaiki	0	-18.9
Rangitaiki+Whakatane	516	0
Rotorua Lakes + Tarawera	106.6	0
Rotorua Lakes + Tarawera + Rangitaiki	891.6	0

Tarawera	737.7	0
Tarawera+Rangitaiki	458	0
Tauranga Harbour	3741.1	-0.3
Whakatane	83.5	0
Whakatane + Ohiwa Harbour and Waiotahe	76	0

Table 9 shows that while groundwater in three WMA's is over-allocated, there is a large surplus of groundwater available, in most WMAs.

3.3 Opportunities and constraints

Phase 1 found that potentially, a substantial amount of land could be irrigated, if there is water available (although it did not confirm/indicate that the reason for not irrigating is a lack of water – other factors such as access to capital, risk averseness, site specific limitations, etc. may be the cause).

Water-related constraints to future development include:

- The availability of water where it is needed – this is variable over the BOP region.
- Water availability is limited by current allocation rules. However interim allocation limits will be revised in each WMA as the NPS-FM is implemented throughout the region.
- Un-used water is locked up under historical consenting practices.
- Over allocation needs to be addressed in some rivers and aquifers.
- Urban & municipal demand - increased urban demand is highly likely, although in most cases this is already provided for within existing consents. Water for the reasonably foreseeable future is already secured.
- Production increases through conversion of pasture-based enterprises to horticulture (whether irrigated or not), could result in increased demand from processing activities.
- Water quality degradation due to increased leaching of nutrients. There is strong pressure to improve water quality.
- Raising the intensity of grazed animal-based enterprises is very unlikely to maintain water quality.

The Phase 1 analysis concluded that identifying opportunities was best tackled at the catchment and aquifer level, and a case study approach was recommended.

Questions raised from Phase 1 were:

- Are factors other than water availability the reason why the opportunity is not being taken?
- Which catchments is it sensible to concentrate on first?
- What land-uses are most likely to feature on new irrigated areas?
- What opportunities are there for implementing demand management to use water more efficiently?
- Can irrigated area be increased by reducing conservatism in water allocation rules?
- Is storage necessary?

3.4 Overview of Māori-land

Increasing the productivity of Māori land was a key opportunity identified in the Regional Growth Study and subsequent action plan. Māori land[24] encompasses over 400,000 hectares, or about 30%, of the Bay of Plenty region, as illustrated in *Figure 3*.

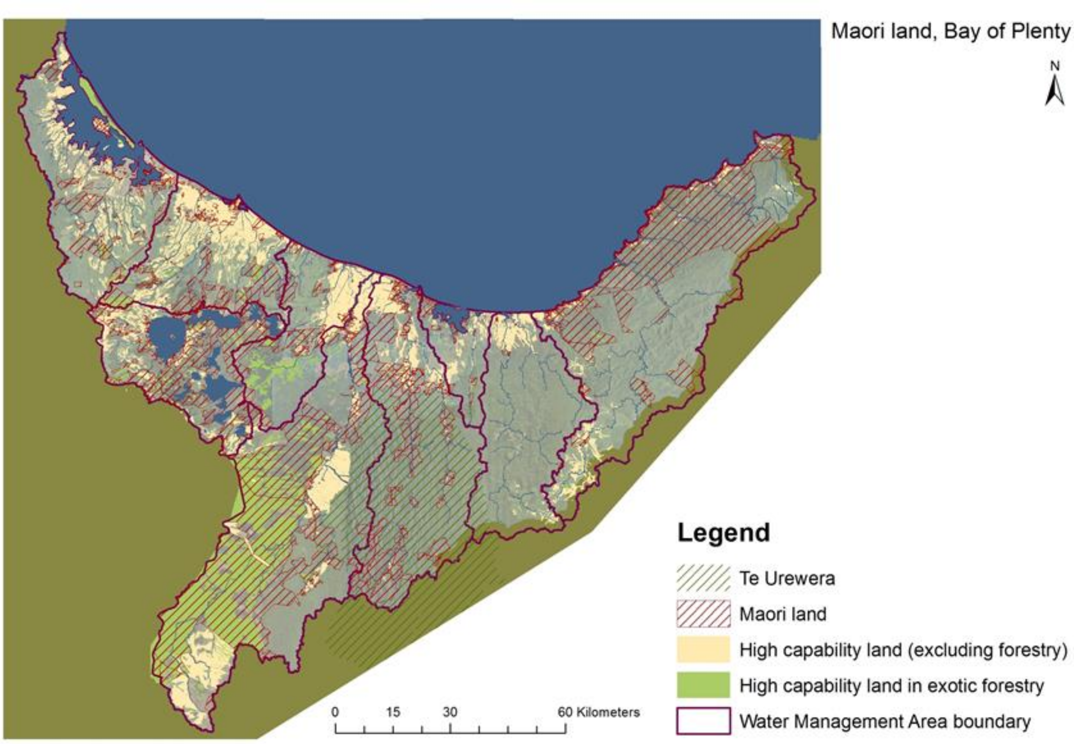

Figure 3: Māori-land in the BOP region

The vast majority of this land is currently in exotic or native forestry. Of the portion in exotic forestry, about 90,000 hectares is within high capability land (LUC 1 to 4), which could theoretically be converted into other land uses, including potentially irrigated land uses. However, due to established lease arrangements, national policy direction and challenges involved in changing land use, it is unlikely that much of this land will convert into other land uses.

For example, only a maximum of 18,000 of the 133,000 hectares of Māori land in exotic forestry in the Rangitāiki WMA is expected to be able to be converted to other land uses over the next 30 years. There are only 28,000 hectares of high capability Māori land across the Bay of Plenty in other land uses, which could be developed or converted.

24 Defined in this case as land included in the Māori Land Online dataset as at December 2015 with some corrections and amendments from other sources, including some land returned under Treaty Settlements. Māori land included here should be considered indicative only as not all Māori land in the Bay of Plenty is necessarily represented here.

4 PHASE 2 – CASE STUDIES

4.1 Waioeka/Otara WMA

4.1.1 Catchment outline

The Waioeka/ Otara catchment area is shown in *Figure 4*. Total catchment area is 123,112 hectares. In this case, the catchment and Waioeka/Otara WMA are the same.

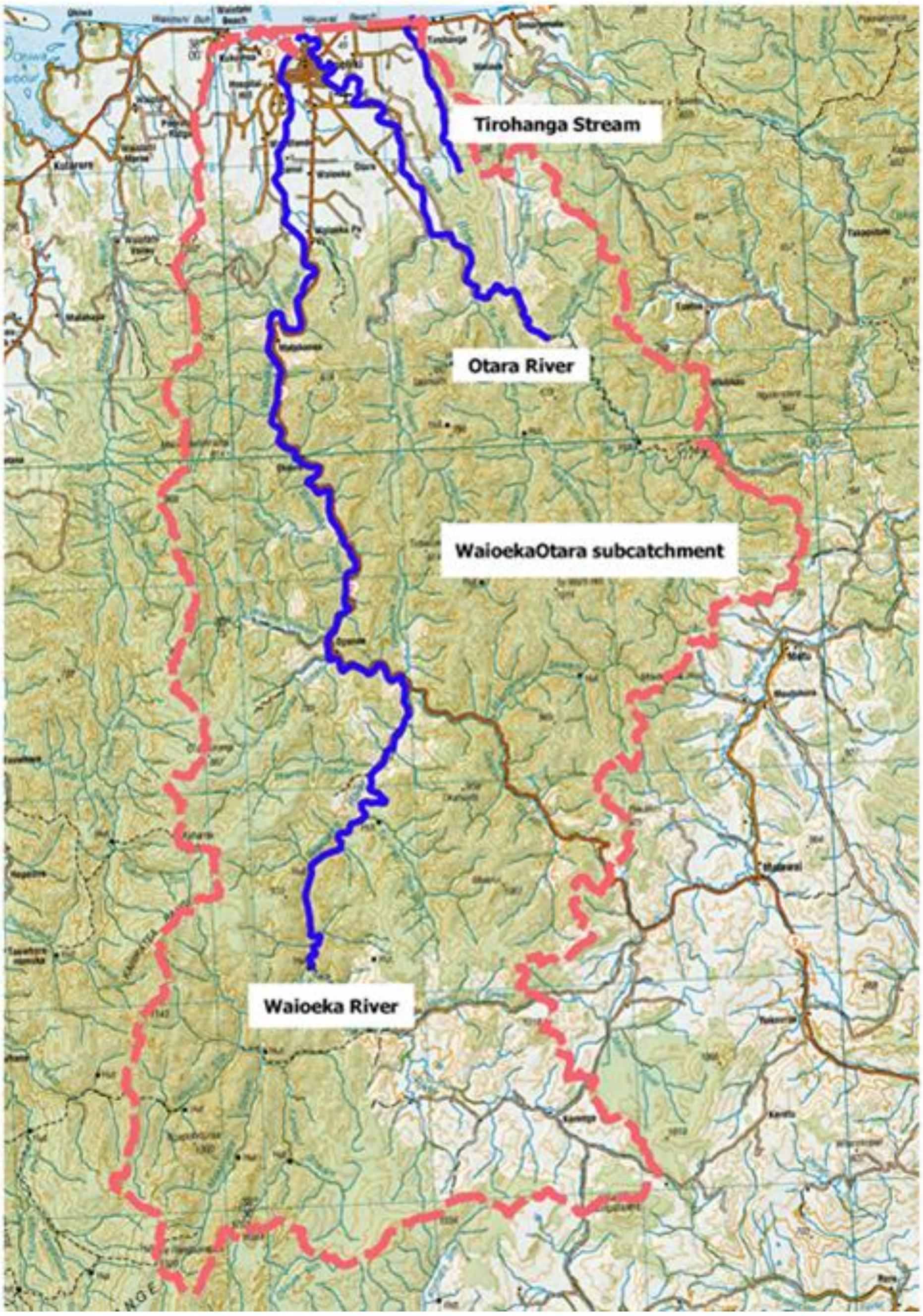

Figure 4: Rivers and streams within Waioeka & Otara WMA

The main river is the Waioeka River, 65 km long, which flows from Te Urewera to the sea at Ōpōtiki.

Figure 5 presents the current land use in the catchment. While kiwifruit is shown separately to avocado/horticulture in *Figure 5*, both land uses could simply be described as horticulture.

Waioeka & Otara Water Management Area: Land use

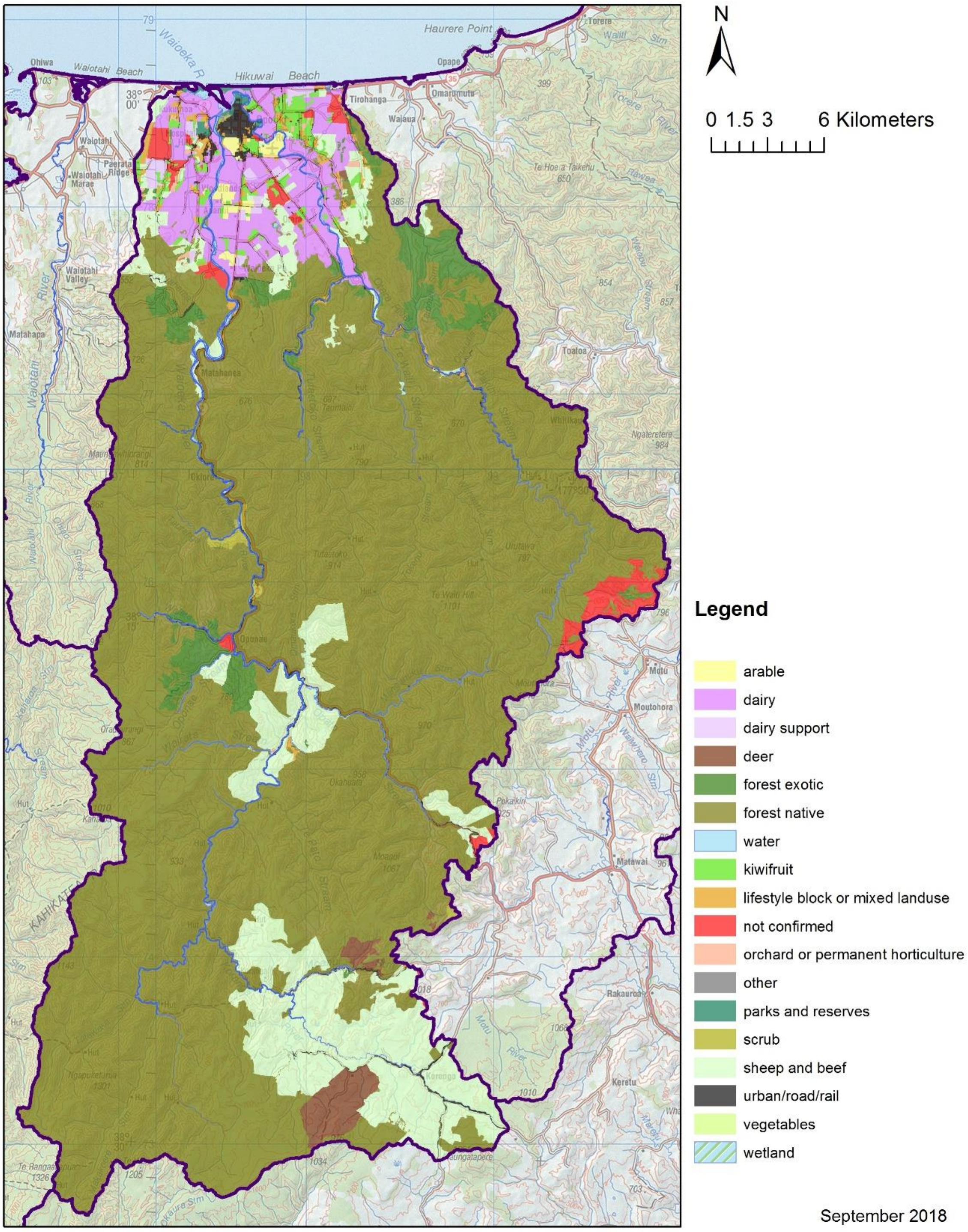

Figure 5: Current Land use in Waioeka & Otara WMA

75% of the catchment is in native forestry, with further area in exotic forestry. The catchment is predominantly rural, with a wide range of water users.

Further detail of the land use is given in *Figure 6*. The number below the label is the area in hectares.

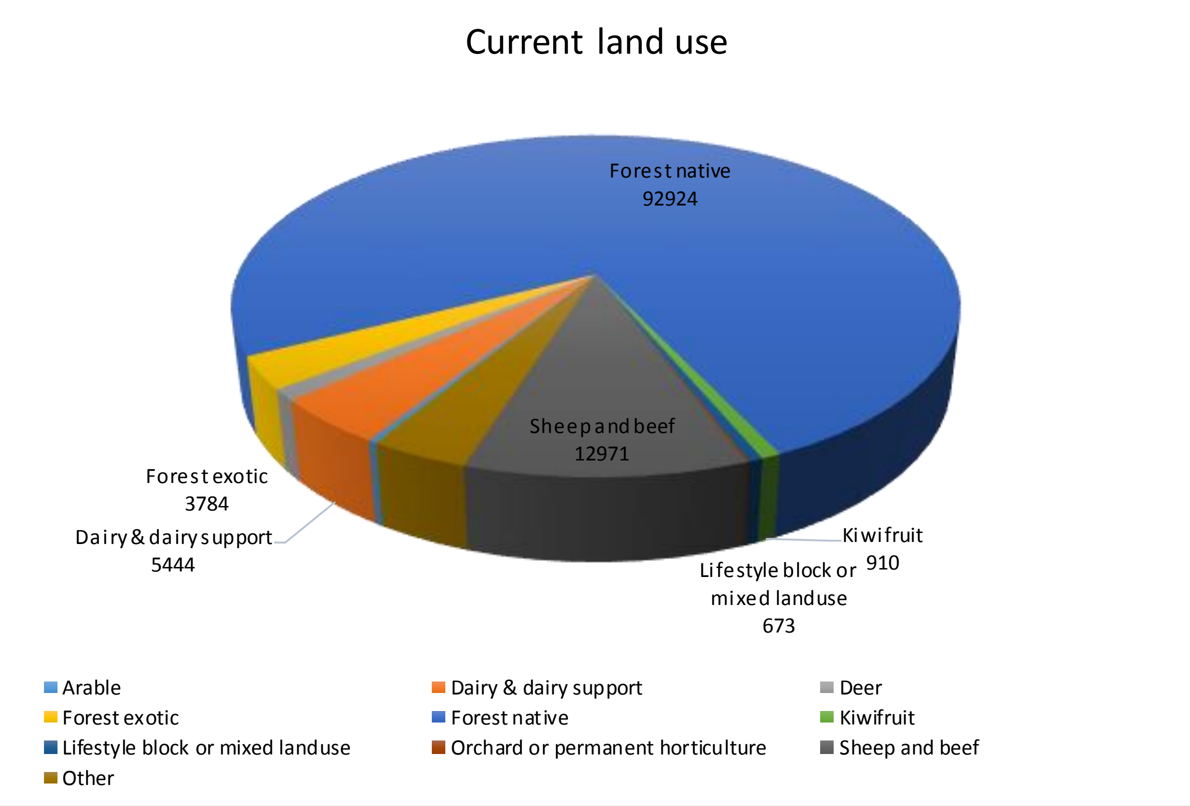

Figure 6: Detailed current land use in Waioeka & Otara WMA

The current consented irrigated area is 498 ha. Within this, 62 hectares is irrigated from surface water and 436 hectares from groundwater. Almost 50% of the existing irrigation is on kiwifruit, with 20% of irrigated horticulture.

4.1.2 Waioeka/Otara total allocation limits

The flow rate of surface water and volume of groundwater allocation limits for abstractive use is as shown in *Table 10*.

Table 10: Current allocation limits for surface water and groundwater

	Surface water (litres/sec)	Groundwater (million m^3/year)
Streams & rivers across both zones[1]	638	
Groundwater[2]		22.7

Note 1: Includes Waioeka River, Waiaua Stream and Otara River.

Note 2: From BOPRC revised groundwater allocation limits.

There are other sources, particularly small streams that have not yet been given specific allocation limits in the availability report that are not included in the cumulative allocation limit above. Small amounts of surface water have been consented from streams that do not currently have allocation limits specified in the availability report. While default allocation limits could be applied, there is insufficient flow data available to calculate the limits.

4.1.3 Allocable water with reasonable use

Table 11 provides a comparison of water supply and demand to determine whether the catchment has a water shortage or surplus.

The table also shows the water shortage or surplus with the reasonable use rates (for surface water) and volumes (for groundwater) which better match the actual need, relative to current allocations.

Reasonable use supply rate is assumed to be a maximum rate over 24 hours of 0.23 l/s/ha (2 mm/day) for kiwifruit and horticulture, and 0.45 l/s/ha (3.9 mm/day) for pasture. Annual volume allocation requirements for irrigation (the volume required to meet demand in a 1 in 10 year drought year) are relatively modest at somewhere between 800 m^3/year/ha to about 3,250 m^3/year/ha, with the lower figures being for deep rooted horticulture and the higher figures for pasture.

Using the reasonable use figures for irrigation and frost protection, the total surface water allocation could reduce from 278 l/s to 214 l/s. The total groundwater allocation could reduce from 13.2 million cubic metres to 10.6 million cubic metres per year.

Table 11: Comparison of supply and demand

	Surface water (litres/sec)		Groundwater (million m^3/year)	
	Current	Reasonable use	Current	Reasonable use
Irrigation & frost protection	78	14	4	1.5
Other consented uses	195	195	8.2	8.2
Permitted/unconsented take estimate	4.7	4.7	0.9	0.9
Total allocated	278	214	13.2	10.6
Allocation limit	638	638	22.7	22.7
SURPLUS	**360**	**424**	**9.5**	**12.1**

Overall, there is a surplus of water allocation available to support potential expansion.

4.1.4 Potential irrigable area and land use change

While there is a surplus of both surface water and groundwater in the catchment, the degree to which water-demanding enterprises can be expanded or developed depends on water demand. The largest potential future water demand is likely to come from irrigation.

To expand the irrigated area, land use will change. The estimated future land use for this catchment is shown in *Figure 7*.

It is predicted that there would be a large increase in the land for kiwifruit and other horticulture. A portion of exotic forest would also increase slightly while the area for dairy land would remain the same.

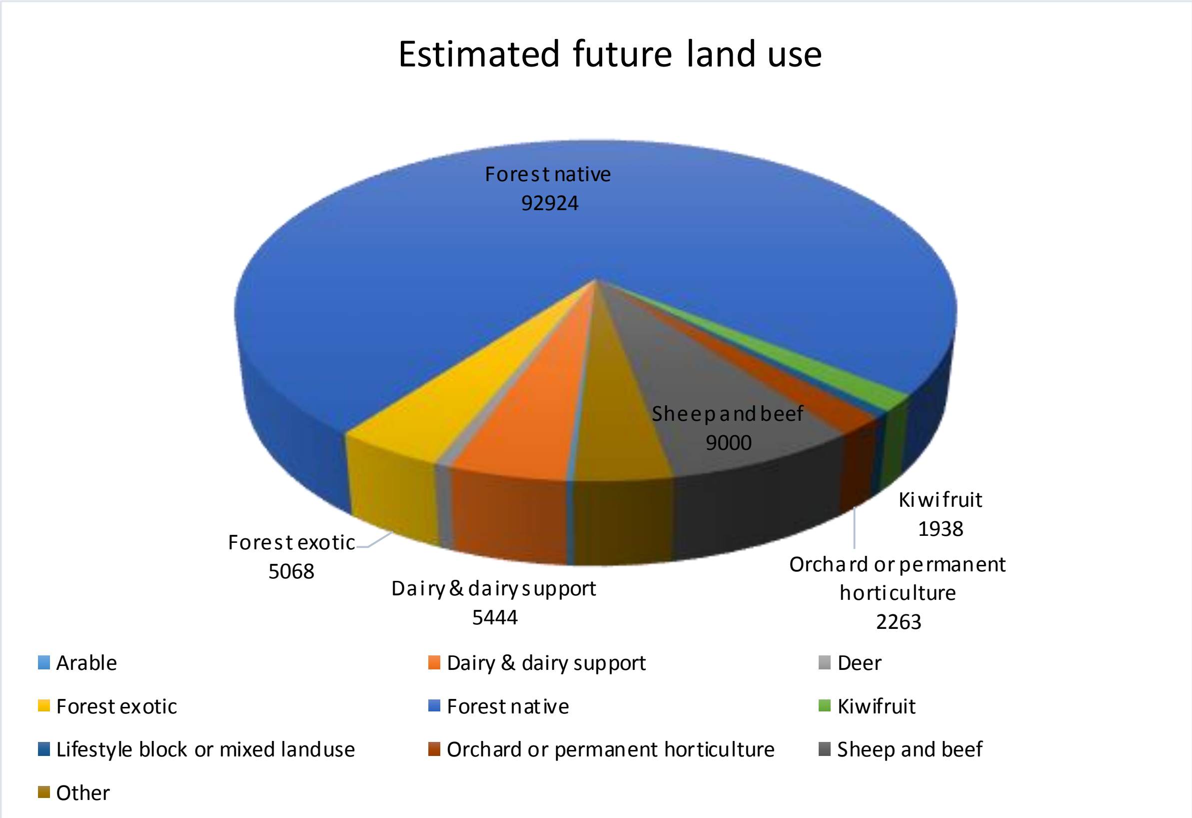

Figure 7: Estimated future land use in Waioeka & Otara WMA

Potential irrigable areas were determined using the criteria outlined in Section 2.2.2.

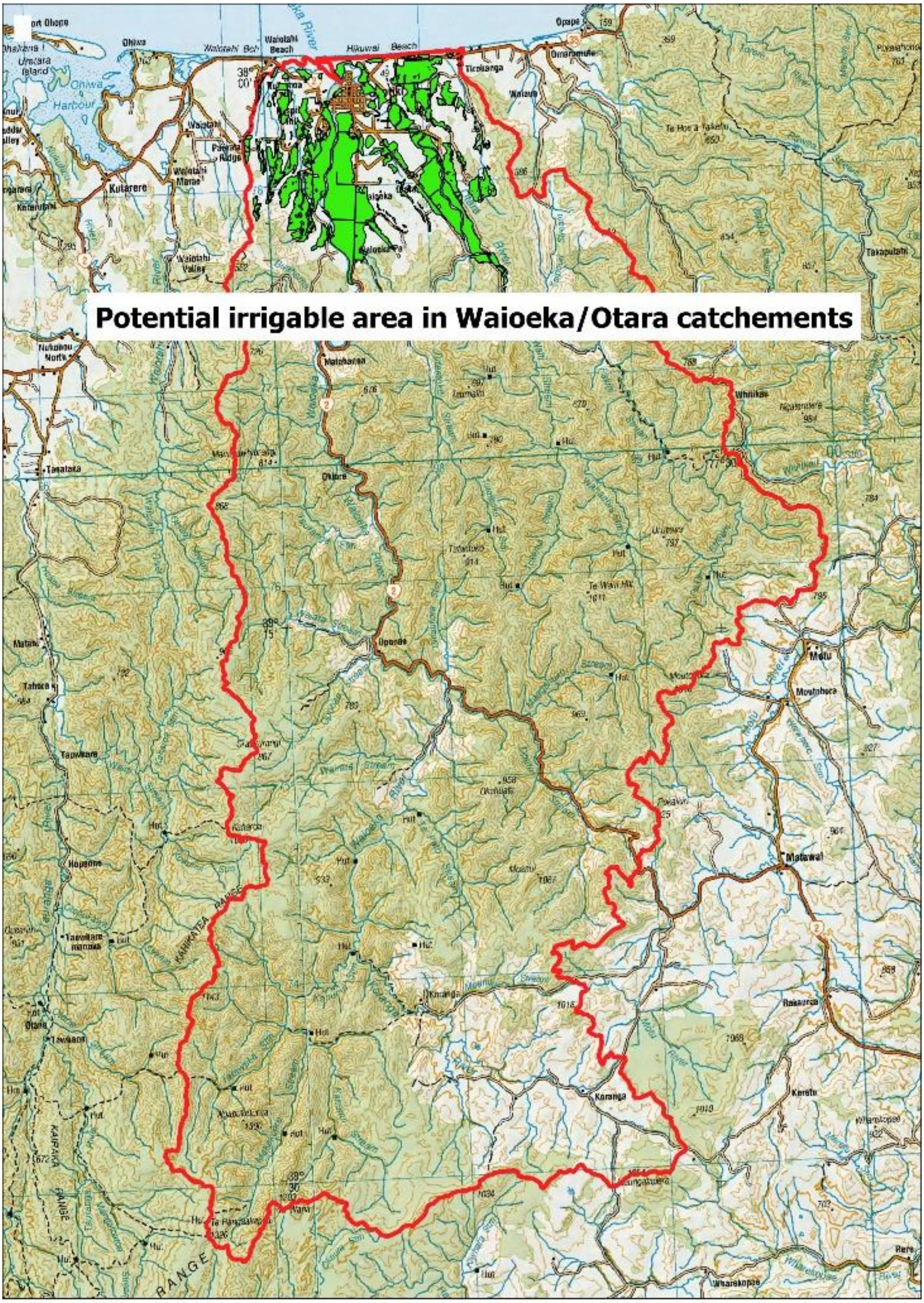

Figure 8: Potential irrigable areas in Waioeka & Otara WMA

A detailed investigation into potential irrigable area provides a figure of 4,202 ha (total of existing irrigated area and potentially new irrigation). The current irrigated area is 498 ha. There is scope, therefore, to increase the irrigated area by 3,704 hectares.

This study assumes the ratio of irrigated land to the total area in a particular crop would stay the same in the future (i.e. 32% for kiwifruit, 25% for avocado/horticulture and 3% for dairy). Therefore the total potential irrigated area would increase by 861 ha, from 498 ha to 1,359 ha. The breakdown of the irrigated area is shown in *Figure 9*.

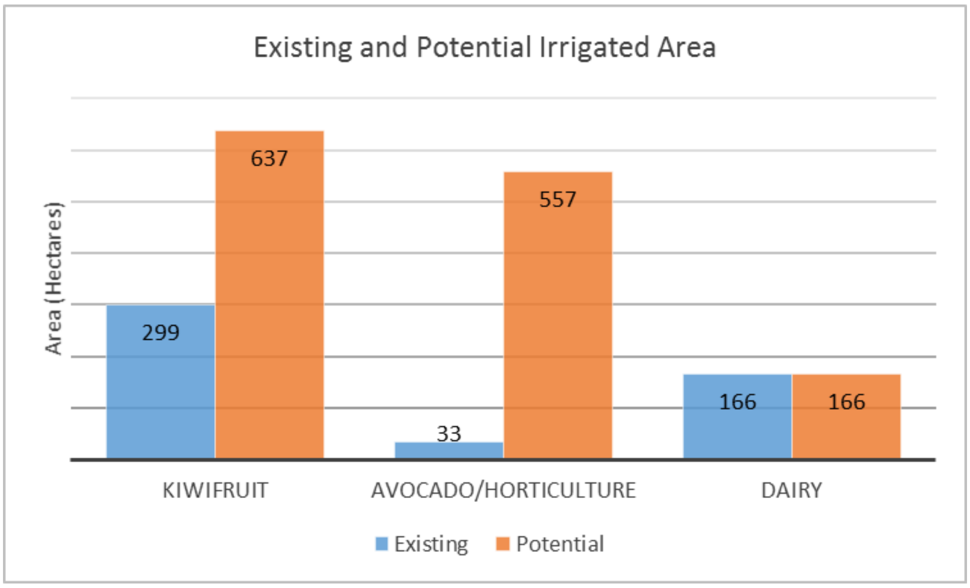

Figure 9: Current and potential irrigated areas

4.1.5 Comparison of supply and demand

To balance the supply of surface and groundwater availability to meet as much of the potential demand as possible, the new development can be supplied from surface water and groundwater.

Using the reasonable use rates, there is sufficient additional surface water available (424 l/s) to meet the total expansion on its own.

By irrigating further 861 ha, the potential demand for surface water could increase to 414 l/s as shown in *Table 12*. After the expansion, there would still be adequate surface water and groundwater resource available (assuming it can be found) to support any foreseeable growth in demand.

Table 12: Comparison of supply and demand with potential expansion

	Surface water (litres/sec)	Groundwater (million m^3/year)
Irrigation & frost protection	214	1.5
Other consented uses	195	8.2
Permitted/unconsented take estimate	4.7	0.9
Total allocated	414	10.6

	Surface water (litres/sec)	Groundwater (million m^3/year)
Allocation limit	638	22.7
SURPLUS	**224**	**12.1**

4.1.6 Economic opportunities

Irrigation of 861 ha expansion, assuming water supply was accessible, has the potential to:

- Increase gross orchard or farm gate revenue by $239 million (driven by horticulture expansion).
- Increase earnings before interest and tax (EBIT or operating profit) by $119 million.
- Increase employment by 1930 full time equivalent employees.

4.1.7 Water quality

Irrigation of another 861 ha could:

- Decrease in N loss to water by 78 tonnes per year.
- Decrease in P loss by 1.4 tonnes per year.

The explanation for the reduction in nutrient losses to water is due to the conversion of some arable land and sheep and beef land to horticulture.

While the use of fresh water for irrigation will provide the increases in revenue and EBIT given above, additional dry land will be converted to unirrigated horticulture and produce additional economic gains and changes in nutrients.

4.1.8 Summary

- Current irrigation in the catchment is just under 500 ha.
- The largest current consented allocations for surface water are for domestic, commercial and industrial use. Permitted takes are estimated to be minor.
- There is surplus surface water and groundwater available.
- Estimated irrigation expansion could be supplied solely by the surplus surface water.
- There would be some surface water and groundwater headroom left after the expansion.
- Intensification, supported by irrigation expansion with the water available, could significantly increase revenue and employment from irrigated agriculture and horticulture, while potentially reducing nutrient loss.

4.2 Wairoa catchment (Tauranga Moana WMA)

4.2.1 Catchment outline

The Wairoa catchment is part of the Tauranga Harbour WMA as shown in *Figure 10*. *Figure 11* shows the catchment in more detail. The total catchment area is 45,421 hectares.

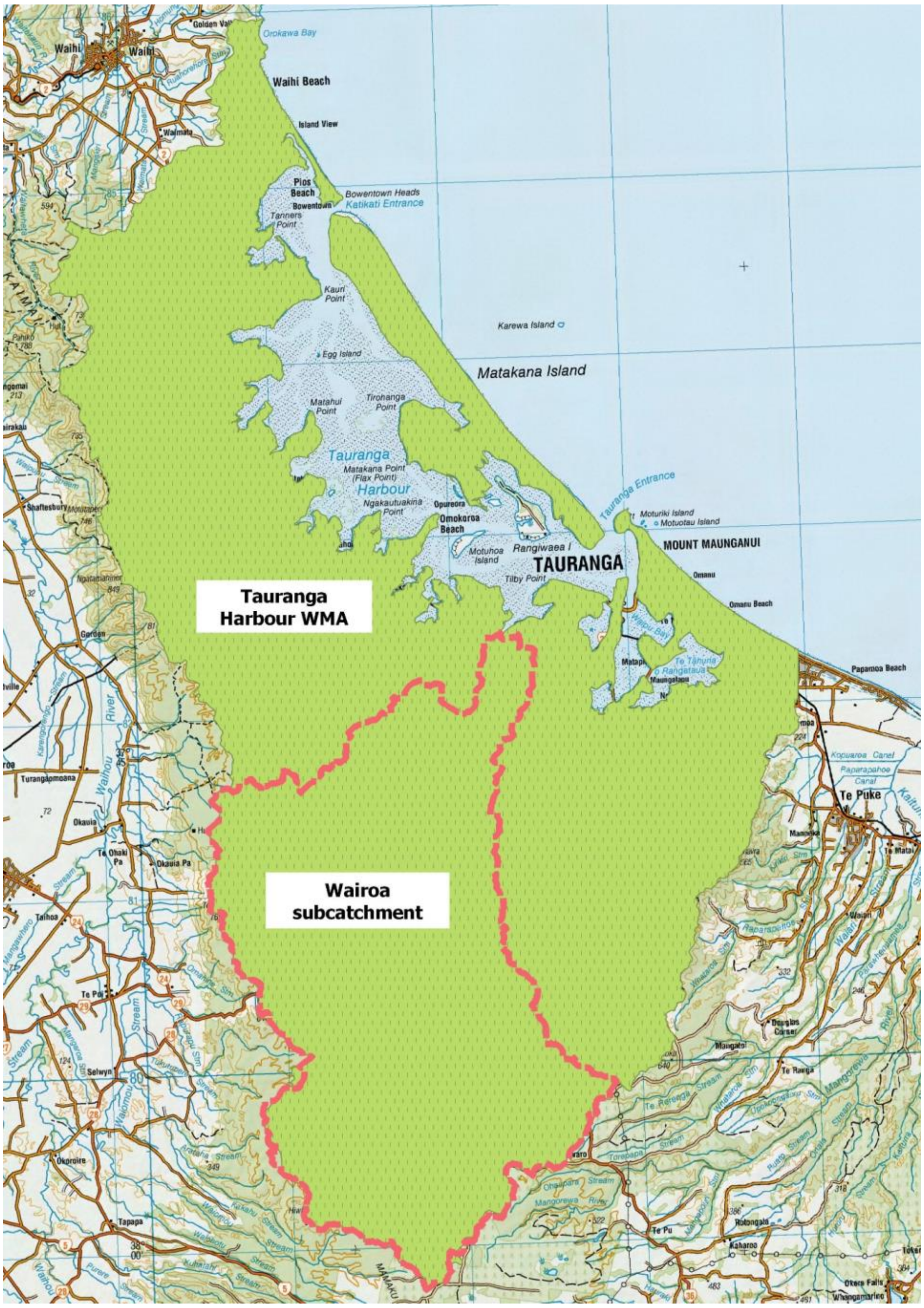

Figure 10: Tauranga Harbour WMA and Wairoa catchment

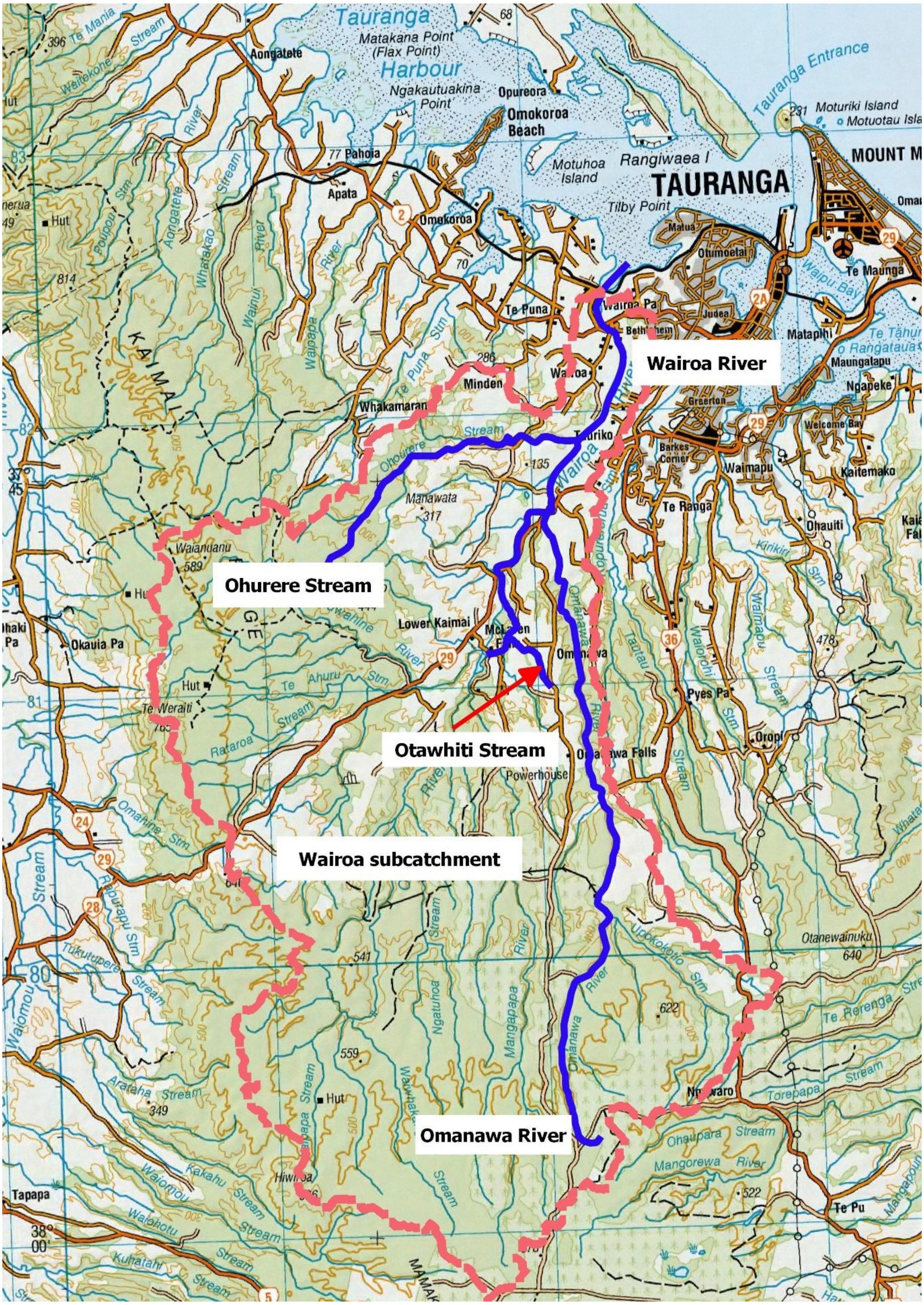

Figure 11: Rivers and Streams in Wairoa catchment

The main rivers are the Wairoa and Omanawa rivers. The Omanawa River flows north from the northern edge of the Mamaku Plateau and reaches the Wairoa River south of Tauranga Harbour. *Figure 12* presents the current land use in the catchment.

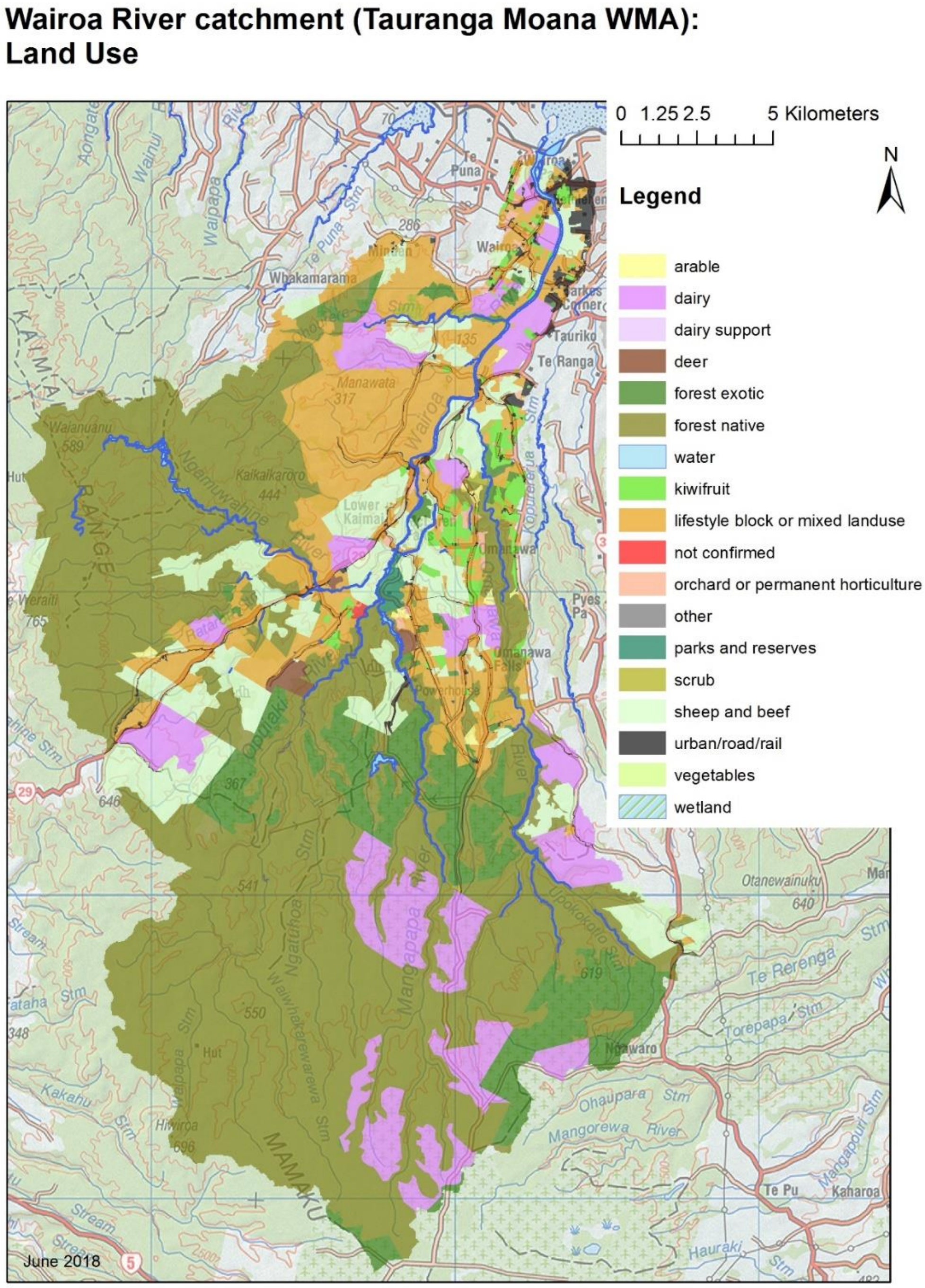

Figure 12: Current Land use in Wairoa catchment

About 53% of catchment is native forestry, with further area in exotic forestry. The catchment is predominantly rural, with a wide range of water users.

Further detail of the land use is given in *Figure 13*. The number below the label is the area in hectares.

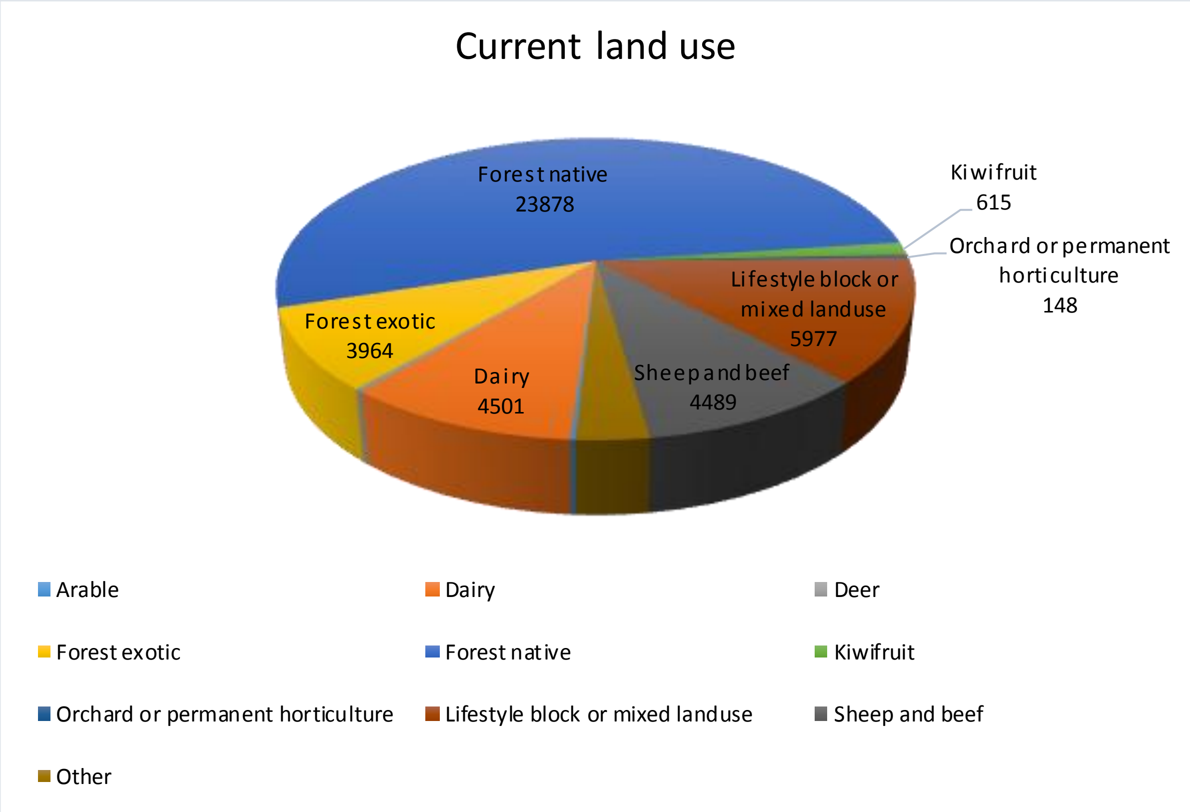

Figure 13: Detailed current land use in Wairoa catchment

The current consented irrigated area is 222 ha. Within this, 35 ha are irrigated from surface water and 187 ha from groundwater. All existing irrigation is on kiwifruit and horticulture.

4.2.2 Wairoa total allocation limits

The flow rate of surface water and volume of groundwater allocation limits for abstractive use are shown in *Table 13*.

Table 13: Current allocation limits for surface water and groundwater

	Surface water (litres/sec)	Groundwater (million m^3/year)
Streams & rivers[1]	194	
Upper and lower groundwater management zones[2]		21.3

Note 1: Includes Wairoa River, Ohourere Stream and Omanawa River.

Note 2: From BOPRC revised groundwater allocation limits.

The Kaimai Hydroelectric Power Scheme is in the Wairoa River catchment. The scheme consists of four power stations: Lloyd Mandeno Station, Lower Mangapapa Station, Ruahihi Station and Kaimai 5 Station. Discharges from this system into the Wairoa River are non-consumptive, so could provide a potential large source of water. This has not been included in the surface water allocation limits in *Table 13*.

Also, there are other sources, particularly small streams that have not yet been given specific allocation limits that are not included in the cumulative allocation limit above. Small amounts of surface water have been consented from streams that do not currently have allocation limits. While default allocation limits could be applied, there is insufficient flow data available to calculate the limits.

4.2.3 Allocable water with reasonable use

Using the reasonable use figures for frost protection and irrigation, the total surface water allocation could reduce from 113 l/s to 100 l/s. The total groundwater allocation could reduce from 6.7 million cubic metres to 6.1 million cubic metres.

Table 14 provides a comparison of water supply and demand to determine whether the catchment has a water shortage or surplus.

The table also shows the water shortage or surplus with the reasonable use rates (for surface water) and volumes (for groundwater) which better match the actual need than the current allocation equivalents.

Reasonable use supply rate (from Hydrus modelling) are 0.23 l/s/ha (2 mm/day) for kiwifruit and horticulture, and 0.45 l/s/ha (3.9 mm/day) for pasture. The annual volume allocation requirements for irrigation (the volume required to meet demand in a 1 in 10 year drought year) are relatively modest at somewhere between 780 m^3/year/ha to about 2,720 m^3/year/ha, with the lower figures being for deep rooted horticulture and the higher figures for pasture.

Using the reasonable use figures for frost protection and irrigation, the total surface water allocation could reduce from 113 l/s to 100 l/s. The total groundwater allocation could reduce from 6.7 million cubic metres to 6.1 million cubic metres.

Table 14: Comparison of supply and demand

	Surface water (litres/sec)		Groundwater (million m^3/year)	
	Current	Reasonable use	Current	Reasonable use
Irrigation & frost protection	21	8	1.0	0.3
Other consented uses	84	84	4.9	4.9
Permitted/unconsented take estimate	8	8	0.9	0.9
Total allocated	113	100	6.7	6.1
Allocation limit	194	194	21.3	21.3
SURPLUS	**81**	**94**	**14.6**	**15.2**

Overall, there is a surplus of water allocation available to support potential expansion.

4.2.4 Potential irrigable area and land use change

While there is a surplus of both surface water and groundwater in the catchment, the degree to which water-demanding enterprises can be expanded or developed depends on water demand. The largest potential future water demand is likely to come from irrigation.

To expand the irrigated area, land use will change. The estimated future land use for this catchment is shown in *Figure 14*.

It is predicted that there would be a large increase in the land for kiwifruit and other horticulture. A portion of exotic forest would also increase slightly while the area for dairy land would remain the same.

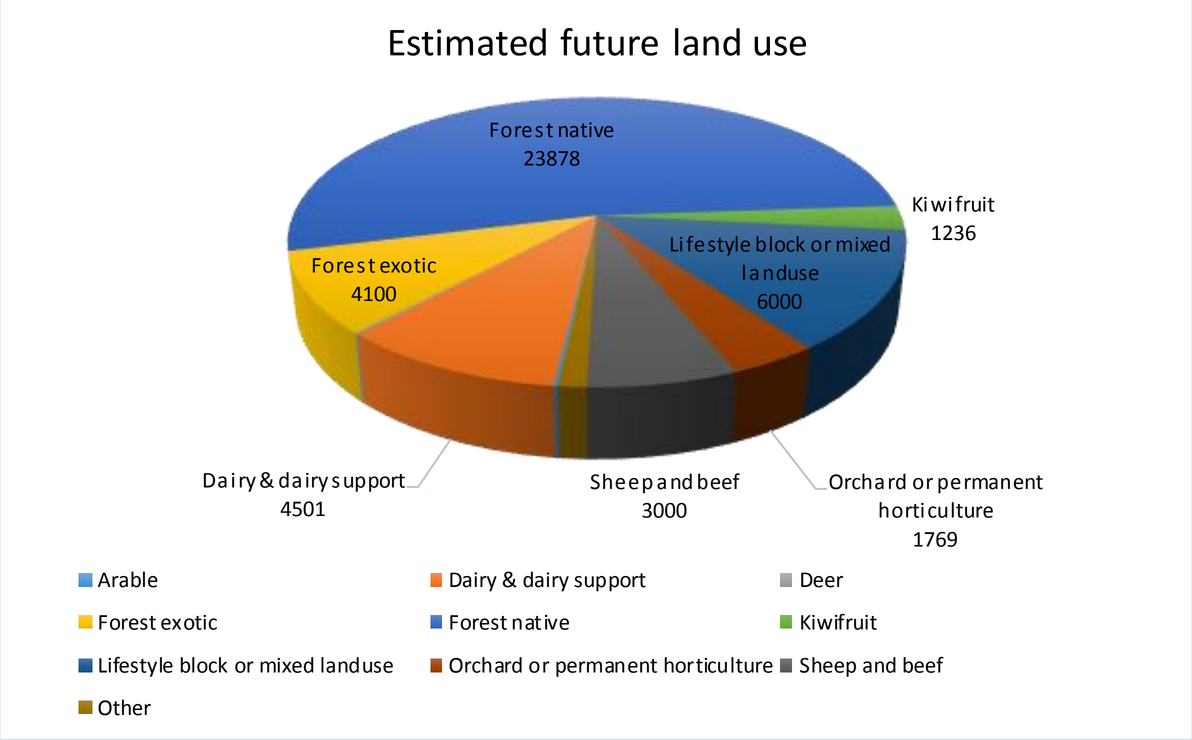

Figure 14: Estimated future land use

Potential irrigable areas were determined using the criteria outlined in Section 2.2.2.

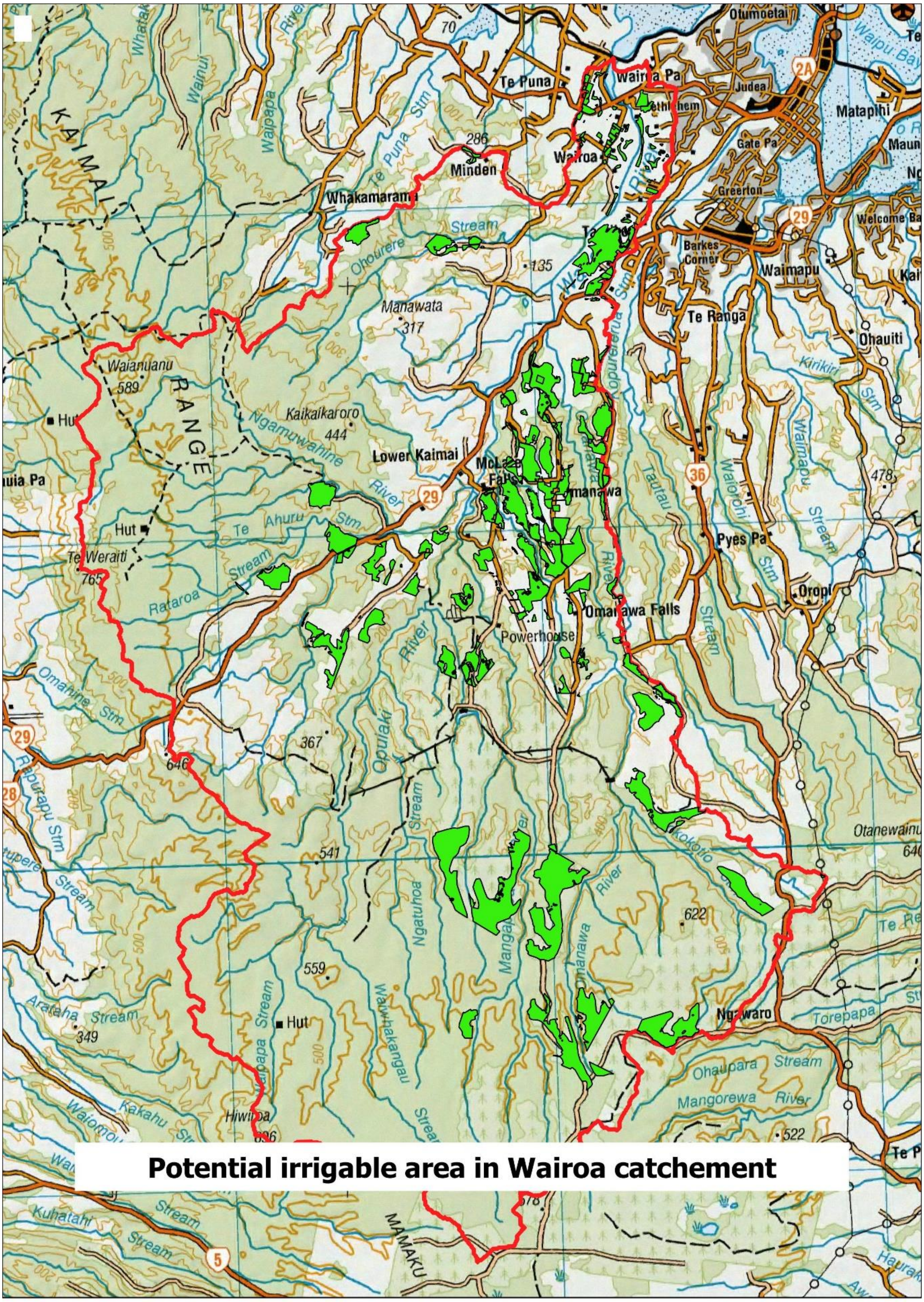

Figure 15: Potential irrigable areas in Wairoa catchment

A detailed investigation into potential irrigable area provides a figure of 3,005 ha (total of existing irrigated area and potentially new irrigation). The current irrigated area is 222 ha. There is scope, therefore, to increase the irrigated area by 2,783 hectares.

This study assumes the ratio of irrigated land to the total area in a particular crop would stay the same in the future (i.e. 32% for kiwifruit and 15% for avocado/horticulture). Therefore the total potential irrigated area would increase by 445 ha, from 222 ha to 667 ha. The breakdown of the irrigated area is shown in *Figure 16*.

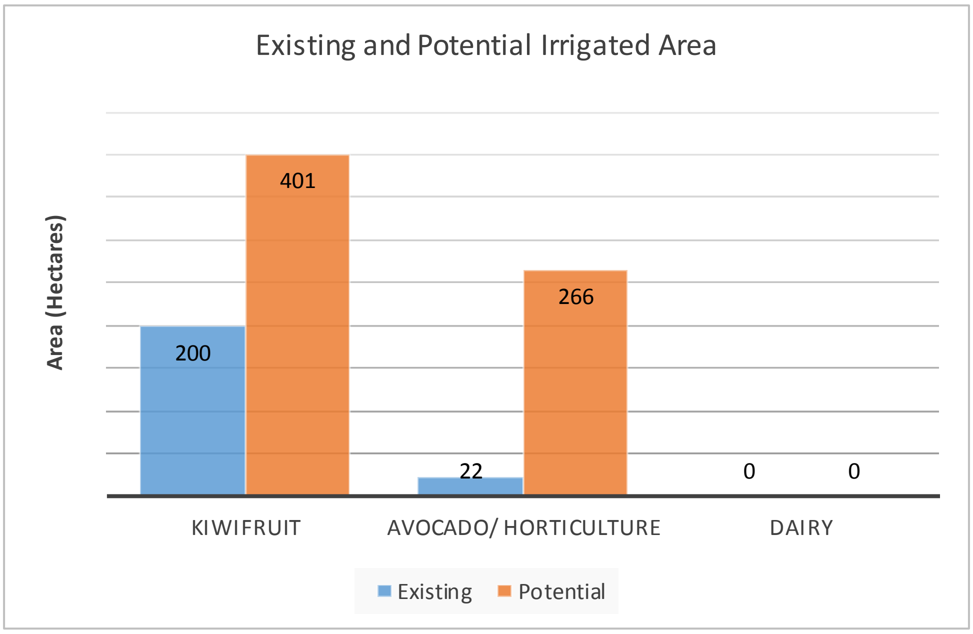

Figure 16: Change in irrigated areas in the Wairoa catchment

4.2.5 Comparison of supply and demand

To balance the supply of surface and groundwater availability to meet as much of the potential demand as possible, the new development can be supplied from surface water and groundwater.

Without considering additional water that may be sourced from hydroelectric discharges or streams without allocation limits, there is insufficient surplus surface water available (94 l/s) to meet the total expansion on its own, so some of the supply will have to come from groundwater.

By irrigating further 445 ha, the potential demand for surface water and groundwater could increase to 194 l/s and 6.5 million m^3/year respectively, as shown in *Table 15*. The split between surface water and groundwater sourced irrigation was determined so that as much of the available surplus surface water possible is used.

After the expansion in irrigated area, there would still be adequate groundwater resource available (assuming it can be found) to support any foreseeable growth in demand.

Table 15: Comparison of supply and demand with potential expansion

	Surface water (litres/sec)	Groundwater (million m^3/year)
Irrigation & frost protection	102	0.8
Other consented uses	84	4.9

	Surface water (litres/sec)	Groundwater (million m^3/year)
Permitted/unconsented take estimate	8	0.9
Total allocated	194	6.5
Allocation limit	194	21.3
SURPLUS	**0**	**14.7**

4.2.6 Economic opportunities

Irrigation of 445 ha expansion, assuming water supply was accessible, has the potential to:

- Increase gross orchard or farm gate revenue by $170 million (driven by horticulture expansion).
- Increase EBIT by $85 million.
- Increase employment by 300 full time equivalent employees.

4.2.7 Water quality

Irrigation of another 445 ha could:

- Increase in N loss to water by 1.2 tonnes per year.
- Decrease in P loss by 0.1 tonnes per year.

While the use of fresh water for irrigation will provide the increases in revenue and EBIT given above, additional dry land will be converted to unirrigated horticulture and produce additional economic gains and changes in nutrients.

4.2.8 Summary

- Current irrigation in catchment 222 ha.
- The largest current consented allocations for surface water are irrigation and municipal use. Permitted takes are estimated to be minor.
- There is surplus surface water and groundwater available.
- Estimated irrigation expansion would use up the surplus surface water and use some of the surplus ground water as well.
- There would be some groundwater allocation left after the expansion.
- Horticulture development, supported by irrigation expansion with the water available, could significantly increase revenue and employment.

4.3 Kaituna-Pongakawa-Waitahanui WMA

Kaituna-Pongakawa-Waitahanui WMA has an area of 107,356 ha. In order to go to a finer level of detail, the WMA has been split into two catchments – Kaituna (including Waiari), and combined Pongakawa and Waitahanui.

4.3.1 Kaituna Catchment

4.3.1.1 Catchment outline

The Kaituna catchment area is shown in *Figure 17*. Total catchment area is 58,748 hectares. It is the west side of the Kaituna-Pongakawa-Waitahanui WMA.

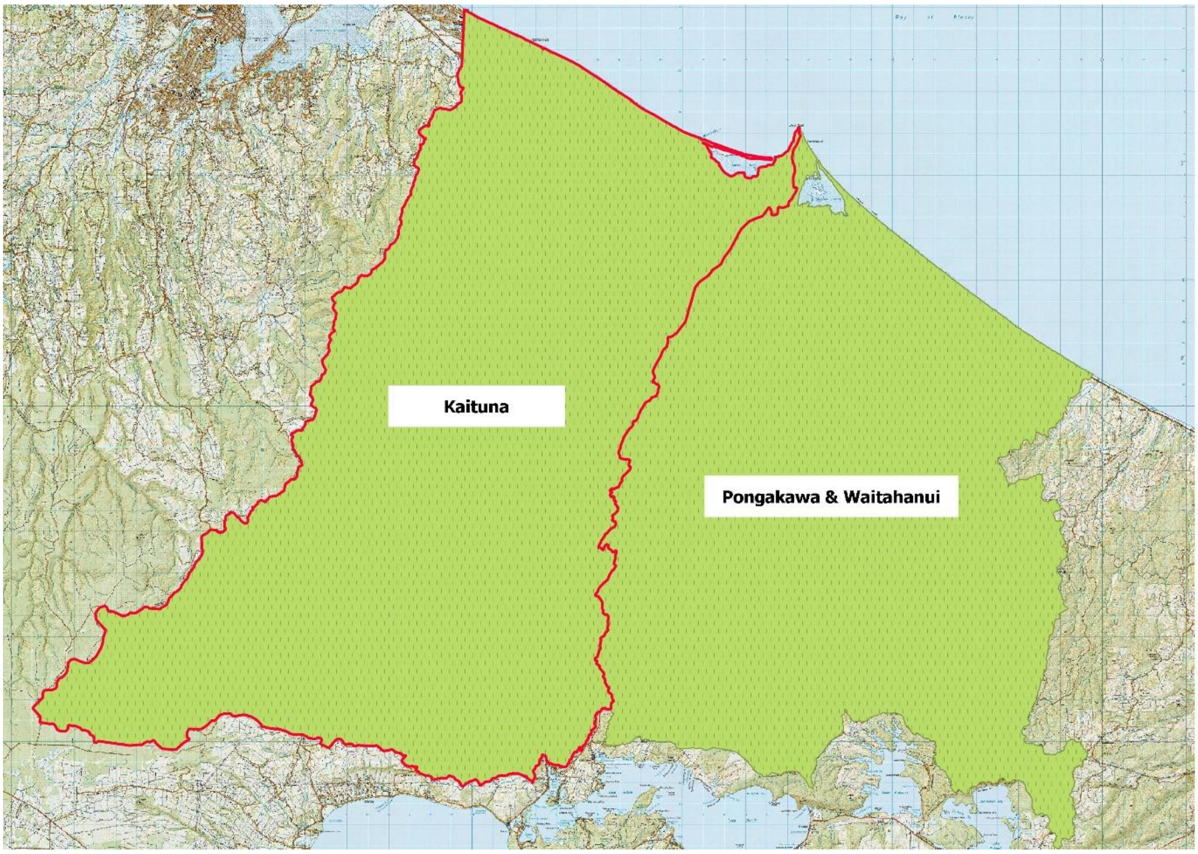

Figure 17: Kaituna-Pongakawa-Waitahanui WMA and Kaituna catchment

The main river is the Kaituna River, 50 km long, which flows from Lake Rotorua and Rotoiti to the sea near Te Puke. There are several other rivers and streams that contribute to the total surface water available.

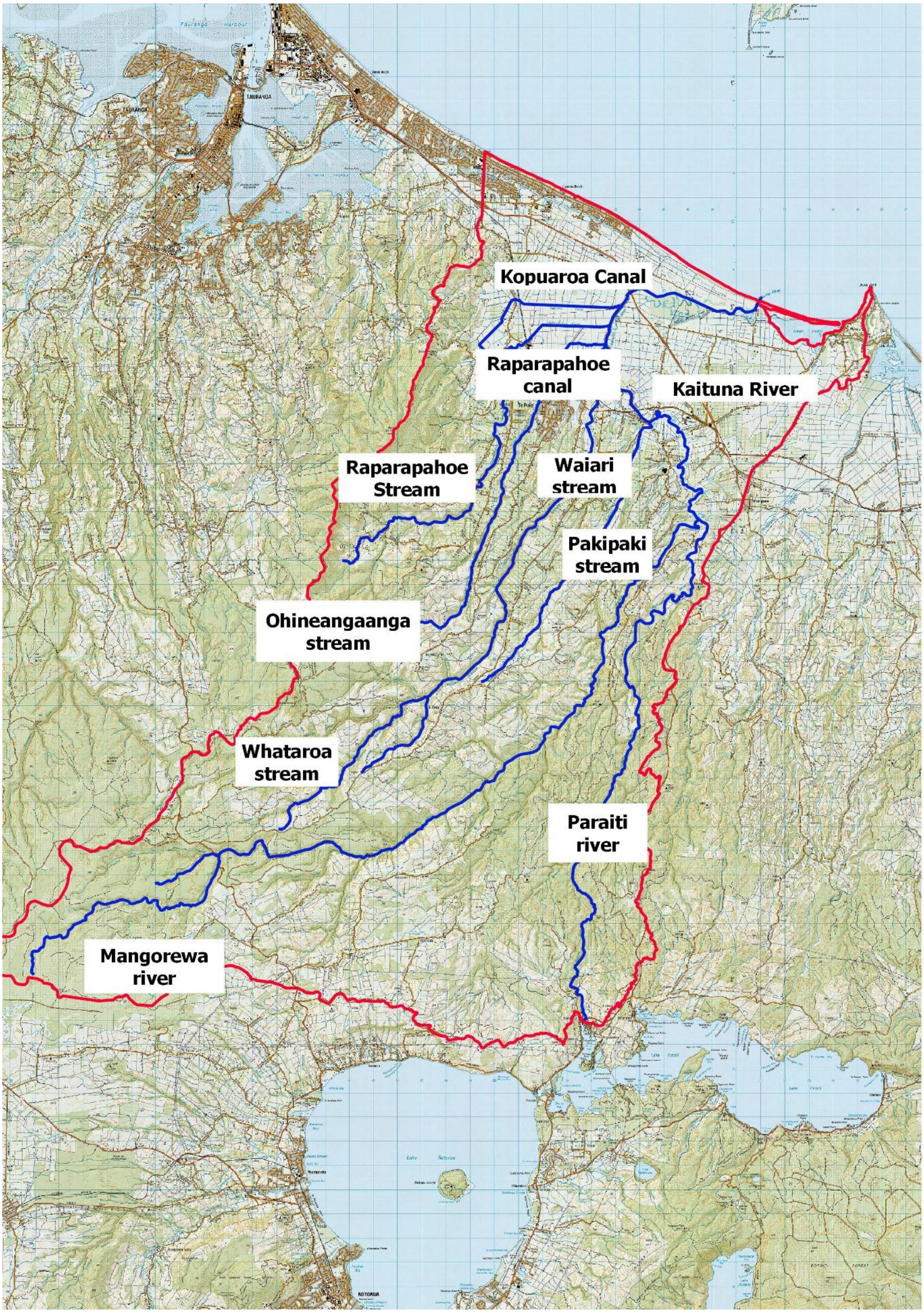

Figure 18: Rivers and streams in the Kaituna catchment

Figure 19 presents the current land use in the catchment. While kiwifruit is shown separately to avocado/horticulture, both land uses could simply be described as horticulture.

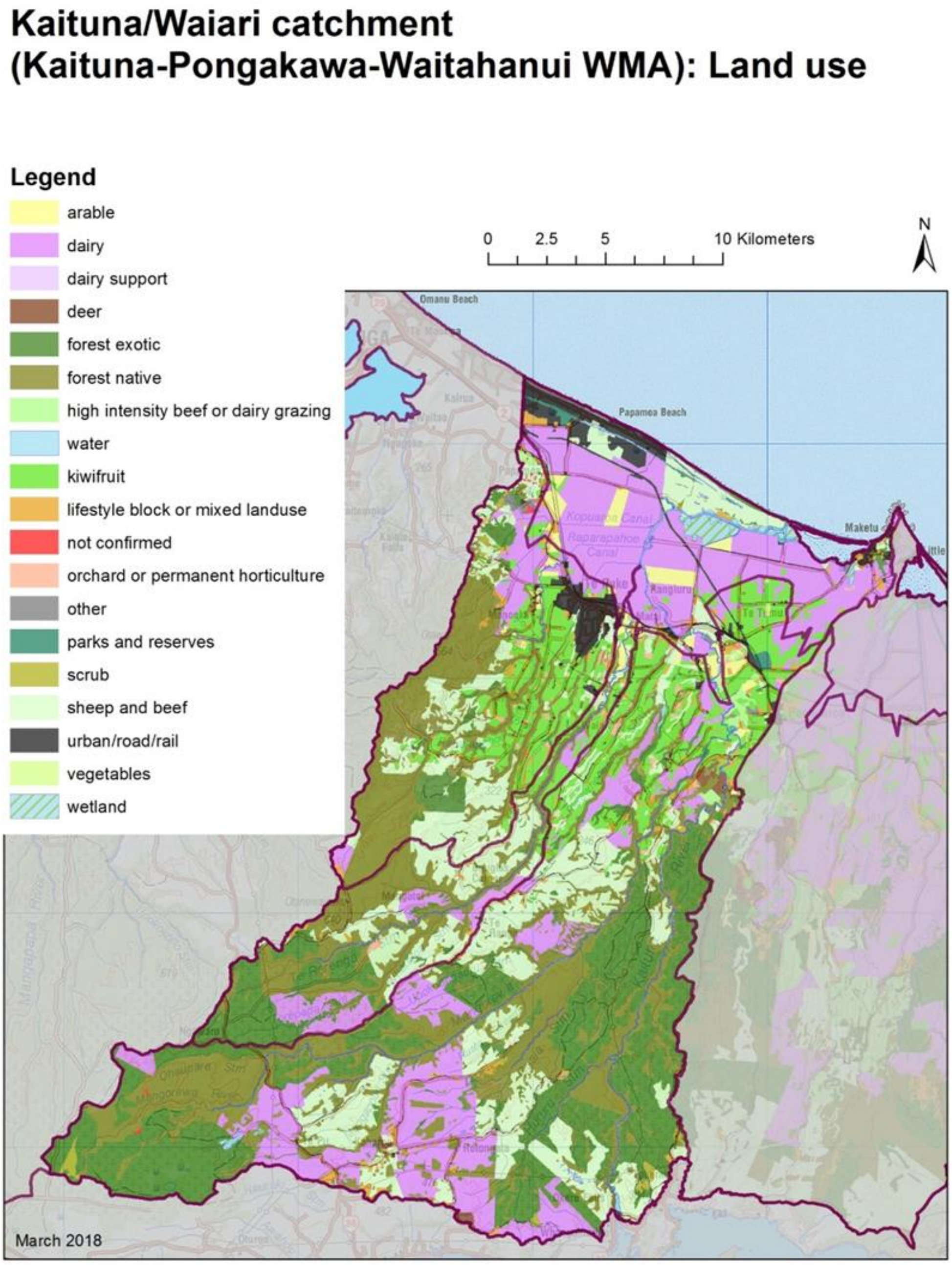

Figure 19: Current Land use in the Kaituna catchment

Native and exotic forestry is 44% of the catchment. Further detail of the land use is given in *Figure 20*. The numbers below the labels are the areas in hectares.

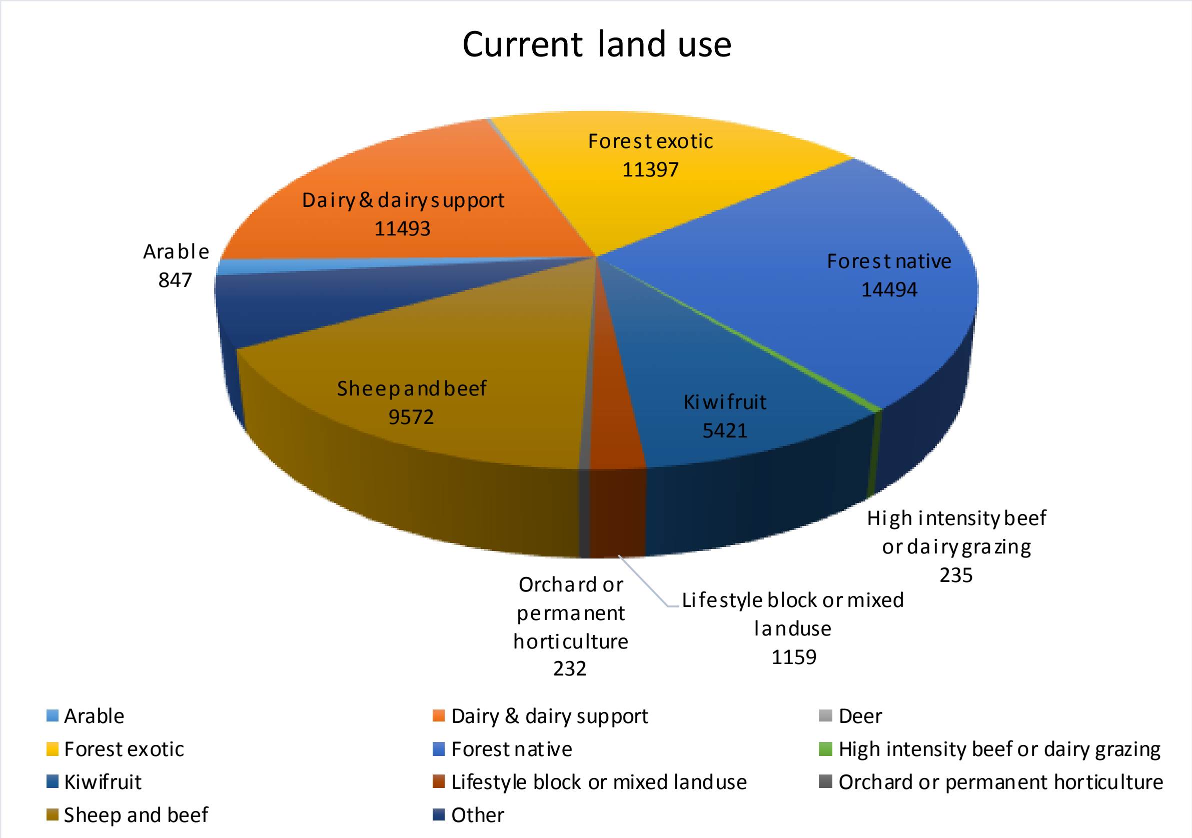

Figure 20: Detailed current land use in Kaituna catchment

The current consented irrigated area is 1,570 ha. Within this, 396 hectares are irrigated from surface water and 1,173 hectares from groundwater. Over 95% of the existing irrigation is on kiwifruit and other horticulture.

4.3.1.2 Kaituna total allocation limits

The flow rate of surface water and volume of groundwater allocation limits for abstractive use are shown in *Table 16*.

Table 16: Current allocation limits for surface water and groundwater

	Surface water (litres/sec)	Groundwater (million m^3/year)
Streams & rivers[1]	3,643	
Upper and lower groundwater management zones[2]		9.7

Note 1: Includes Kaituna River, Waiari Stream, Kopuroa Canal, Mangorewa River, Onineangaanga Stream, Pakipaki Stream, Raparapahoe Stream, and Whataroa Stream

Note 2: From BOPRC revised groundwater allocation limits.

Some individual streams in the Kaituna catchment (e.g. Waiari) are over-allocated, which will restrict where in the catchment development could occur under current allocation limits. The assessment above looked at the catchment as a whole.

4.3.1.3 Allocable water with reasonable use

Using the reasonable use figures for irrigation and frost protection, the total surface water allocation could reduce from 1,631 l/s to 980 l/s. The total groundwater allocation could reduce from 14.8 million cubic metres to 11.1 million cubic metres.

Table 17 provides a comparison of water supply and demand to determine whether the catchment has a water shortage or surplus.

Using the reasonable use figures for irrigation and frost protection, the total surface water allocation could reduce from 1,631 l/s to 980 l/s. The total groundwater allocation could reduce from 14.8 million cubic metres to 11.1 million cubic metres.

Table 17 also shows the water shortage or surplus with the reasonable use rates (for surface water) and volumes (for groundwater) which better match the actual need than the current allocation equivalents.

Reasonable use supply rate is assumed to be 0.23 l/s/ha (2 mm/day) for kiwifruit and horticulture, and 0.45 l/s/ha (3.9 mm/day) for pasture. Annual volume allocation requirements for irrigation (the volume required to meet demand in a 1 in 10 year drought year) are relatively modest at somewhere between 640 m^3/year/ha to about 2,660 m^3/year/ha, with the lower figures being for deep rooted horticulture and the higher figures for pasture.

Using the reasonable use figures for irrigation and frost protection, the total surface water allocation could reduce from 1,631 l/s to 980 l/s. The total groundwater allocation could reduce from 14.8 million cubic metres to 11.1 million cubic metres.

Table 17: Comparison of supply and demand

	Surface water (litres/sec)		Groundwater (million m^3/year)	
	Current	Reasonable use	Current	Reasonable use
Irrigation & frost protection	760	109	6.5	2.8
Other consented uses	839	839	5.8	5.8
Permitted/unconsented take estimate	31	31	2.5	2.5
Total allocated	1,631	980	14.8	11.1
Allocation limit	3,643	3,643	9.7	9.7
SURPLUS	**2,012**	**2,663**	**-5.1**	**-1.4**

Overall, there is a surplus of surface water allocation available to support potential expansion.

4.3.1.4 Land use change

While there is a surplus of surface water in the catchment, the degree to which water-demanding enterprises can be expanded or developed depends on water demand. The largest potential future water demand is likely to come from irrigation.

To expand the irrigated area, land use will change. The estimated future land use is shown in *Figure 21*.

It is predicted that there would be increases in the land for kiwifruit, exotic forestry and ‘other’ (urban area and wetlands).

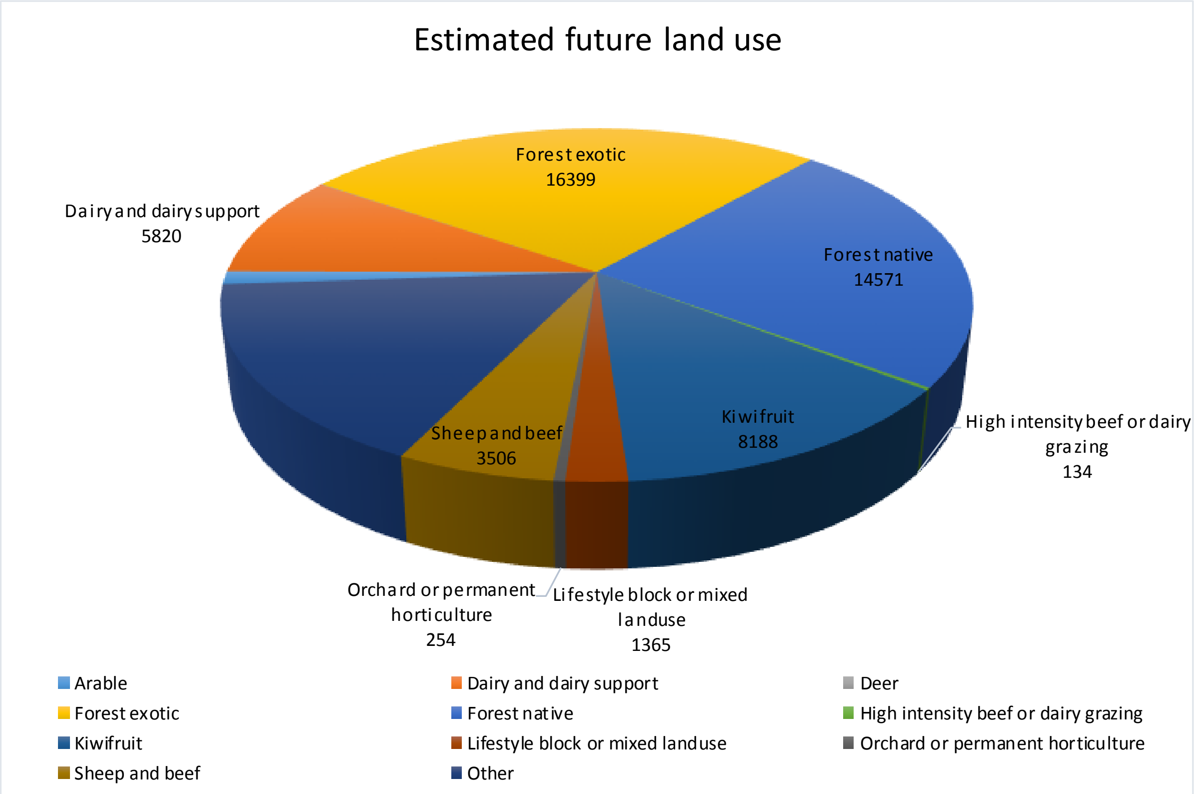

Figure 21: Estimated future land use change in Kaituna catchment

This study assumes the ratio of irrigated land to dry land would stay the same in the future (i.e. 25% for kiwifruit, 65% for avocado/horticulture and 1% for dairy). The total potential irrigated area would increase by 684 ha, from 1,570 ha to 2,254 ha. The breakdown of the irrigated area is shown in *Figure 22*.

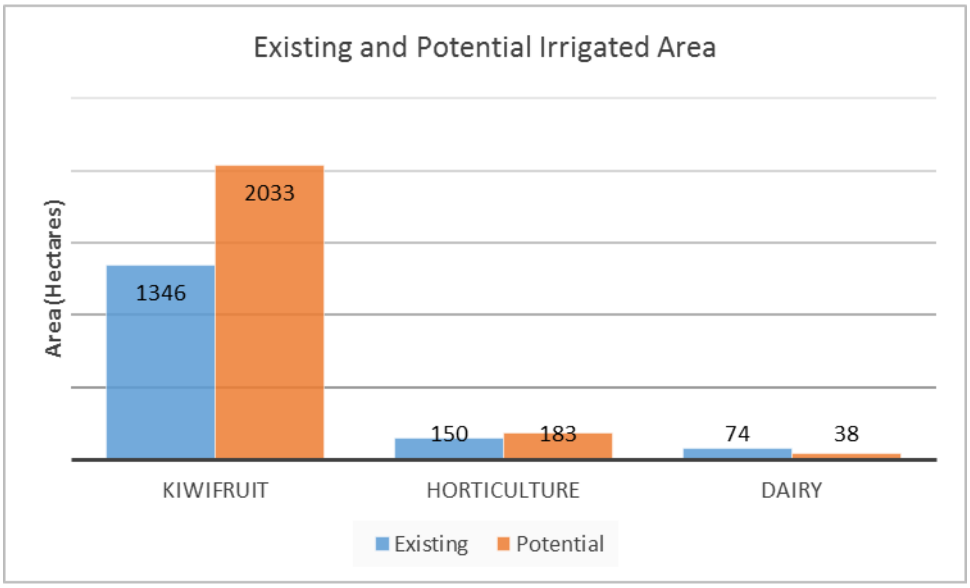

Figure 22: Change in irrigated areas in Kaituna catchment

4.3.1.5 Comparison of supply and demand

Groundwater is already over-allocated and therefore new development will have to be supplied solely from surface water.

By irrigating a further 684 ha, the potential demand for surface water could increase to 1,130 l/s as shown in *Table 18*. After the expansion, there would still be adequate surface water available to support any additional growth in demand.

Table 18: Comparison of supply and demand with potential expansion

	Surface water (litres/sec)	Groundwater (million m^3/year)
Irrigation & frost protection	259	2.8
Other consented uses	839	5.8
Permitted/unconsented take estimate	31	2.5
Total allocated	1,130	11.1
Allocation limit	3,643	9.7
SURPLUS	**2,513**	**-1.4**

4.3.1.6 Economic opportunities

Irrigation of 684 ha expansion, assuming water supply was accessible, has the potential to:

- Increase gross orchard or farm gate revenue by $142 million (driven by horticulture expansion).
- Increase EBIT by $53 million.

- Increase employment by 1,220 full time equivalent employees.

4.3.1.7 Water quality

Irrigation of another 684 ha could:

- Decrease in N loss to water by 300 tonnes per year.
- Increase in P loss by 3.4 tonnes per year.

4.3.1.8 Summary

- Current irrigation in catchment is slightly under 1,600 ha.
- The largest current consented allocations for surface water are for irrigation and frost protection, closely followed by domestic/ commercial/ industrial. Permitted takes are estimated to be minor.
- There is no surplus groundwater available.
- Estimated irrigation expansion would need to be supplied solely from surface water.
- There would be adequate amount of surface water allocation left after the expansion.
- Intensification, supported by irrigation expansion with the water available, could significantly increase revenue and employment from irrigated agriculture and horticulture.

4.3.2 Pongakawa and Waitahanui catchments

4.3.2.1 Catchment outline

The Pongakawa and Waitahanui catchments make up the east side of the Kaituna-Pongakawa-Waitahanui WMA as shown in *Figure 23*. Total catchment area is 48,609 hectares.

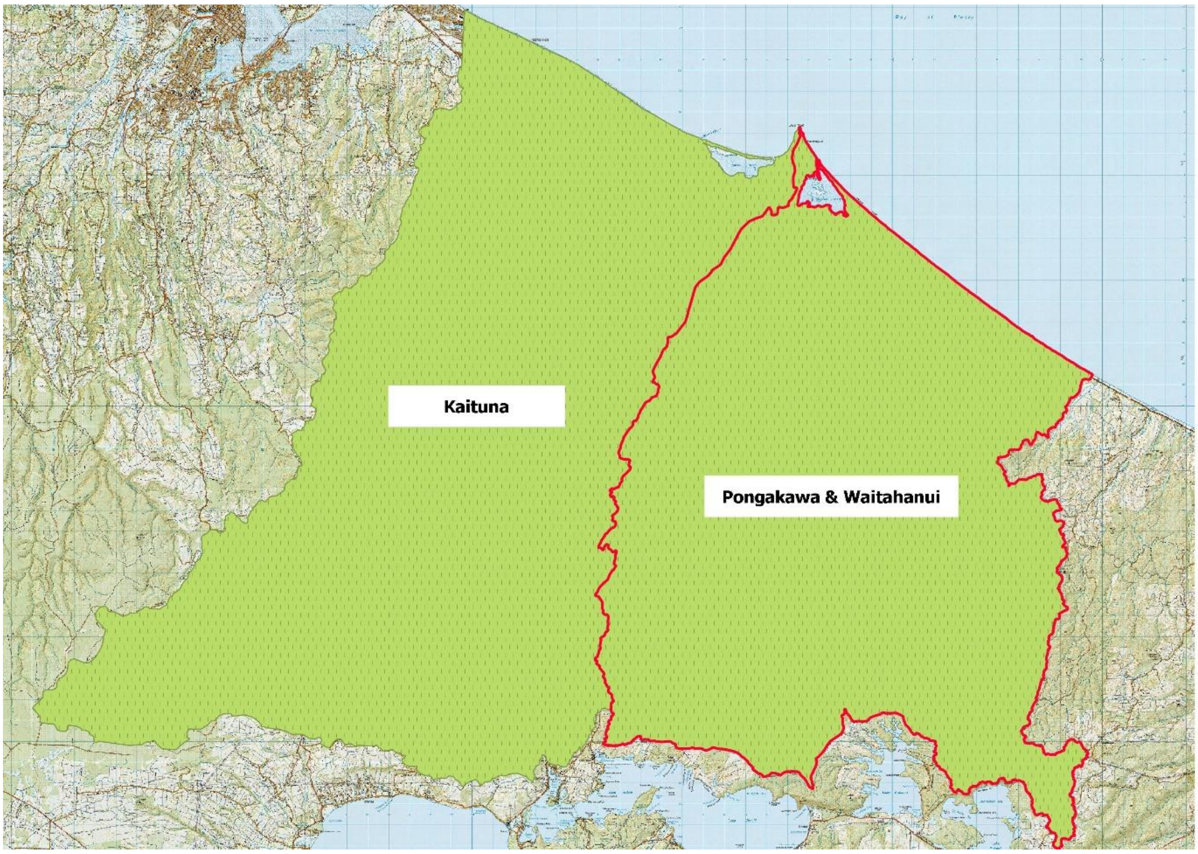

Figure 23: Kaituna-Pongakawa-Waitahanui WMA and Pongakawa & Waitahanui

The main surface water bodies in the Pongakawa and Waitahanui catchments are shown in *Figure 24*. The main surface water bodies are Pongakawa Stream and Waitahanui Stream. Pongakawa Stream is 27 km long and runs through the middle of the combined catchment. It connects to Pongakawa Canal to and flows into Waihi Estuary. Waitahanui Stream is 24 km long, flows northward to the sea at Otamarakau.

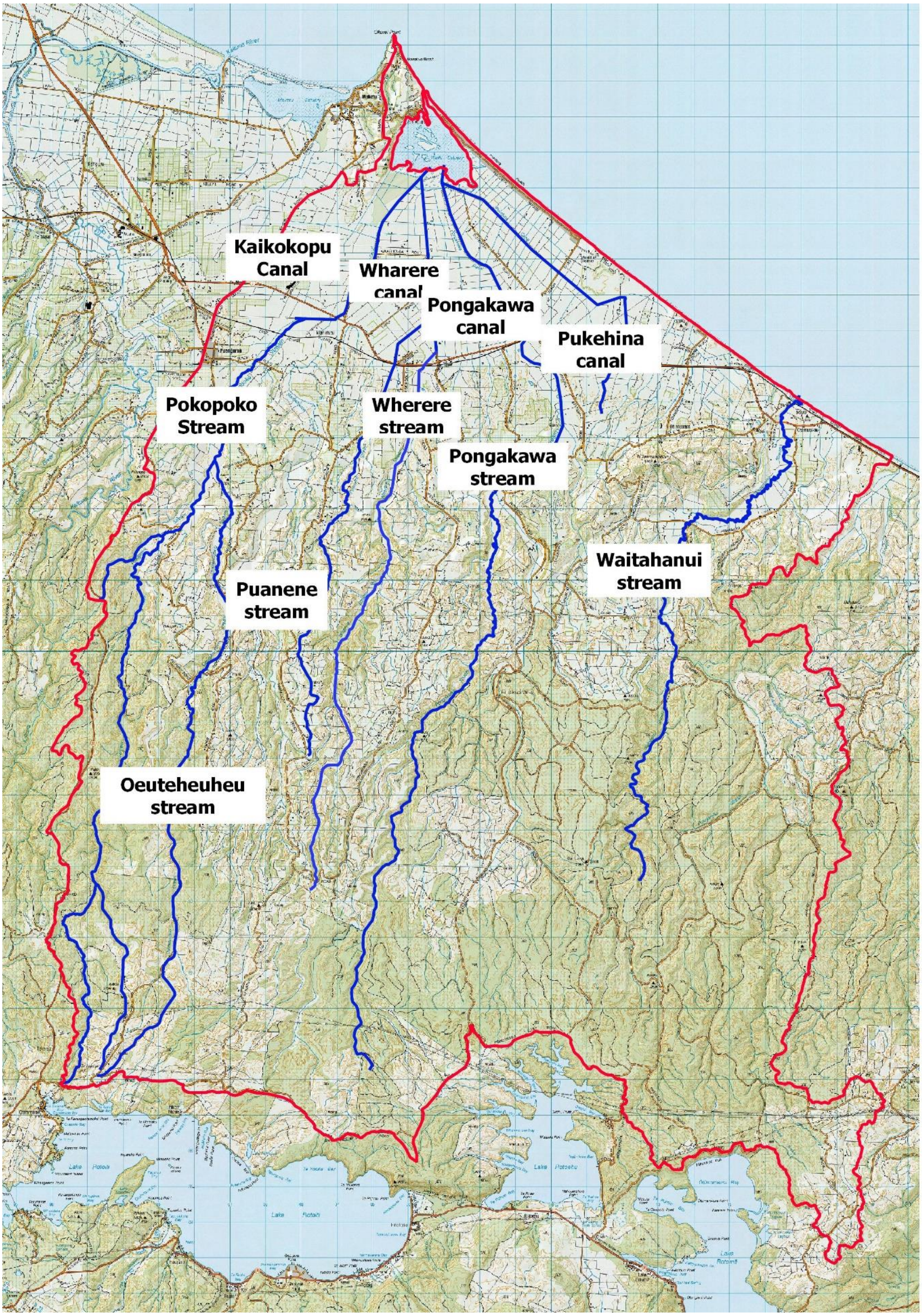

Figure 24: Rivers and streams in Pongakawa & Waitahanui catchment

Figure 25 presents the current land use in the catchment. While kiwifruit is shown separately to avocado/horticulture, both land uses could simply be described as horticulture.

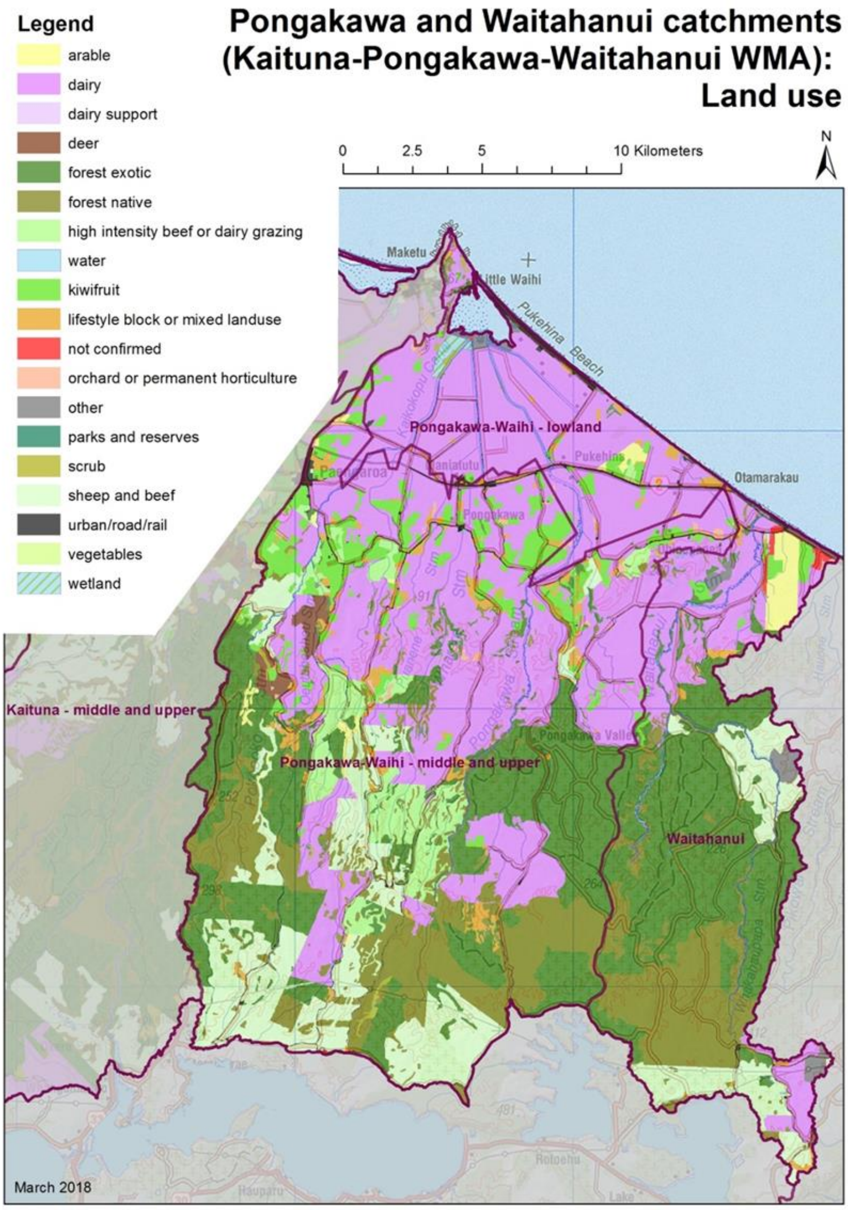

Figure 25: Current land use within Pongakawa & Waitahanui

Native and exotic forestry is about 38 % of the catchments. Further detail of the land use is given in *Figure 26*. The number below the land use label is the area of that land use in hectares.

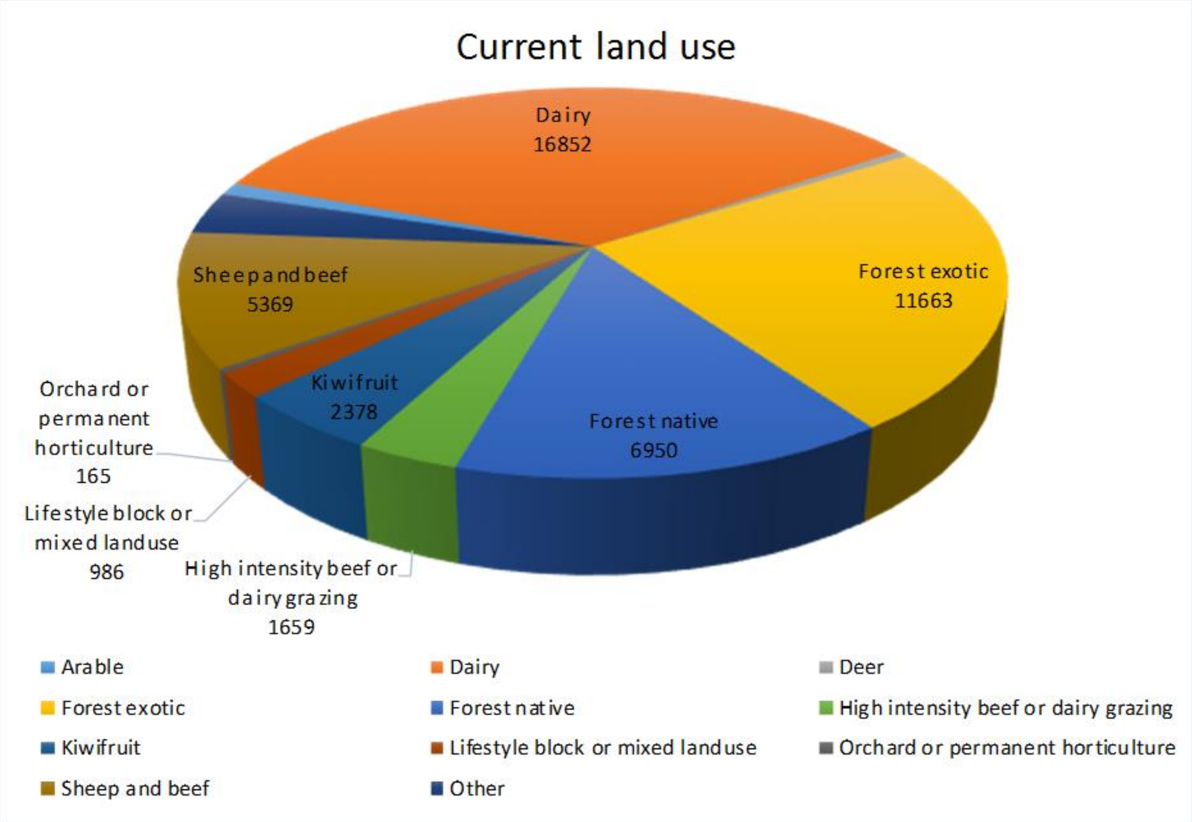

Figure 26: Detailed current land use in Pongakawa & Waitahanui

The current consented irrigated area is 4,263 ha. Within this, 2,352 hectares are irrigated from surface water and 1,911 hectares from groundwater. About 59% of the existing irrigation is on kiwifruit and other horticulture.

4.3.2.2 Pongakawa & Waitahanui total allocation limits

The flow rate of surface water and volume of groundwater allocation limits for abstractive use are shown in *Table 19*.

Table 19: Current allocation limits for surface water and groundwater

	Surface water (litres/sec)	Groundwater (million m^3/year)
Streams & rivers[1]	1,078	
Groundwater[2]		27.8

Note 1: Includes Oeuteheuheu Stream, Pokopoko Stream, Pongakawa Stream, Waitahanui Stream, and Wharere Stream.

Note 2: From BOPRC revised groundwater allocation limits.

There are other sources, particularly small streams that have not yet been given specific allocation limits that are not included in the cumulative allocation limit above. Small amounts of surface water have been consented from streams that do not currently have flow data (and therefore no specific allocation limits). While default allocation limits could be applied, there is insufficient flow data available to calculate the limits.

4.3.2.3 Allocable water with reasonable use

Table 20 provides a comparison of water supply and demand to determine whether the catchment has a water shortage or surplus.

The table also shows the water shortage or surplus with the reasonable use rates (for surface water) and volumes (for groundwater) which better match the actual need than the current allocation equivalents.

Reasonable use supply rate is assumed to be 0.23 l/s/ha (2 mm/day) for kiwifruit and horticulture, and 0.45 l/s/ha (3.9 mm/day) for pasture. Annual volume allocation requirements for irrigation (the volume required to meet demand in a 1 in 10 year drought year) are relatively modest at somewhere between 640 m^3/year/ha to 2,660 m^3/year/ha, with the lower figures being for deep rooted horticulture and the higher figures for pasture.

Using the reasonable use figures for irrigation and frost protection, the total surface water allocation could reduce from 3,868 l/s to 1,581 l/s. The total groundwater allocation could reduce from 24.6 million cubic metres to 16.5 million cubic metres per year.

Table 20: Comparison of supply and demand

	Surface water (litres/sec)		Groundwater (million m^3/year)	
	Current	Reasonable use	Current	Reasonable use
Irrigation & frost protection	3,118	831	15.2	7.1
Other consented uses	725	725	7.9	7.9
Permitted/unconsented take estimate	25	25	1.5	1.5
Total allocated	3,868	1,581	24.6	16.5
Allocation limit	1,079	1,079	27.8	27.8
SURPLUS	**-2,790**	**-502**	**3.2**	**11.3**

Overall, there is a surplus of groundwater allocation available to support potential expansion.

4.3.2.4 Land use change

While there is a surplus of groundwater in the catchment, the degree to which water-demanding enterprises can be expanded or developed depends on water demand. The largest potential future water demand is likely to come from irrigation.

To expand the irrigated area, land use will change. The estimated future land use is shown in *Figure 27*. It is predicted that there would be a large increase in the land for kiwifruit (as well as wetlands and exotic forestry, although these of course are not irrigated).

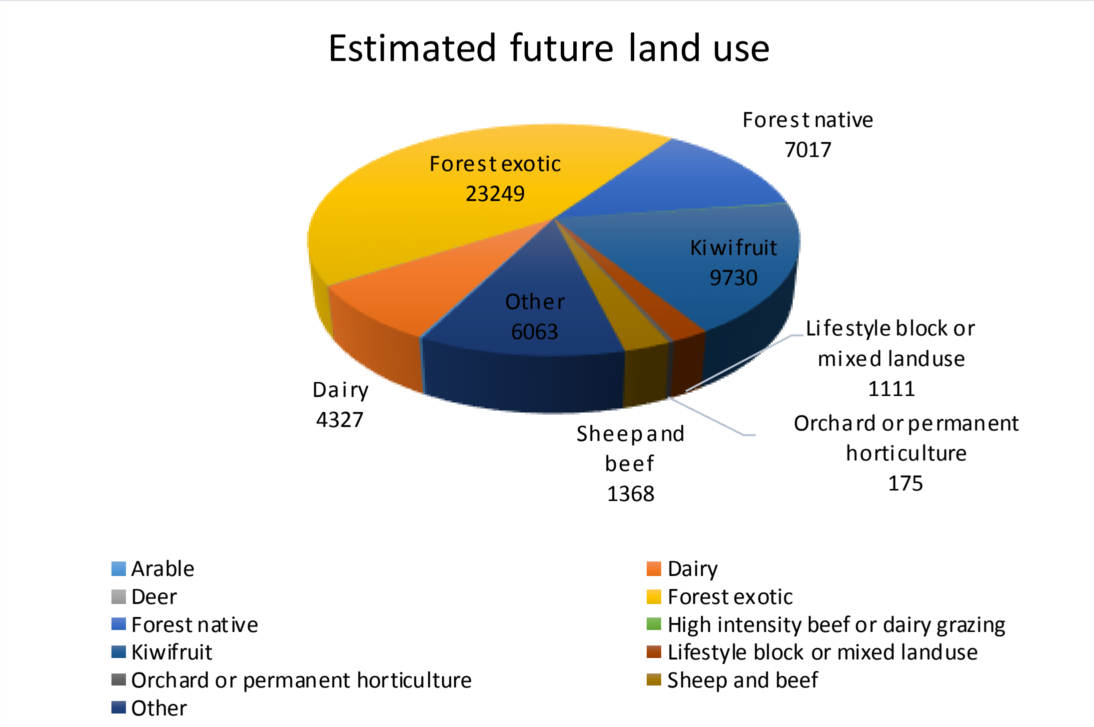

Figure 27: Estimated future land use

This study assumes the ratio of irrigated land to dry land would stay the same in the future where possible. For these catchments, a smaller ratio (current 100% irrigation to 61% irrigation) was used for kiwifruit in order to keep the total demand within the allocation limit. The total potential irrigated area would increase by 2,275 ha, from 4,263 ha to 6,538 ha. The breakdown of the irrigated area is shown in *Figure 28*.

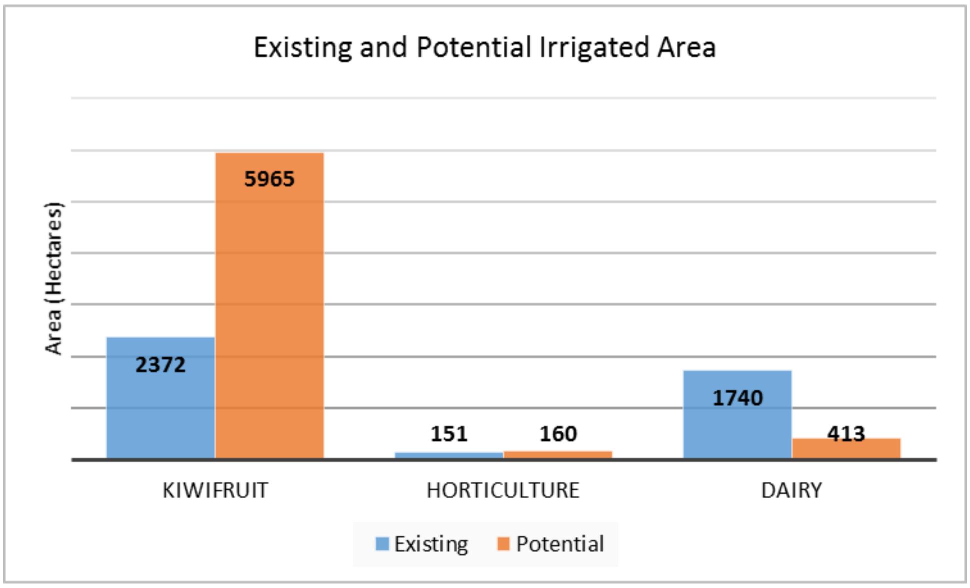

Figure 28: Change in irrigated areas in the Pongakawa-Waitahanui catchments

4.3.2.5 Comparison of supply and demand

Surface water is already over-allocated and therefore the new development will have to be supplied solely from groundwater.

Irrigation of the additional 2,275 ha would use up the surplus groundwater as shown in *Table 21*. Therefore, any higher ratio of irrigated land to dry land than the current state cannot be supported.

Table 21: Comparison of supply and demand with potential expansion

	Surface water (litres/sec)	Groundwater (million m^3/year)
Irrigation & frost protection	831	18.3
Other consented uses	725	7.9
Permitted/unconsented take estimate	25	1.5
Total allocated	1.581	27.8
Allocation limit	1.079	27.8
SURPLUS	**-502**	**0**

4.3.2.6 Economic opportunities

Irrigation of 2,275 ha expansion, assuming water supply was accessible, has the potential to:

- Increase gross orchard or farm gate revenue by $398 million per year (driven by horticulture expansion).
- Increase EBIT by $148 million per year.
- Increase employment by 3,390 full time equivalent employees.

4.3.2.7 Water quality

Irrigation of another 2,275 ha could:

- Decrease in N loss to water by 752 tonnes per year.
- Increase in P loss by 6.0 tonnes per year.

4.3.2.8 Summary

- Current irrigation in catchment is about 4,300 ha.
- The largest current consented allocations for surface water are for irrigation and frost protection. Other uses are relatively minor.
- There is no excess surface water available.
- Estimated irrigation expansion would use up the surplus groundwater.
- There would be no surplus water allocation after the expansion.
- Horticulture development, supported by irrigation expansion with the water available, could significantly increase revenue and employment.

4.4 Rangitāiki WMA

Rangitāiki WMA has an area of 295,584 ha and it is the largest WMA in the region. In order to go to a finer level of detail, the WMA has been split into two regions based on Freshwater Management Units (FMUs). (1) Lower Rangitāiki and (2) Mid-Upper Rangitāiki combined with Te Urewera/Whirinaki area.

4.4.1 Lower Rangitāiki Catchments

The Lower Rangitāiki FMU area is shown in *Figure 29*. Total area is 15,352 hectares. It covers a part of the Rangitāiki Plains, below the Matahina Dam.

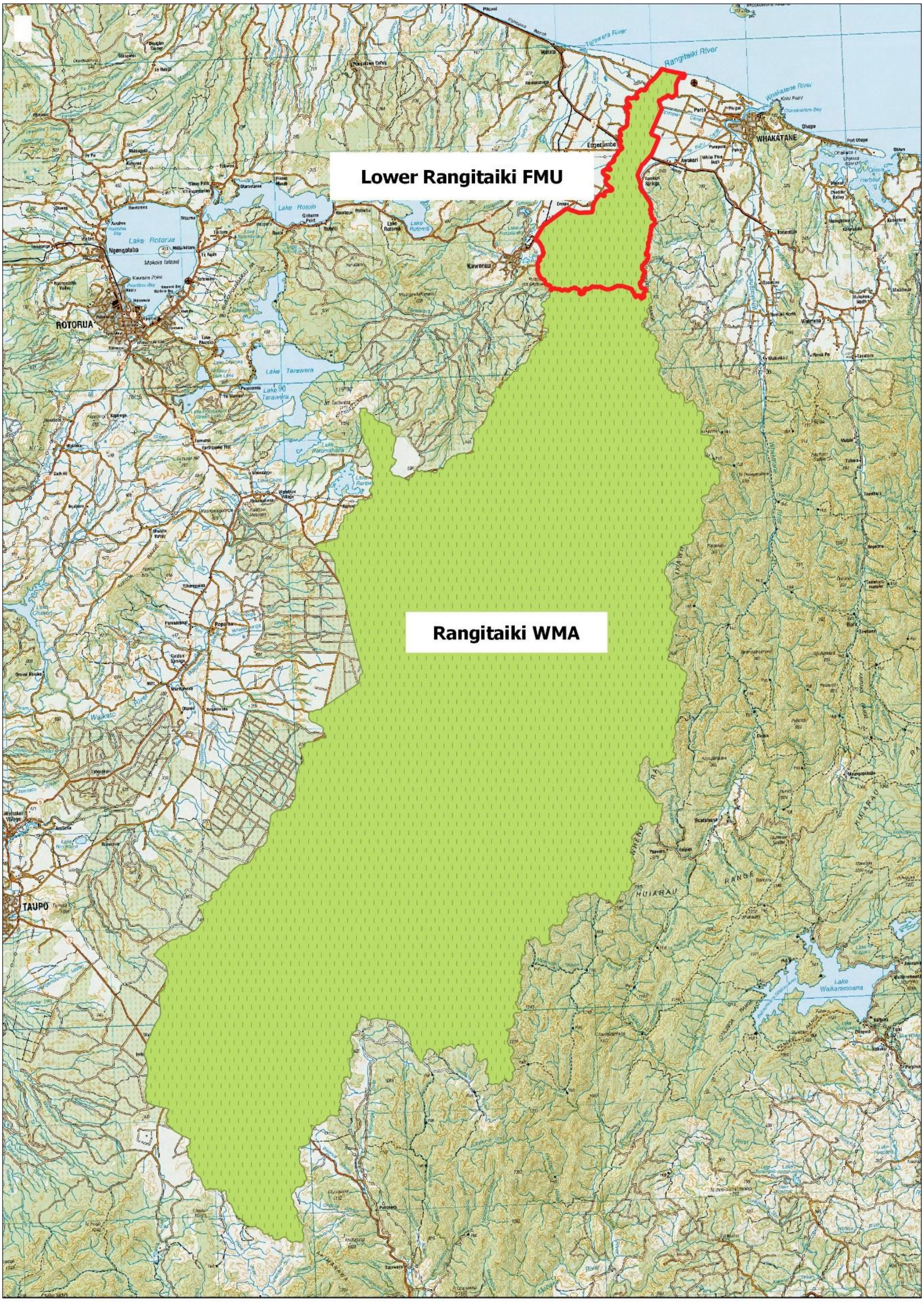

Figure 29: Rangitāiki WMA and Lower Rangitāiki Freshwater Management Unit

The principal river is the Rangitāiki River; it is the longest river in the Bay of Plenty region, at 155 kilometres. It rises inland from northern Hawkes Bay to the east of the Kaingaroa Forest and flows in a generally north-easterly direction, through Murupara, then close to the western edge of Te Urewera before turning northwards, flowing past Edgecumbe, the Rangitāiki Plains and into the Bay of Plenty about 5 km east of the Tarawera River mouth.

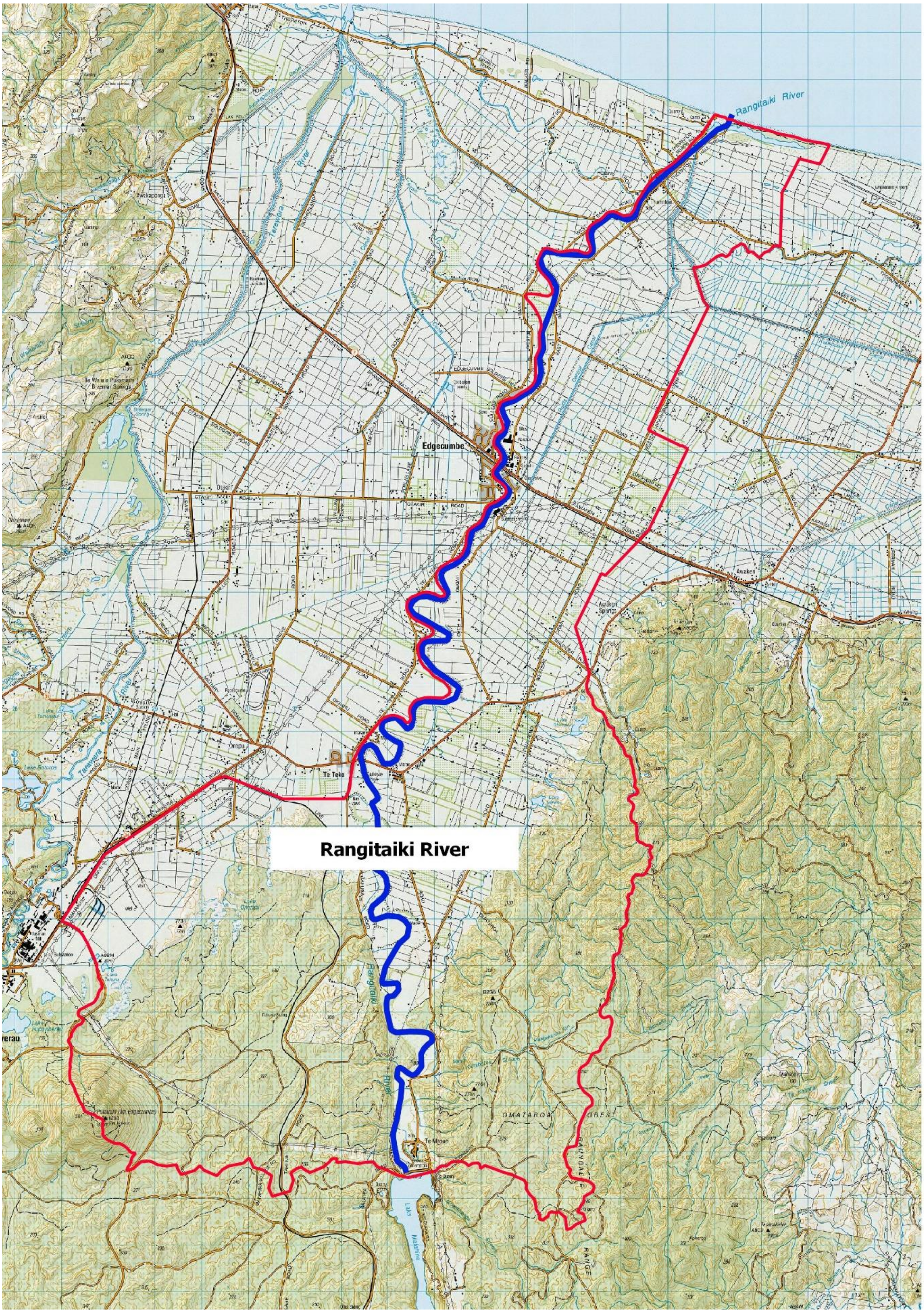

Figure 30: Rivers and streams in Lower Rangitāiki

Figure 31 presents the current land use in the catchment. While kiwifruit is shown separately to avocado/horticulture in *Figure 31*, both land uses could simply be described as horticulture. About 44% of the catchment is in native or exotic forest.

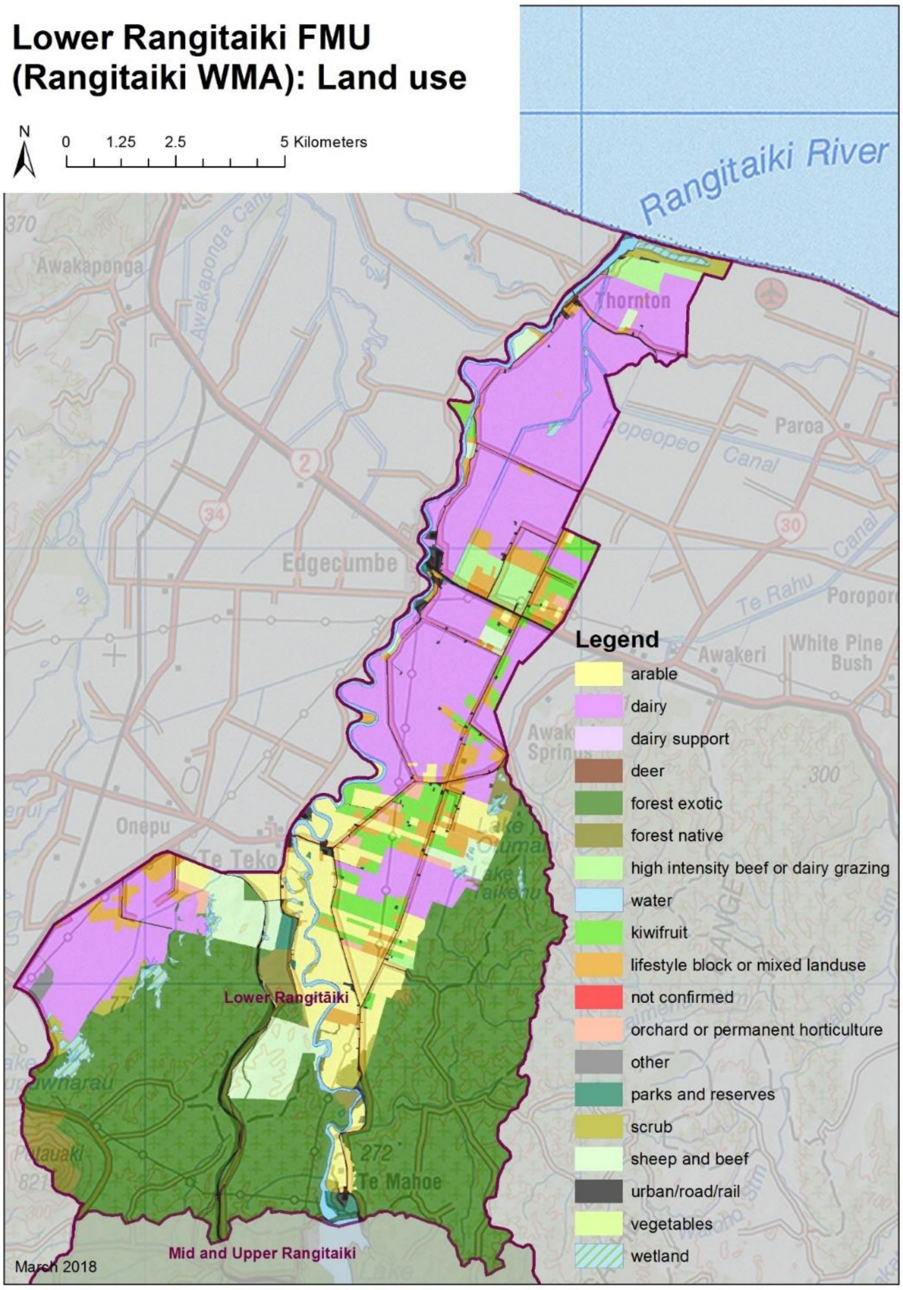

Figure 31: Current land use in Lower Rangitāiki

Further detail of the land use is given in *Figure 32*. The number below the label is the area in hectares.

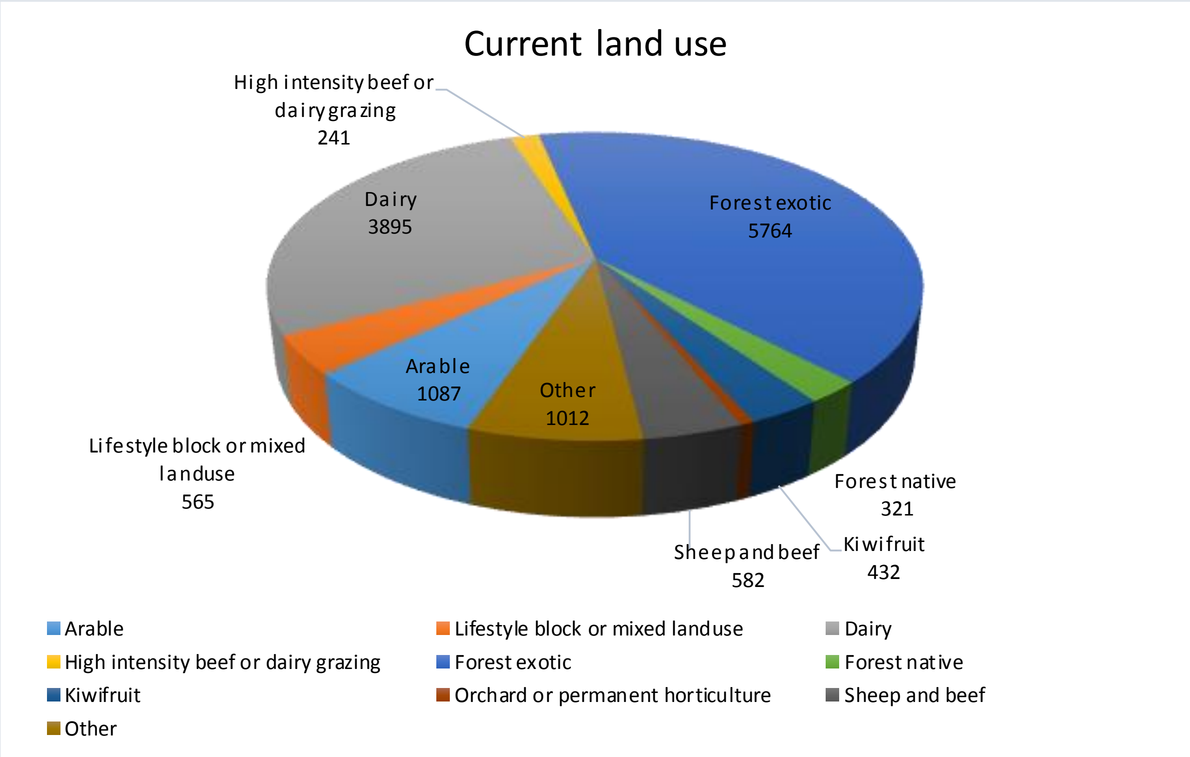

Figure 32: Detailed current land use in Lower Rangitāiki Freshwater Management Unit

The current consented irrigated area is 1,558 ha. Within this, 495 hectares are irrigated from surface water and 1,063 hectares from groundwater. About 40% of the existing irrigation is on kiwifruit and other horticulture.

4.4.1.1 Lower Rangitāiki total allocation limits

The flow rate of surface water and volume of groundwater allocation limits for abstractive use is as shown in *Table 22*.

Table 22: Current allocation limits for surface water and groundwater

	Surface water (litres/sec)	Groundwater (million m^3/year)
Rangitāiki River	3,765	
Groundwater[1]		13.1

Note 1: From BOPRC revised groundwater allocation limits.

Small amounts of surface water have been consented from streams that do not currently have specific allocation limits. While default allocation limits could be applied, there is insufficient flow data available to calculate the limits.

4.4.1.2 Allocable water with reasonable use

Table 23 provides a comparison of water supply and demand to determine whether the catchment has a water shortage or surplus.

Table 23 also shows the water shortage or surplus with the reasonable use rates (for surface water) and volumes (for groundwater) which better match the actual need than the current allocation equivalents.

Reasonable use supply rate is assumed to be 0.23 l/s/ha (2 mm/day) for kiwifruit and horticulture, and 0.45 l/s/ha (3.9 mm/day) for pasture. Annual volume allocation requirements for irrigation (the volume required to meet demand in a 1 in 10 year drought year) are at somewhere between 1,520 m^3/year/ha to about 4,000 m^3/year/ha, with the lower figures being for deep rooted horticulture and the higher figures for pasture.

Using the reasonable use figures for irrigation and frost protection, the total surface water allocation could reduce from 1,463 l/s to 1,097 l/s. The total groundwater allocation could reduce from 11.6 million cubic metres to 7.5 million cubic metres per year.

Table 23: Comparison of supply and demand

	Surface water (litres/sec)		Groundwater (million m^3/year)	
	Current	Reasonable use	Current	Reasonable use
Irrigation & frost protection	558	192	8.5	4.5
Other consented uses	901	901	2.6	2.6
Permitted/unconsented take estimate	4	4	0.4	0.4
Total allocated	1,463	1,097	11.6	7.5
Allocation limit	3,765	3,765	13.1	13.1
SURPLUS	**2,302**	**2,668**	**1.6**	**5.6**

Overall, there is a surplus of allocation available to support potential expansion. However, the large headroom is subject to the hydro scheme discharge regime and an existing point discharge consent, so it may not necessarily be available all of the time (although will be available at some stage within a given day or a week).

To be able to fully utilise the surplus, short-term storage of water may be required.

4.4.1.3 Land use change

While there is a surplus of both surface water and groundwater in the FMU, the degree to which water-demanding enterprises can be expanded or developed depends on water demand. The largest potential future water demand is likely to come from irrigation.

To expand the irrigated area, land use will change. The estimated future land use is shown in *Figure 33*. It is predicted that there would be a large increase in the land for kiwifruit while the other land use areas would decrease.

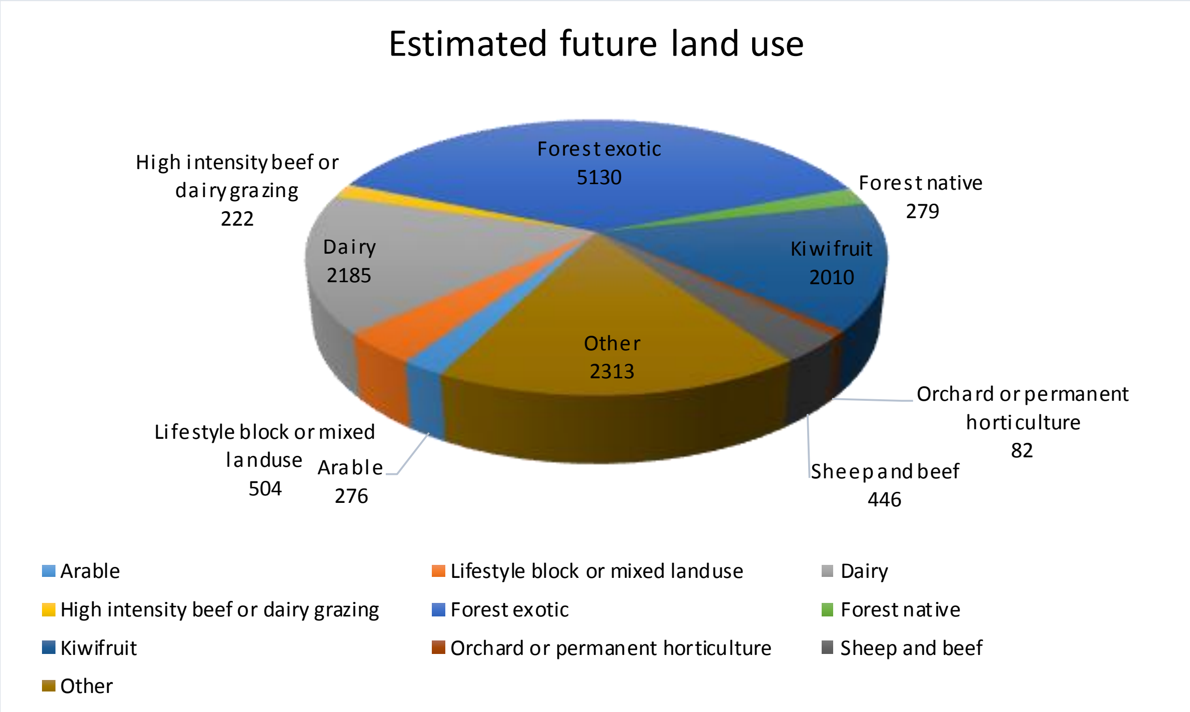

Figure 33: Estimated future land use

This study assumes the ratio of irrigated land to dry land would stay the same in the future (i.e. 100% for kiwifruit, 100% for avocado/horticulture and 23% for dairy). The total potential irrigated area would increase by 1,187 ha, from 1,558 ha to 2,745 ha. The breakdown of the irrigated area is shown in *Figure 34*.

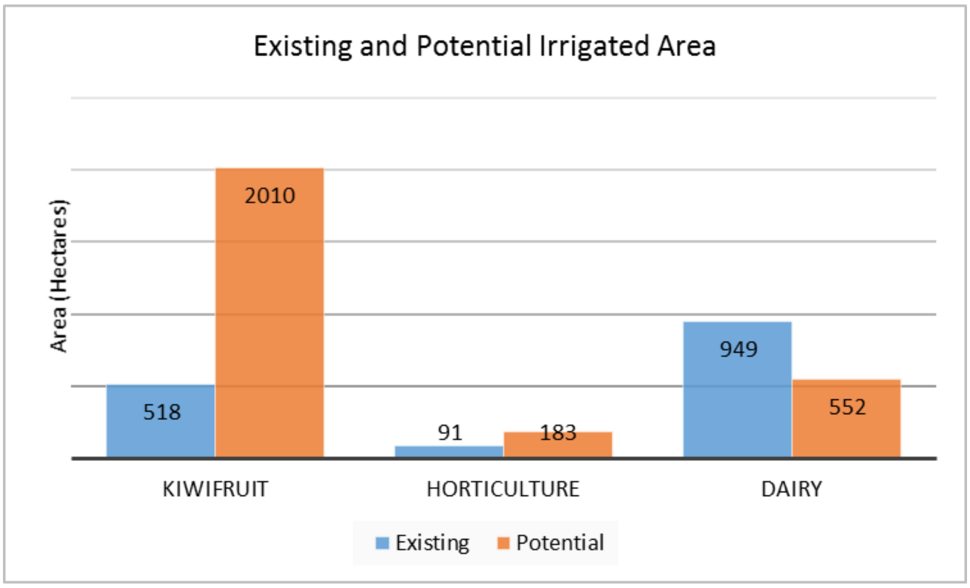

Figure 34: Potential irrigated area in the Lower Rangitāiki FMU

4.4.1.4 Comparison of supply and demand

There is plenty of surface water left for irrigation expansion. By irrigating a further 1,187 ha, the potential demand for surface water could increase to 1,285 l/s as shown in *Table 24*. After the expansion, there would still be adequate surface water available (as well as groundwater) to support any additional growth in demand.

Table 24: Comparison of supply and demand with potential expansion

	Surface water (litres/sec)	Groundwater (million m^3/year)
Irrigation & frost protection	380	4.5
Other consented uses	901	2.6
Permitted/unconsented take estimate	4	0.4
Total allocated	1,285	7.5
Allocation limit	3,765	13.1
SURPLUS	**2,480**	**5.6**

4.4.1.5 Economic opportunities

Irrigation of 1,187 ha expansion, assuming water supply was accessible, has the potential to:

- Increase gross orchard or farm gate revenue by $94 million (driven by horticulture expansion).
- Increase EBIT by $31 million.
- Increase employment by 800 full time equivalent employees.

4.4.1.6 Water quality

Irrigation of another 1,187 ha could:

- Decrease in N loss to water by 83 tonnes per year.
- Decrease in P loss by 0.6 tonnes per year.

4.4.1.7 Summary

- Current irrigation in the FMU is slightly under 1,600 ha.
- The largest current consented allocations for surface water are for domestic/ commercial/ industrial, followed by irrigation and frost protection. Permitted takes are estimated to be minor.
- There is surplus surface water and groundwater available, although not everywhere.
- Estimated irrigation expansion could be supplied solely from surface water.
- There would be adequate amount of surface water allocation left after the expansion.
- Horticulture development, supported by irrigation expansion with the water available, could significantly increase revenue and employment, while reducing nutrient losses.

4.4.2 Mid and Upper Rangitāiki Catchments

4.4.2.1 Catchment outline

The Mid and Upper Rangitāiki FMU is shown in *Figure 35*. Total catchment area is 284,945 hectares. It covers the remainder of the WMA, upstream from the Matahina dam, including the area within Te Urewera and the Whirinaki Conservation Park.

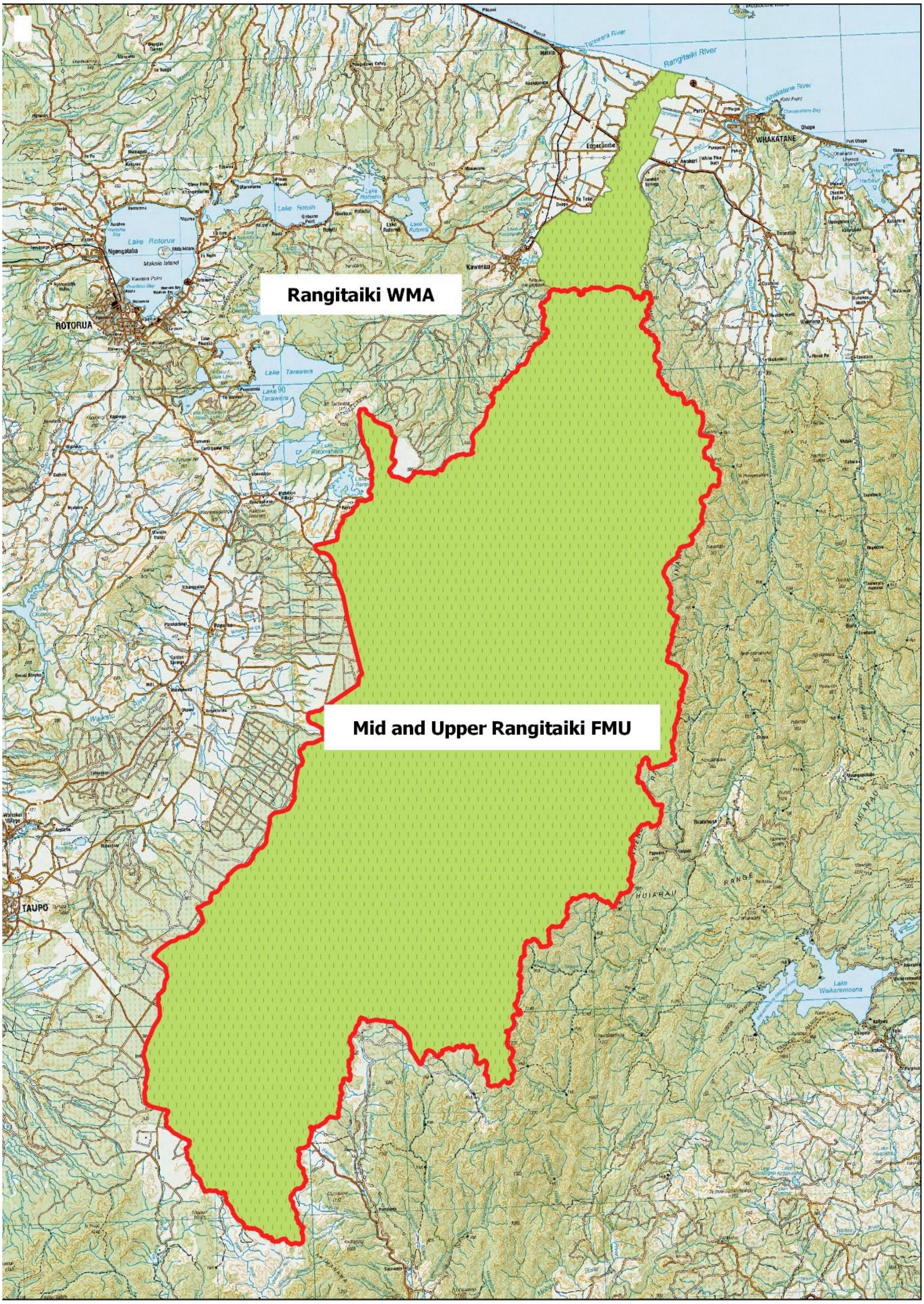

Figure 35: Rangitāiki WMA and combined Mid & Upper Rangitāiki FMU

Two man-made lakes, Lake Aniwaniwa and Lake Matahina, have been formed by hydro-electric dams on the Rangitāiki River.

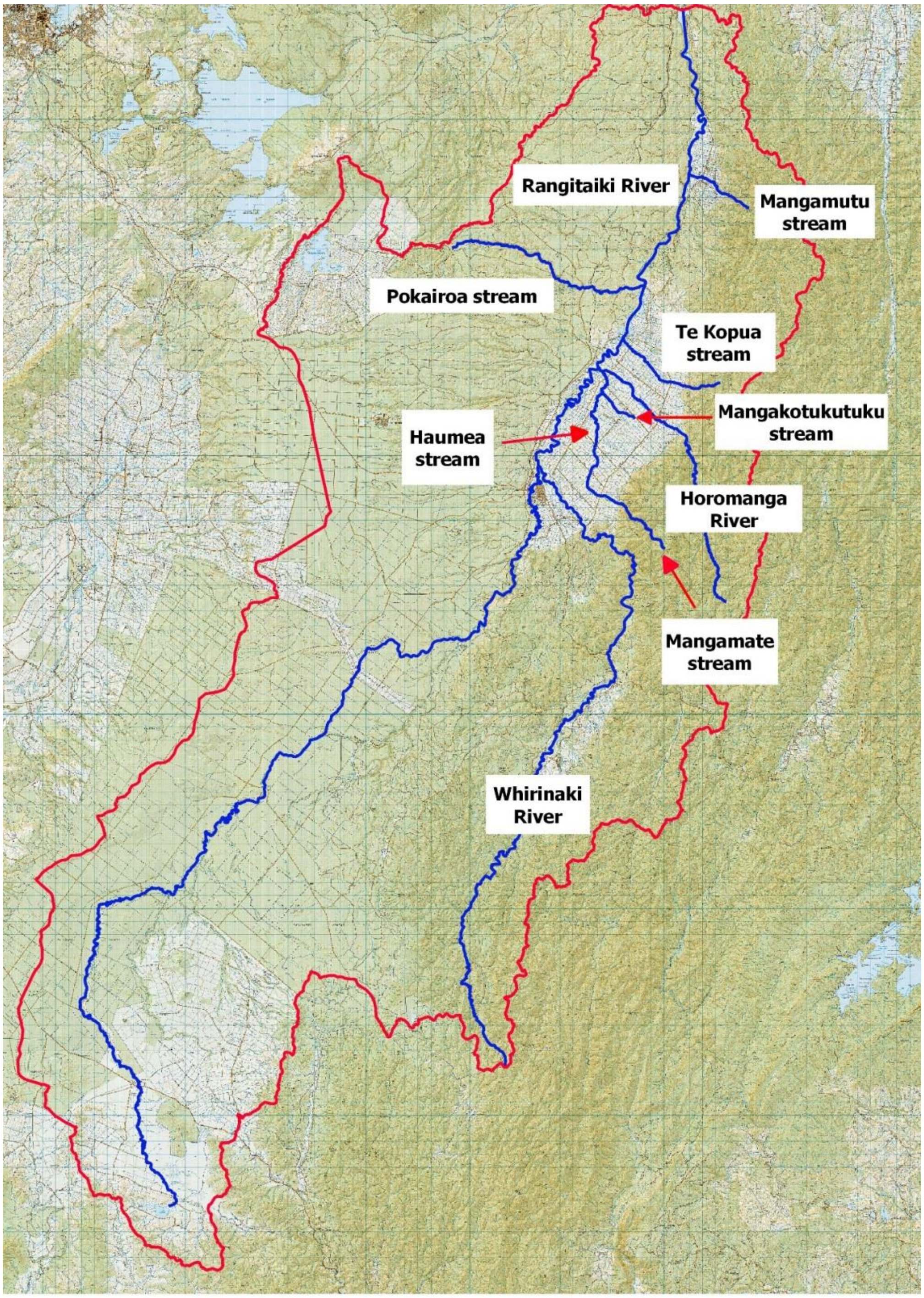

Figure 36: Rivers and streams in Mid & Upper Rangitāiki catchment

Figure 37 presents the current land use in the catchment. Over 83% of the catchment is in native or exotic forest. Further detail of the land use is given in *Figure 38*. The figure below the label is the area in hectares.

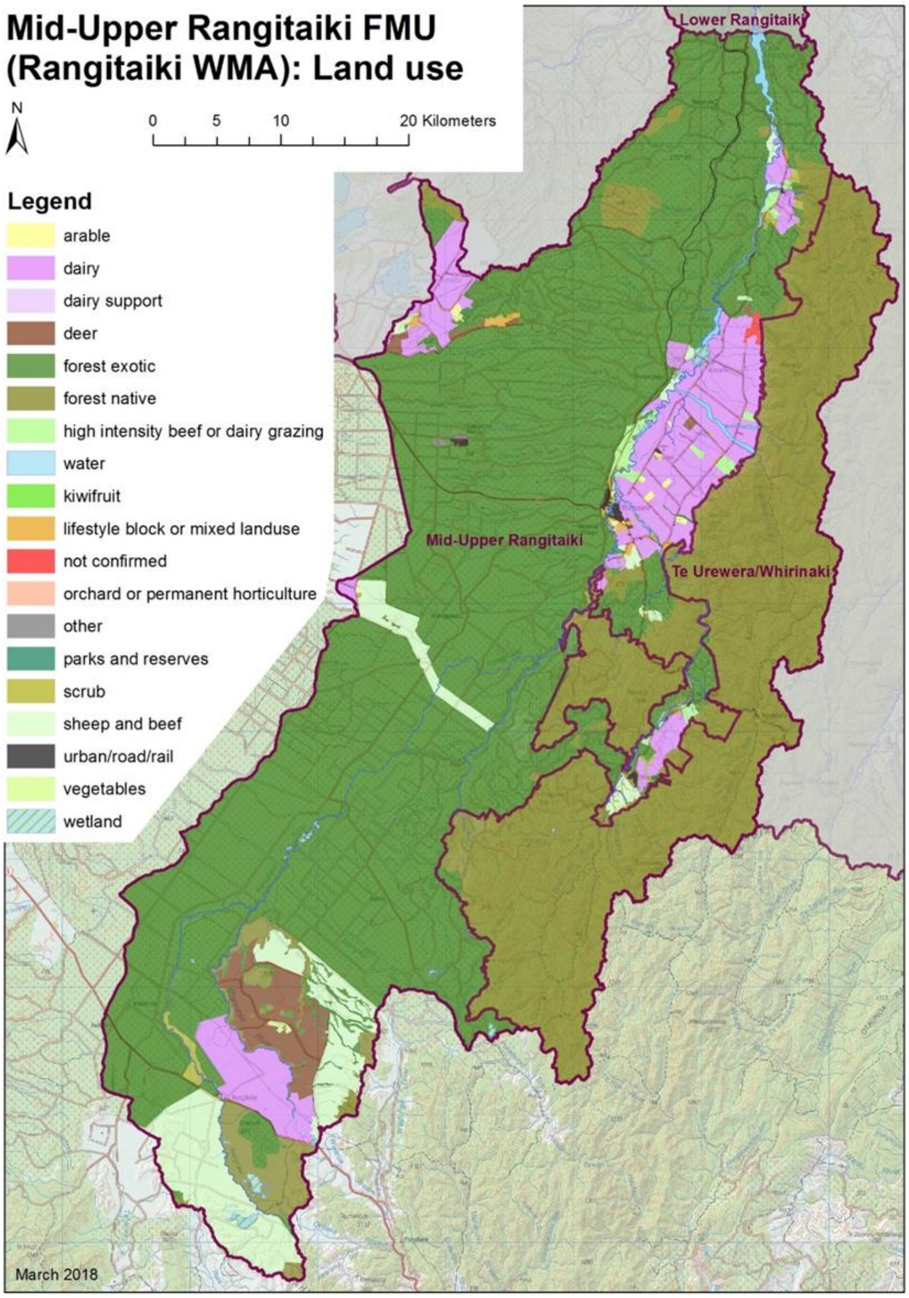

Figure 37: Current land use in the mid-upper Rangitāiki FMU

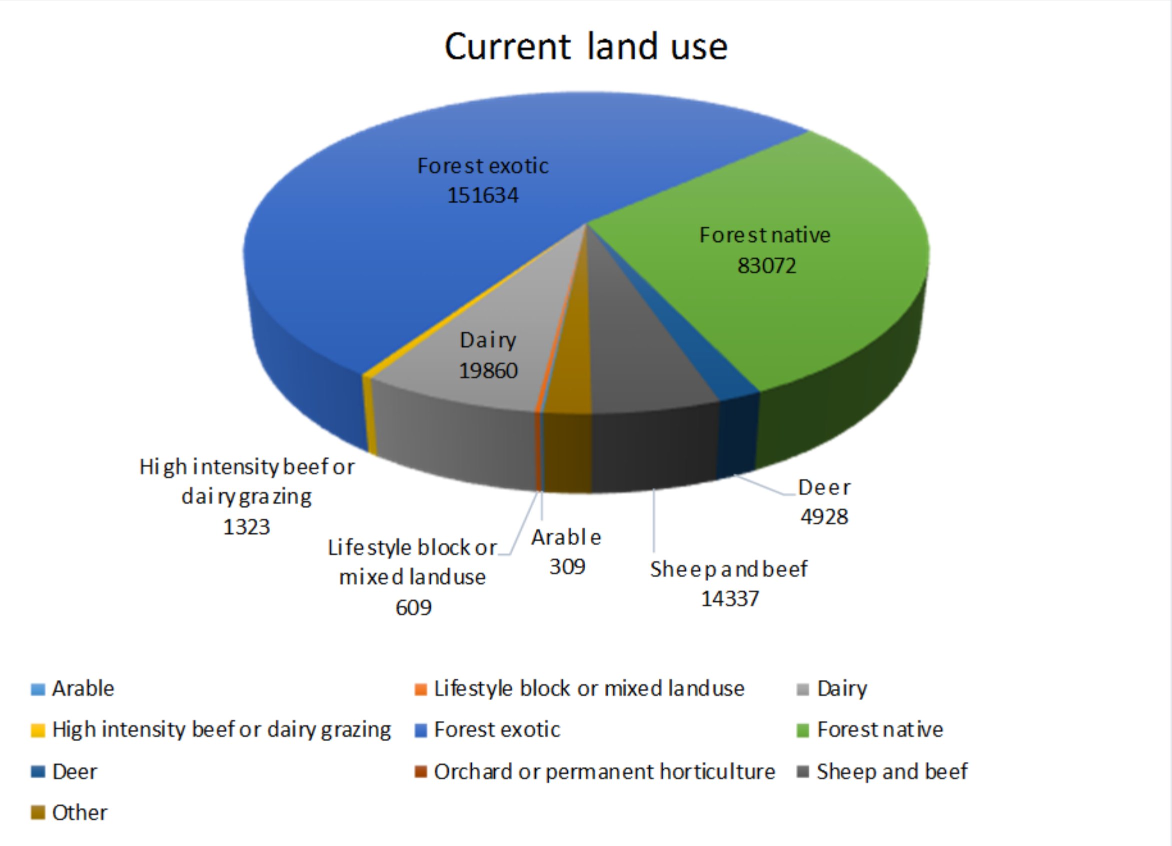

Figure 38: Detailed current land use in Mid and Upper Rangitāiki catchment

The current consented irrigated area is 3,003 ha. Within this, 2,201 hectares are irrigated from surface water and 802 hectares from groundwater. The existing irrigation is on pasture only.

4.4.2.2 Mid & Upper Rangitāiki total allocation limits

The flow rate of surface water and volume of groundwater allocation limits for abstractive use is as shown in *Table 25*.

Table 25: Current allocation limits for surface water and groundwater

	Surface water (litres/sec)	Groundwater (million m^3/year)
Surface water[1]	1,829	
Groundwater[2]		36.4

Note 1: Includes Rangitāiki River, Whirinaki River, Haumea Stream, Horomanga River, Mangakotukutuku Stream, Mangamutu Stream and Te Kopua Stream

Note 2: Revised groundwater allocation limits from BOPRC (includes Kāingaroa North, Galatea Plain and Waiohau Basin groundwater zones, but not other groundwater zones which are predominantly under native or exotic forestry).

Surface water availability in the Mid-Upper Rangitāiki FMU is constrained by existing consents, particularly by hydro-electricity generation consents. New consents cannot generally derogate from these pre-existing consents. The surface water allocation limit above reflects this.

Likewise, access to groundwater is subject to abstractions not having an adverse effect on surface water flows, which has not been determined. No impact from groundwater abstraction on surface water flows, and therefore full availability, are assumed in the analysis presented here.

There are other sources, particularly small streams that have not yet been given specific allocation limits that are not included in the cumulative allocation limit above. However, any additional allocation from these tributaries of the Rangitāiki River would also be constrained by existing downstream consents.

4.4.2.3 Allocable water with reasonable use

Table 26 provides a comparison of water supply (allocation limits) and demand to determine whether the catchment has a water shortage or surplus.

The table also shows the water shortage or surplus with the reasonable use rates (for surface water) and volumes (for groundwater) which better match the actual need than the current allocation equivalents.

Reasonable use supply rate is assumed to be 0.23 l/s/ha (2 mm/day) for kiwifruit and horticulture, and 0.45 l/s/ha (3.9 mm/day) for pasture. Annual volume allocation requirements for irrigation (the volume required to meet demand in a 1 in 10 year drought year) are at somewhere between 368 m^3/year/ha to about 1,888 m^3/year/ha, with the lower figures being for deep rooted horticulture and the higher figures for pasture.

Using the reasonable use figures for irrigation, the total surface water allocation could reduce from 1,891 l/s to 1,133 l/s. The total groundwater allocation could reduce from 6.9 million cubic metres to 2.6 million cubic metres per year.

Table 26: Comparison of supply and demand

	Surface water (litres/sec)		Groundwater (million m^3/year)	
	Current	Reasonable use	Current	Reasonable use
Irrigation & frost protection	1,777	1,019	5.7	1.5
Other consented uses	84	84	0.7	0.7
Permitted/unconsented take estimate	31	31	0.4	0.4
Total allocated	1,891	1,133	6.9	2.6
Allocation limit	1,829	1,829	36.4	36.4
SURPLUS	**-62**	**696**	**29.6**	**33.8**

Overall, there is a surplus of allocation available to support potential expansion.

4.4.2.4 Potential irrigable area and land use change

While there would be a surplus of both surface water and groundwater in the catchment once existing consents are adjusted to reasonable use, the degree to which water-demanding enterprises can be expanded or developed depends on water demand. The largest potential future water demand is likely to come from irrigation.

To expand the irrigated area, land use will change. The estimated future land use is shown in *Figure 39*. It is predicted that there would be a large increase in the horticultural and high intensity beef and dairy grazing land while the other land use areas would decrease.

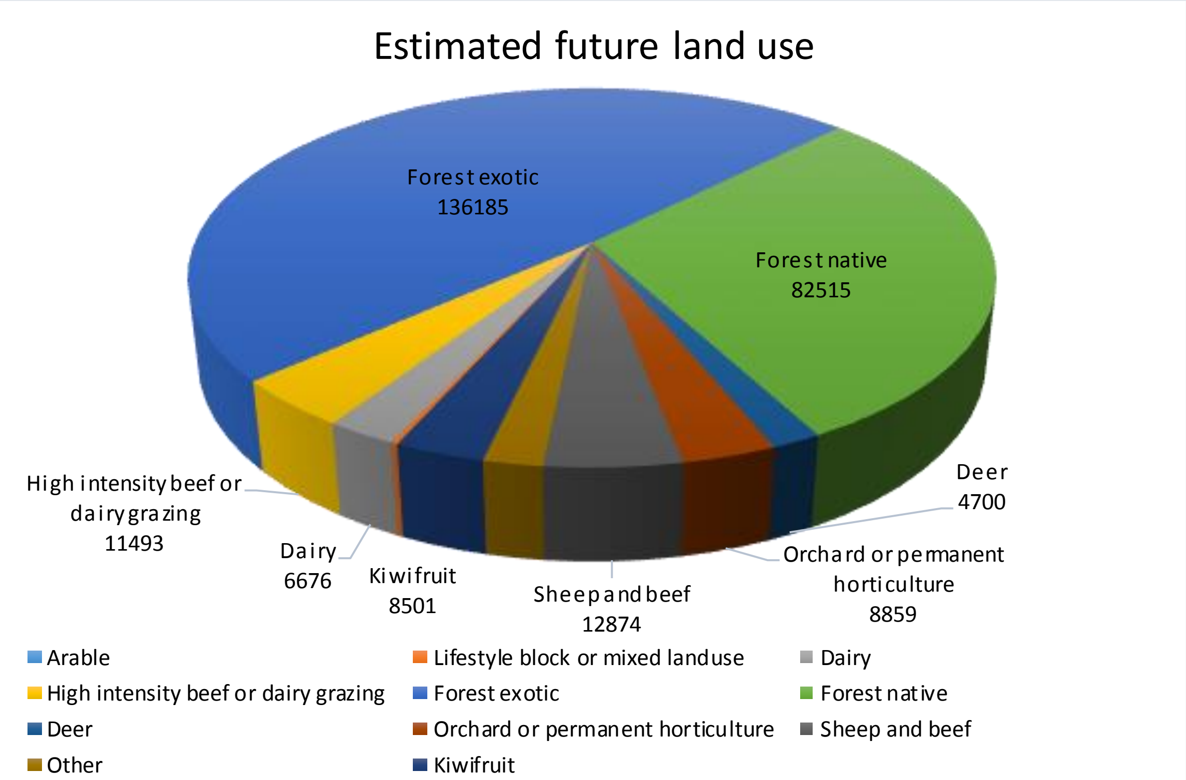

Figure 39: Estimated future land use in Mid & Upper Rangitāiki catchment

This study assumes the ratio of irrigated land to dry land would stay the same in the future. In these catchments, currently 15% of pasture is irrigated while there is no irrigated horticultural land and hence 80% of the potential horticultural land has been assumed to be irrigated. With these assumptions, the total irrigated area would increase by 13,632 ha, from 3,003 ha to 16,635 ha. The breakdown of the irrigated area is shown in *Figure 40*.

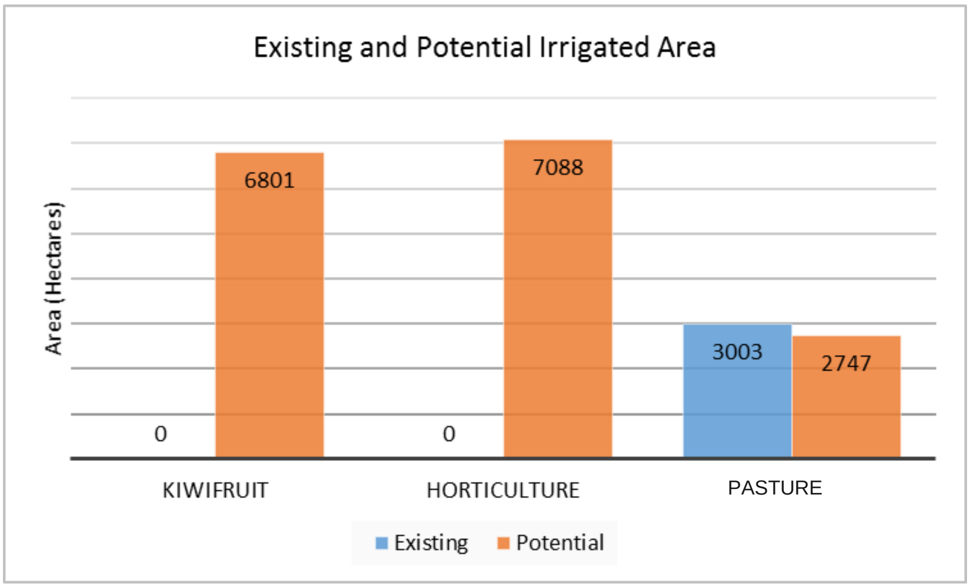

Figure 40: Potential irrigated areas in Mid & Upper Rangitāiki FMU

4.4.2.5 Comparison of supply and demand

To balance the supply of surface and groundwater availability to meet as much of the potential demand as possible, the new development can be supplied from surface water and groundwater.

There is insufficient additional surface water available (696 l/s) to meet the total expansion on its own, so some of the supply will have to come from groundwater.

By irrigating a further 13,633 ha, the potential demand for surface water and groundwater could increase to 1,714 l/s and 33.4 million m^3/year respectively, as shown in *Table 27*. The split between surface water and groundwater sourced irrigation was determined so that much of the surplus surface water is used.

After the expansion, there would still be some groundwater resource available (assuming it can be found and that it does not derogate from existing consents) to support any foreseeable growth in demand.

Table 27: Comparison of supply and demand with potential expansion

	Surface water (litres/sec)	Groundwater (million m^3/year)
Irrigation & frost protection	1,714	33.4
Other consented uses	84	0.7
Permitted/unconsented take estimate	31	0.4
Total allocated	1,828	34.6
Allocation limit	1,829	36.4
SURPLUS	**0**	**1.9**

4.4.2.6 Economic opportunities

Irrigation of 13,633 ha expansion, assuming water resources were accessible, has the potential to:

- Increase gross orchard or farm gate revenue by $1.4 billion per year (driven by horticulture expansion).
- Increase EBIT by $615 million per year.
- Increase employment by 11,000 full time equivalent employees.

4.4.2.7 Water quality

Irrigation of another 13,633 ha could:

- Increase in N loss to water by 74 tonnes per year.
- Decrease in P loss by 5.5 tonnes per year.

4.4.2.8 Summary

- Current irrigation in the FMU is slightly over 3,000 ha.
- Excluding hydro-electricity generation, the largest current consented allocations for surface water are for irrigation and frost protection. Other uses are minor.
- There would be surplus surface water and groundwater available, if existing consents are reduced to reasonable use rates.
- Estimated irrigation expansion would use up the surplus surface water and use much of the surplus groundwater as well.
- There would be a small amount of groundwater allocation left after the expansion.
- Intensification, supported by irrigation expansion with the water available, could significantly increase revenue and employment from irrigated agriculture and horticulture.

4.5 Tarawera WMA

4.5.1 Catchment outline

The Tarawera case study area is shown in *Figure 41*. Total catchment area is 79,606 hectares.

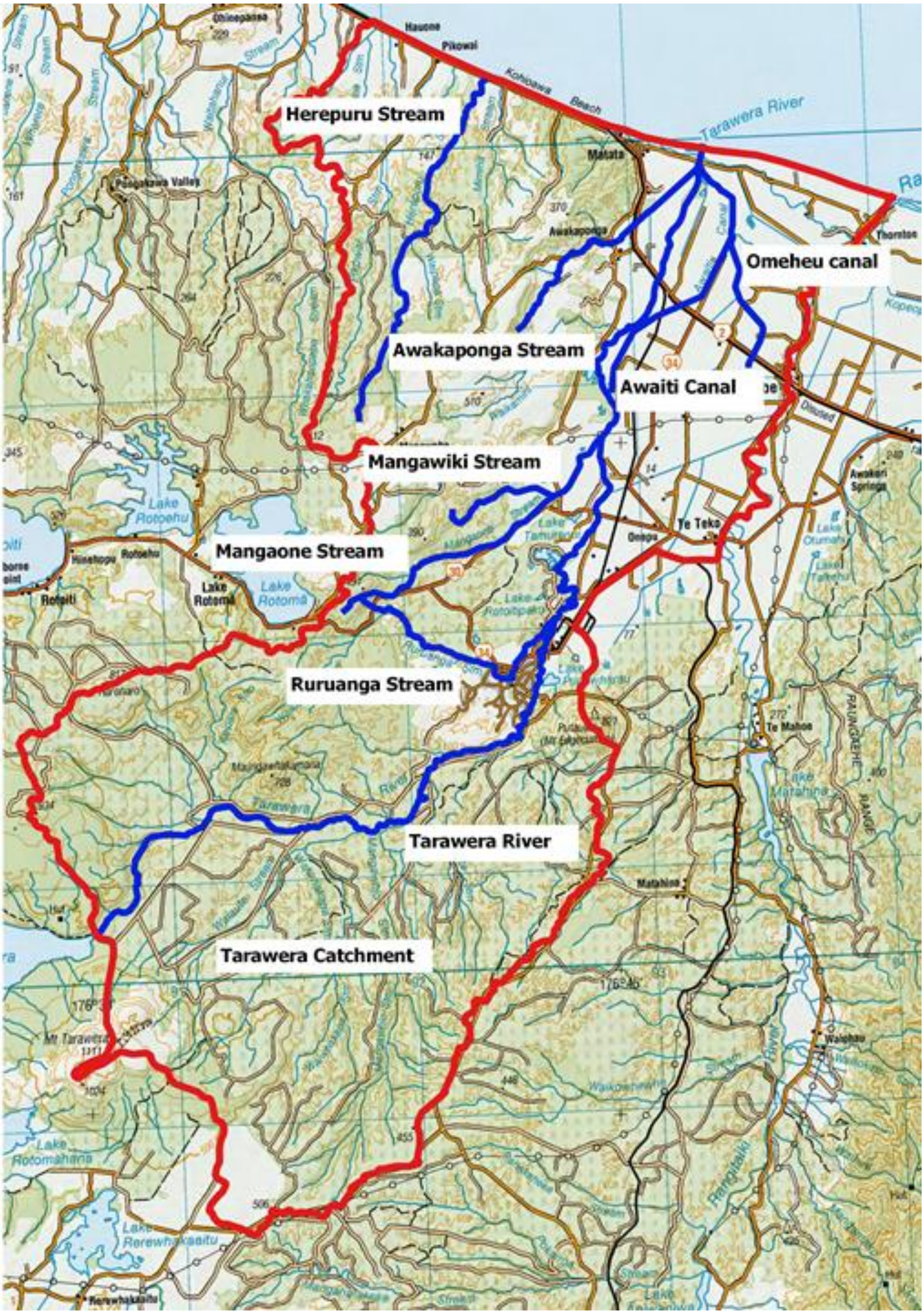

Figure 41: Outline of Tarawera case study area

The main river is the Tarawera River, 65 km long, which flows from Lake Tarawera, north east across the northern flanks of Mount Tarawera, and past the town of Kawerau before turning north, reaching the Bay of Plenty 6 kilometres west of Edgecumbe. *Figure 42* presents the current land use in the catchment.

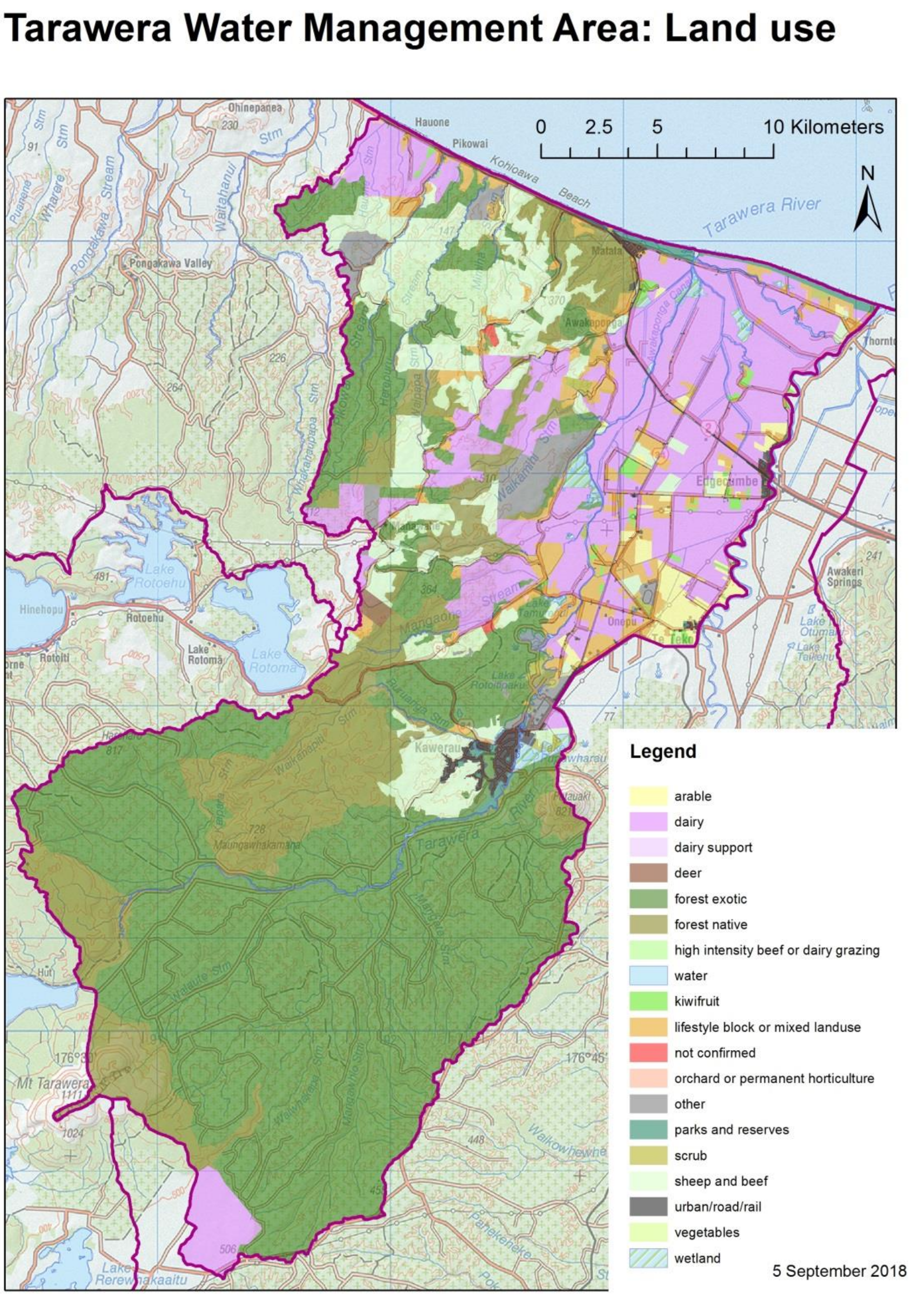

Figure 42: Current land use in Tarawera WMA

It is a predominantly rural catchment with over 60% of catchment in exotic or native forestry. Further detail of the land use is given in *Figure 43*. The number below the label is the area in hectares.

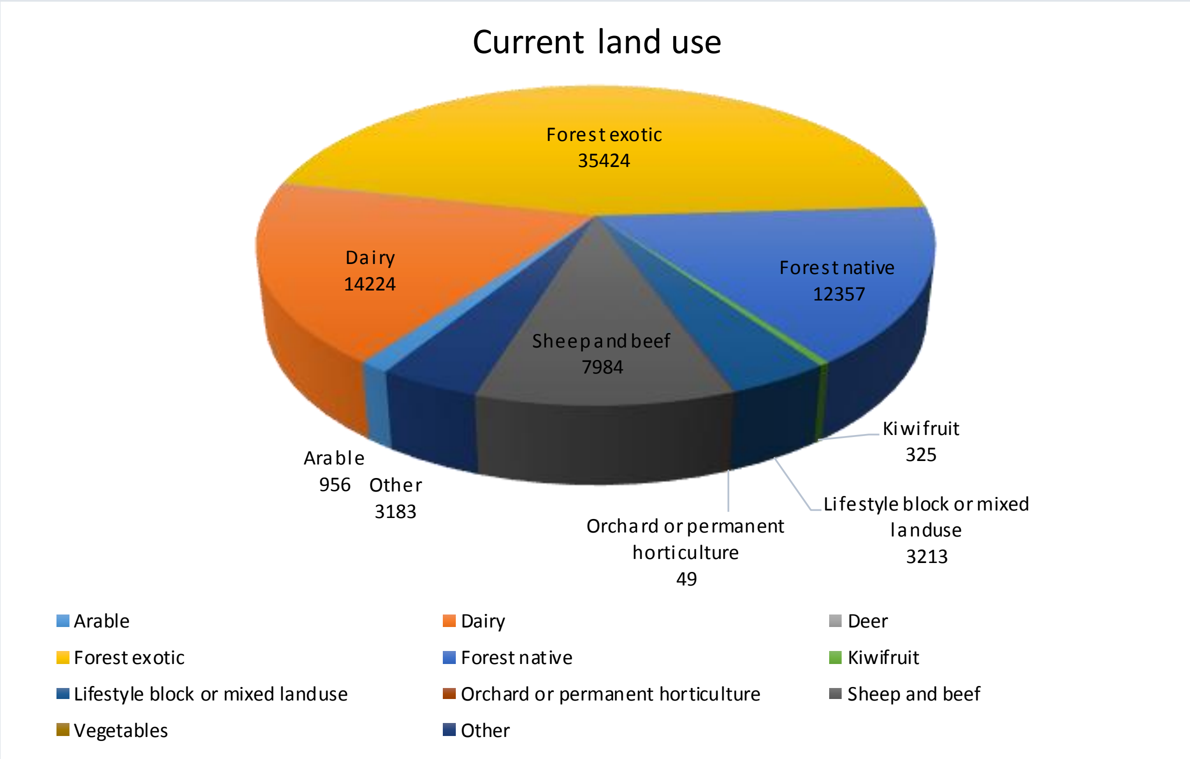

Figure 43: Current land use in the Tarawera catchment

The largest non-forested areas are dairy farming/ dairy support and sheep and beef farming.

The current consented irrigated area is 3,043 ha. Within this, 2,411 hectares are irrigated from surface water and 633 hectares from groundwater. About 90% of the existing irrigation is on pasture.

4.5.2 Tarawera total allocation limits

The flow rate of surface water and volume of groundwater available for allocation for abstractive use, under proposed Plan Change 9, are as shown in *Table 28*. Under the Tarawera River Catchment Plan, there are different limits for water allocation which may constrain development opportunities differently. These were not considered in the analysis.

Table 28: Current allocation limits for surface water and groundwater

	Surface water (litres/sec)	Groundwater (million m^3/year)
Surface water[1]	2,233.5	
Groundwater[2]		80.5

Note 1: Includes Tarawera River, Awaiti Canal, Mangawiki Stream, Ngakaroa Stream & others

Note 2: From availability report.

There are other sources, particularly small streams that have not yet been given specific allocation limits that are not included in the cumulative allocation limit above. Small amounts of surface water have been consented from streams that do not currently have specific allocation limits. While default allocation limits could be applied, there is insufficient flow data available to calculate the limits.

4.5.3 Allocable water with reasonable use

Table 29 provides a comparison of water supply and demand to determine whether the catchment has a water shortage or surplus.

The most prominent water users are agriculture (irrigation and frost protection) and industrial (the paper mills). In addition, the Braemar springs - Plains water supply for Whakatāne District Council is a significant user of fresh water.

Table 29 also shows the water shortage or surplus with the irrigation and frost protection reasonable use rates (for surface water) and volumes (for groundwater) that better match the actual need than the current allocation equivalents.

Reasonable use supply rate is assumed to be 0.23 l/s/ha (2 mm/day) for kiwifruit and horticulture, and 0.45 l/s/ha (3.9 mm/day) for pasture. Annual volume allocation requirements for irrigation (the volume required to meet demand in a 1 in 10 year drought year) are somewhere between 1,520 m^3/year/ha to about 4,000 m^3/year/ha, with the lower figures being for deep rooted horticulture and the higher figures for pasture.

Using the reasonable use figures for frost protection and irrigation, the total surface water allocation could increase slightly from 2,568 l/s to 2,573 l/s. The total groundwater allocation could reduce from 13.5 million cubic metres to 11.3 million cubic metres per year.

Table 29: Comparison of supply and demand

	Surface water (litres/sec)		Groundwater (million m^3/year)	
	Current	Reasonable use	Current	Reasonable use
Irrigation & frost protection	1,073	1,079	4.7	2.6
Other consented uses	1,478	1,478	7.9	7.9
Permitted/unconsented take estimate	17	17	0.8	0.8
Total allocated	2,568	2,573	13.5	11.3
Allocation limit	2,234	2,234	80.5	80.5
SURPLUS	**-335**	**-340**	**67.0**	**69.2**

Overall, there is a surplus of groundwater allocation available to support potential expansion.

4.5.4 Potential irrigable area and land use change

While there is a surplus of groundwater in the catchment, the degree to which water-demanding enterprises can be expanded or developed depends on water demand. The largest potential future water demand is likely to come from irrigation or industry.

To expand the irrigated area, land use will change. The estimated future land use for this catchment is shown in *Figure 44*. It is predicted that there would be a large increase in the land for kiwifruit and other horticulture.

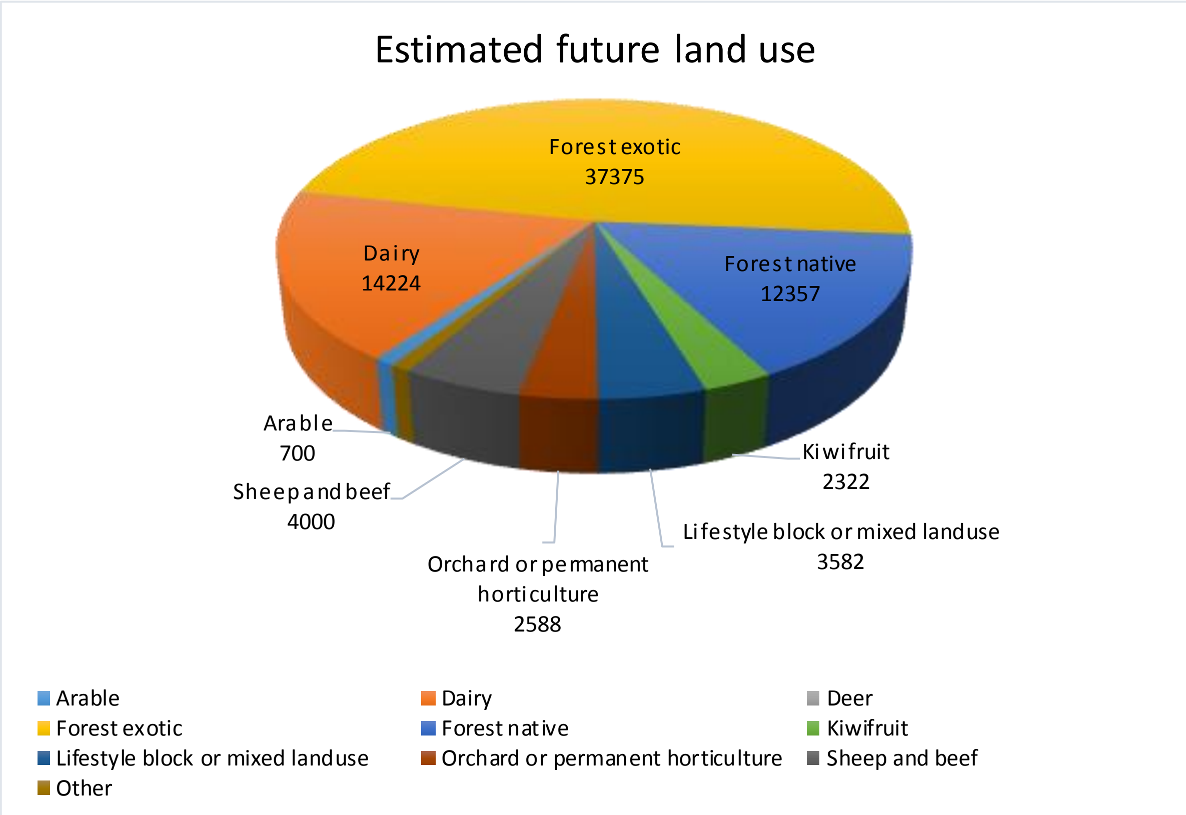

Figure 44: Estimated future land use

Potential irrigable areas were determined using the criteria outlined in Section 2.2.2.

Figure 45: Potential irrigable areas in Tarawera

As can be seen from *Figure 45*, a large part of the catchment area is currently in native and exotic forestry.

This study assumes the ratio of irrigated land to dry land would stay the same in the future (i.e. 70% for kiwifruit, 42% for horticulture, 19% for dairy). Therefore the total potential irrigated area would increase by 2,692 ha, from 3,043 ha to 5,735 ha. The breakdown of the irrigated area is shown in *Figure 46*.

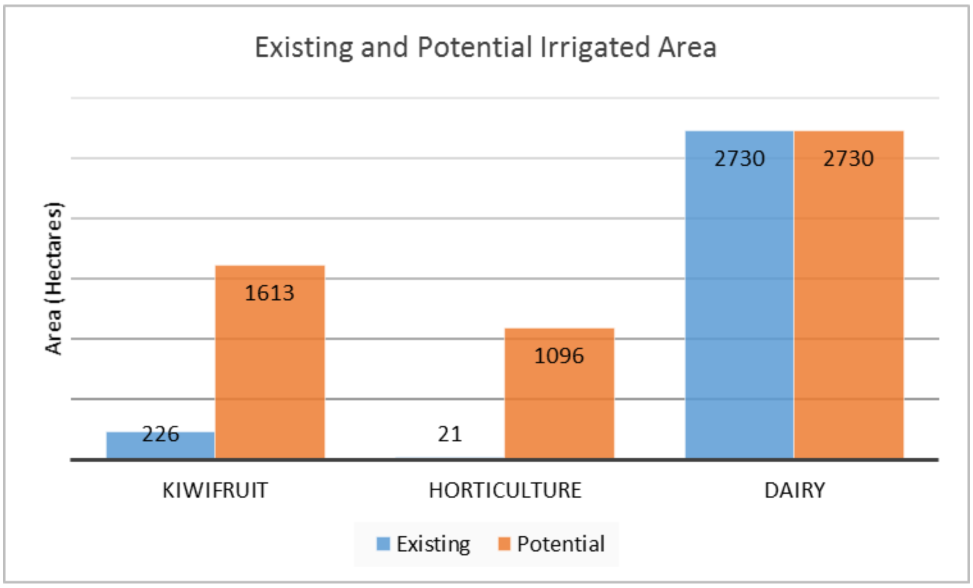

Figure 46: Estimated future irrigated area

4.5.5 Comparison of supply and demand

There is no additional surface water available to meet the total expansion, so all of the supply will have to come from groundwater.

By irrigating further 2,692 ha, the potential demand for groundwater could increase to 23 million cubic metres per year as shown in *Table 30*. After the expansion, there would still be adequate groundwater allocation available to support any additional growth in demand (e.g. for industrial purposes).

Table 30: Comparison of supply and demand with potential expansion

	Surface water (litres/sec)	Groundwater (million m^3/year)
Irrigation & frost protection	1,079	14.3
Other consented uses	1,478	7.9
Permitted/unconsented take estimate	17	0.8
Total allocated	2,573	23.0
Allocation limit	2,234	80.4
SURPLUS	**-340**	**57.4**

After irrigating the potential irrigable area of 2,692 ha, there is still adequate groundwater resource available (assuming it is accessible) to support any additional growth in demand.

4.5.6 Economic opportunities

Full irrigation of 2,692 ha expansion, assuming water supply was accessible, has the potential to:

- Increase gross orchard or farm gate revenue by $348 million per year (driven by horticulture expansion).
- Increase EBIT by $165 million per year.
- Increase employment by 2,800 full time equivalent employees.

4.5.7 Water quality

Irrigation of another 2,692 ha could:

- Decrease in N loss to water by 86 tonnes per year.
- Decrease in P loss by 0.04 tonnes per year.

4.5.8 Summary

- Current irrigation in the catchment is just over 3,000 ha.
- The largest current consented allocations for surface water are for dairy farm irrigation and domestic, commercial and industrial use. Permitted takes are estimated to be minor users of groundwater.
- Some potential for irrigation expansion in the catchment.
- Potential for expansion of industry (such as paper mills), which is likely a significant future use.
- There is insufficient surface water allocation to use for further use.
- There is excess groundwater allocation available.
- Horticulture development, supported by irrigation expansion with the water available, could significantly increase revenue and employment, while reducing nutrient loss from land use.

4.6 Whakatāne & Ōhiwa/Waiōtahe WMAs

4.6.1 Catchment outline

The Whakatāne & Ōhiwa/Waiōtahe case study area is shown in *Figure 47*. Total catchment area is 213,578 hectares. It is a predominantly rural catchment with a wide range of water users.

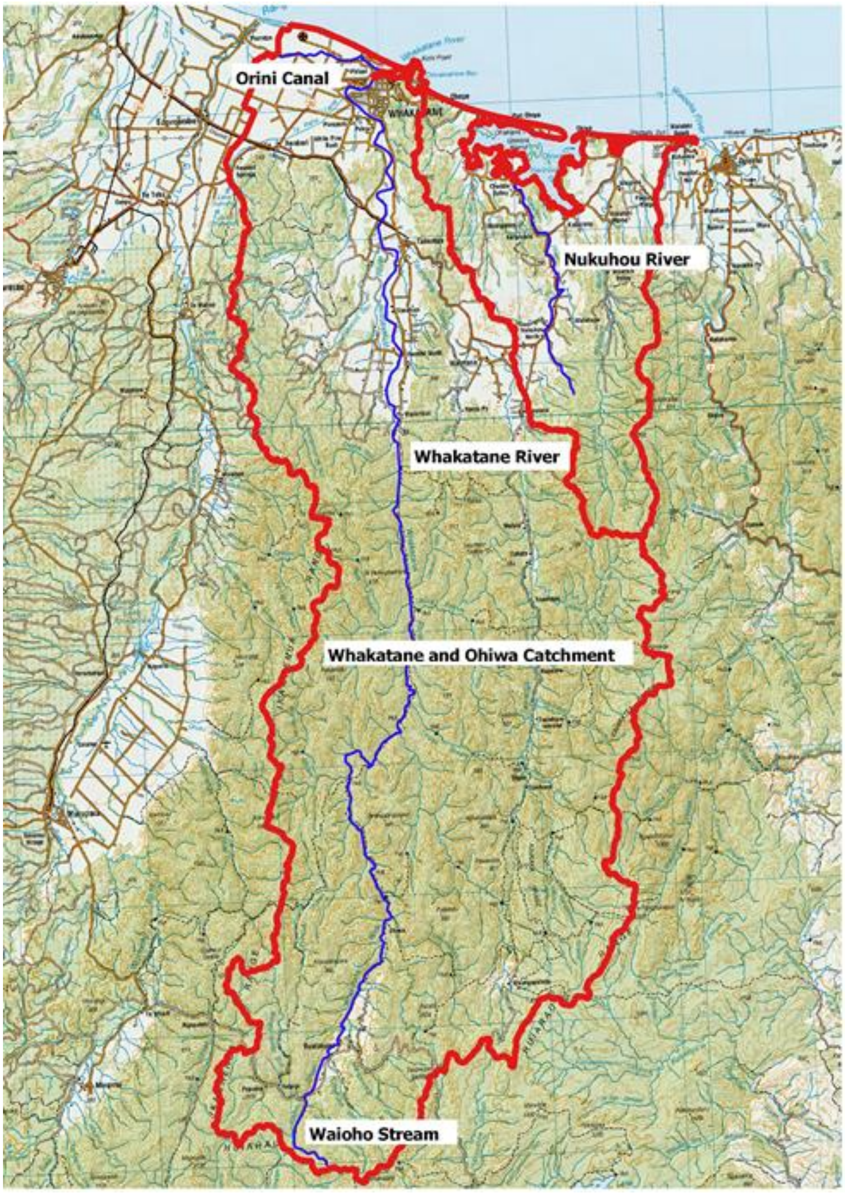

Figure 47: Outline of Whakatāne, Ōhiwa/Waiōtahe – Case study area

Figure 48 presents the current land use in the catchment. While kiwifruit is shown separately to avocado/horticulture, both land uses could simply be described as horticulture.

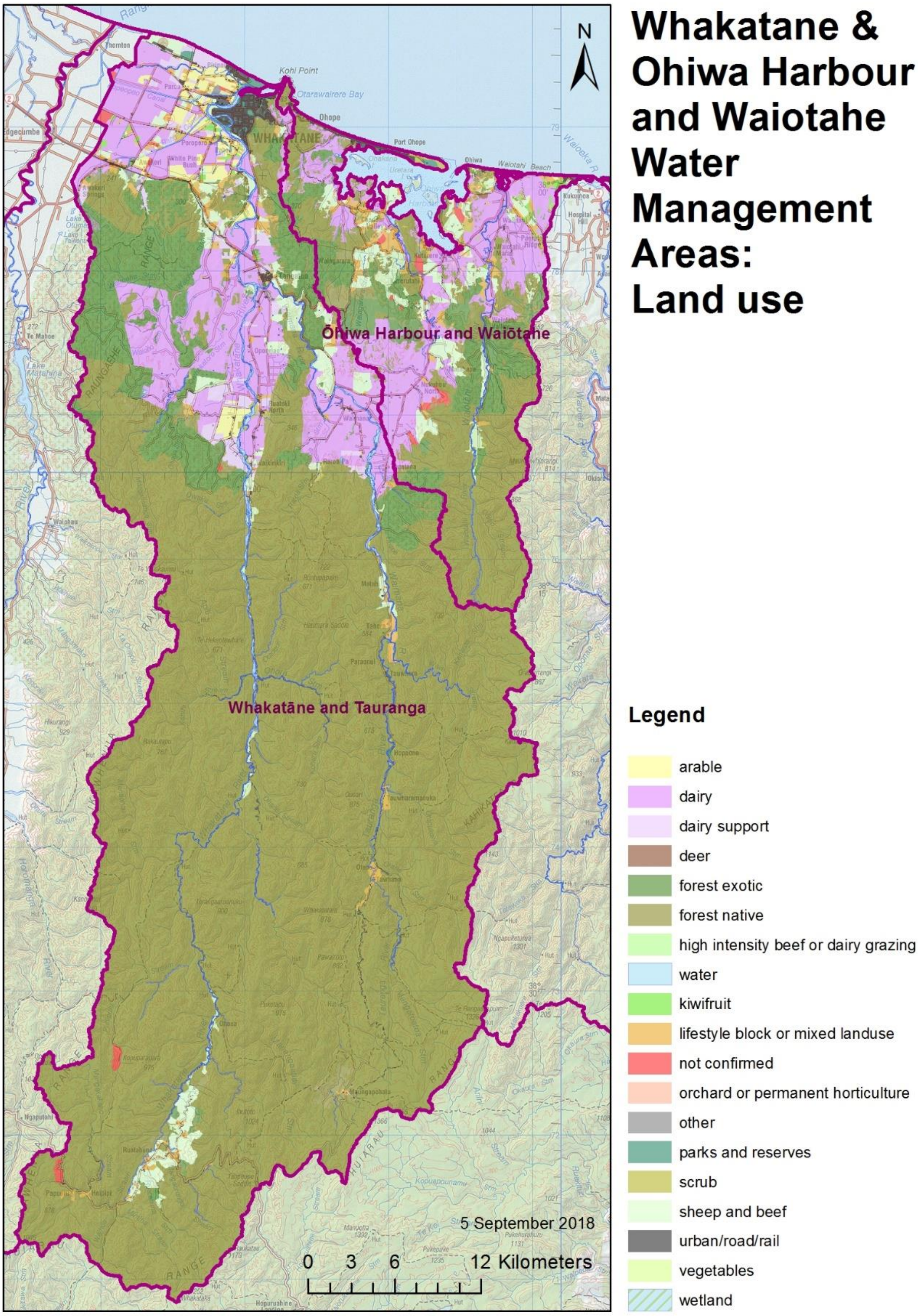

Figure 48: Current land use in Whakatāne & Ōhiwa/Waiōtahe catchments

71% of catchment is native forestry, with further area in exotic forestry. The catchment is predominantly rural, with a wide range of water users.

Further detail of the land use is given in *Figure 49*.

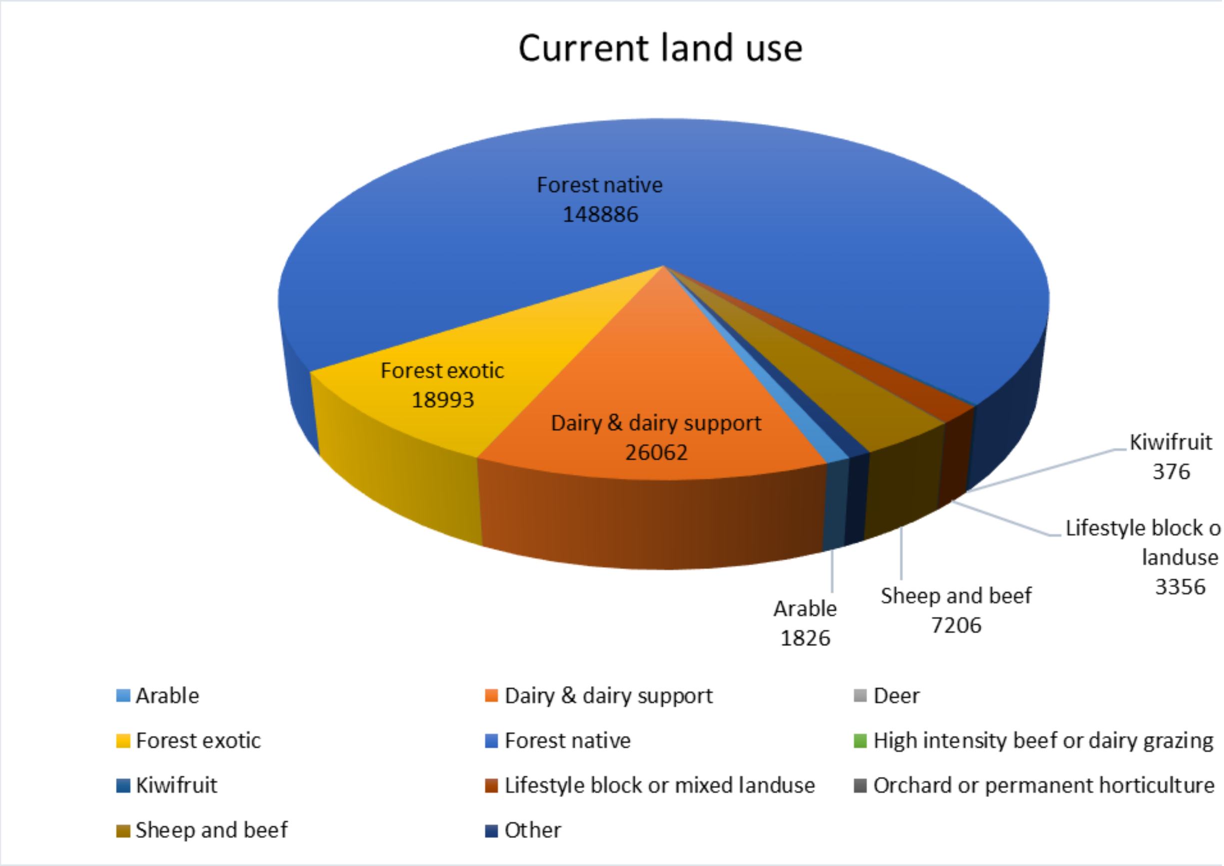

Figure 49: Detailed current land use in the Whakatāne Ōhiwa/Waiōtahe catchments

4.6.2 Whakatāne & Ōhiwa/Waiōtahe total allocation limits

The flow rate of surface water and volume of groundwater allocation limits for abstractive use is as shown in *Table 31*.

Table 31: Current allocation limits for surface water and groundwater

	Surface water (litres/sec)	Groundwater (million m^3/year)
Streams & rivers across both zones[1]	904.5	
Groundwater[2]		32.4

Note 1: Includes Whakatāne River, Waioho Stream and Nukuhou River.

Note 2: From BOPRC revised groundwater allocation limits.

There are other sources, particularly small streams that have not yet been given specific allocation limits that are not included in the cumulative allocation limit above. Small amounts of surface water have been consented from streams that do not currently have specific allocation limits. While default allocation limits could be applied, there is insufficient flow data available to calculate the limits.

4.6.3 Allocable water with reasonable use

Table 32 provides a comparison of water supply and demand to determine whether the catchment has a water shortage or surplus.

The table also shows the water shortage or surplus with the reasonable use rates (for surface water) and volumes (for groundwater) which better match the actual need than the current allocation equivalents.

Reasonable use supply rate is assumed to be 0.23 l/s/ha (2mm/day) for kiwifruit and horticulture, and 0.45 l/s/ha (3.9 mm/day) for pasture. Annual volume allocation requirements for irrigation (the volume required to meet demand in a 1 in 10 year drought year) are relatively modest at somewhere between 800 m^3/year/ha to 3,248 m^3/year/ha, with the lower figures being for deep rooted horticulture and the higher figures for pasture.

Using the reasonable use figures for irrigation and frost protection, the total surface water allocation could reduce from 639 l/s to 495 l/s. The total groundwater allocation could reduce from 6.0 million cubic metres to 5.7 million cubic metres.

Table 32: Comparison of supply and demand

	Surface water (litres/sec)		Groundwater (million m^3/year)	
	Current	Reasonable use	Current	Reasonable use
Irrigation & frost protection	361	216	2.7	2.4
Other consented uses	267	267	1.5	1.5
Permitted/unconsented take estimate	11	11	1.7	1.7
Total allocated	639	495	6.0	5.7
Allocation limit	905	905	32.4	32.4
SURPLUS	**265**	**410**	**26.5**	**26.7**

Overall, there is a surplus of water allocation available to support potential expansion.

4.6.4 Potential irrigable area and land use change

While there is a surplus of both surface water and groundwater in the catchment, the degree to which water-demanding enterprises can be expanded or developed depends on water demand. The largest potential future water demand is likely to come from irrigation.

To expand the irrigated area, land use will change. The estimated future land use for this catchment is shown in *Figure 50*. It is predicted that there would be a large increase in the land for kiwifruit and other horticulture while the area for dairy would decrease.

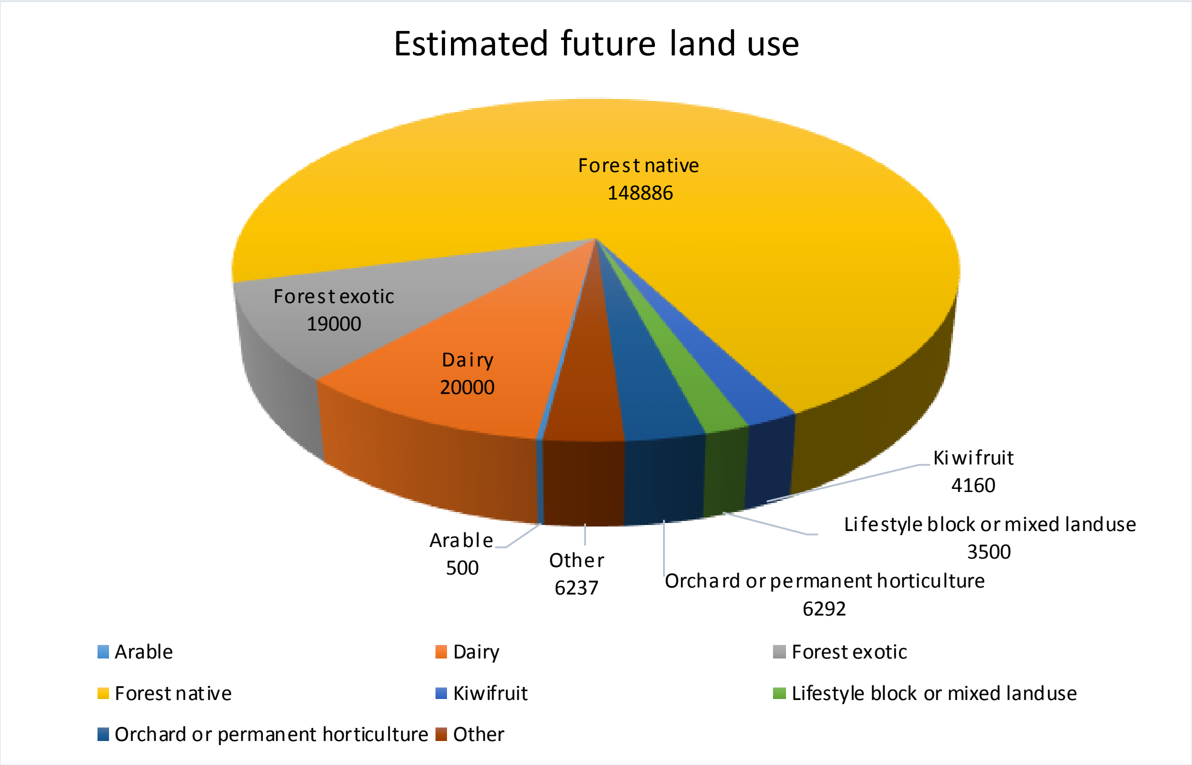

Figure 50: Estimated future land use

Potential irrigable areas were determined using the criteria outlined in Section 2.2.2.

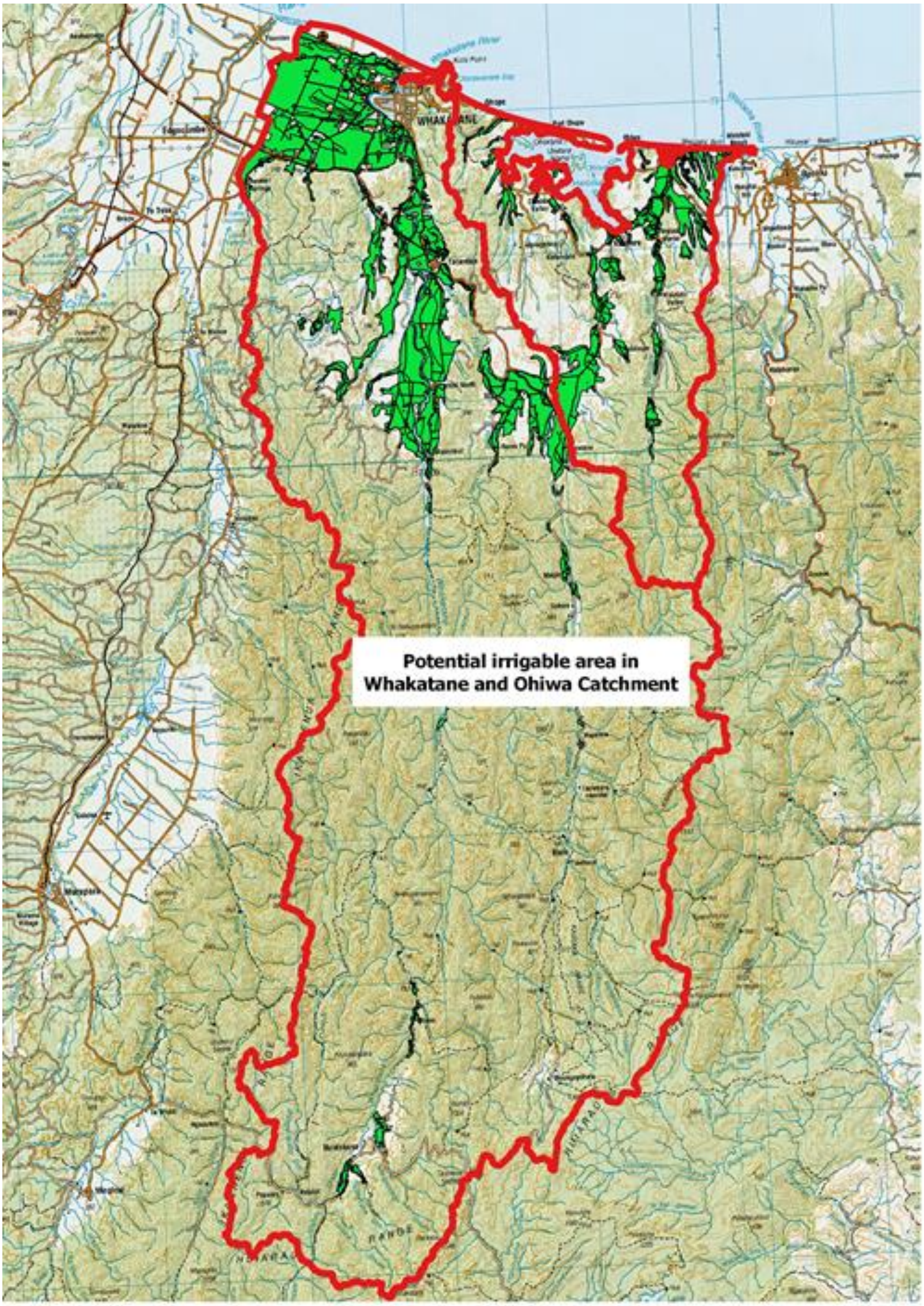

Figure 51: Potential irrigable areas in Whakatāne Ōhiwa/Waiōtahe

This study assumes the ratio of irrigated land to dry land would stay the same in the future (i.e. 49% for kiwifruit, 16% for avocado/horticulture and 3% for dairy). Therefore the total potential irrigated area would increase by 2,755 ha, from 864 ha to 3,618 ha. The breakdown of the irrigated area is shown in *Figure 52*.

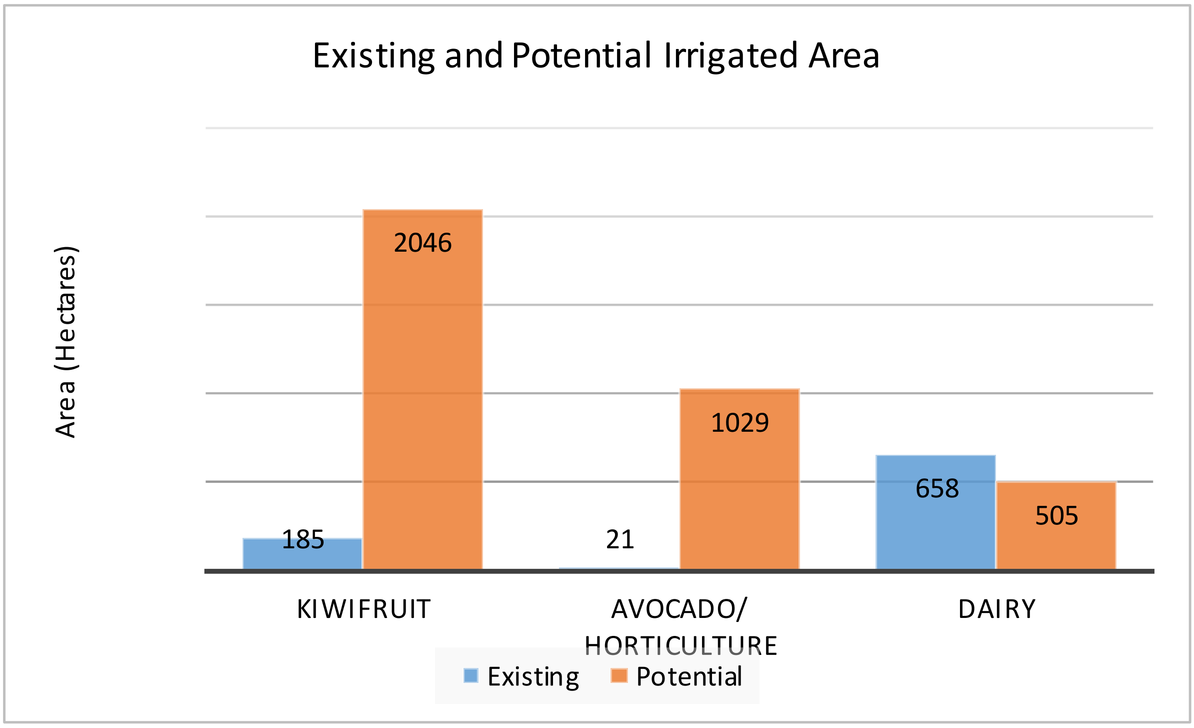

Figure 52: Potential irrigated land use (includes existing irrigation)

The Whakatāne District Council operates a rural water scheme (the Plains Water Scheme), supplying potable water to the Rangitāiki Plains. Opus[25] carried out a study looking at water demand 50 years out (Opus, 2011)[26]. The strategy, which is being implemented over time by Whakatāne District Council, is "future proofing" rural and municipal supply. On that basis, no further substantial increase in municipal and residential water demand beyond what has already been consented is expected.

4.6.5 Comparison of supply and demand

To balance the supply of surface and groundwater availability to meet as much of the potential demand as possible, the new development can be supplied from surface water and groundwater.

There is insufficient additional surface available (410 l/s) to meet the total expansion on its own, so some of the supply will have to come from groundwater.

By irrigating a further 2,755 ha, the potential demand for surface water and groundwater could increase to 905 l/s and 13.0 million m^3/year respectively, as shown in *Table 12*. The split between surface water and groundwater sourced irrigation was determined so that much of the surplus surface water is used.

[25] Now WSP Opus NZ
[26] Opus (2011). Plains 50 Year Strategy Study. Completed for Whakatāne District Council by Opus International Consultants Limited 2011.

After the expansion, there would still be adequate groundwater resource available (assume it can be found) to support any foreseeable growth in demand.

Table 33: Comparison of supply and demand with potential expansion

	Surface water (litres/sec)	Groundwater (million m^3/year)
Irrigation & frost protection	626	9.7
Other consented uses	267	1.5
Permitted/unconsented take estimate	11	1.7
Total allocated	905	13
Allocation limit	905	32.4
SURPLUS	**0**	**19.4**

4.6.6 Economic opportunities

Full irrigation of 2,755 ha expansion, assuming water supply was accessible, has the potential to:

- Increase gross orchard or farm gate revenue by $705 million per year (driven by horticulture expansion).
- Increase EBIT by $342 million per year.
- Increase employment by 1,810 full time equivalent employees.

4.6.7 Water quality

Irrigation of another 2,755 ha could:

- Decrease in N loss to water by 382 tonnes per year.
- Increase in P loss by 0.02 tonnes per year.

4.6.8 Summary

- Current irrigation (at least on paper) in the catchment is relatively modest (864 ha).
- The largest current consented allocations for surface water are irrigation and municipal use. Permitted takes are estimated to be minor.
- Some potential for irrigation expansion in the catchment.
- There is excess surface water and groundwater allocation available to support irrigation expansion.
- Horticulture development, supported by irrigation expansion with the water available, could significantly increase revenue and employment.

4.7 East Coast WMA

4.7.1 Catchment outline

The East Coast WMA runs from Waiaua in the west to Cape Runaway in the north east.

The WMA comprises of a series of bays, small river flats and villages alongside State Highway 35. The inland areas consist of large tracts of hill country bush and forest.

The total WMA area is 275,418 hectares. Most of the land is Māori-owned and native bush.

The lower reaches of the Raukokore catchment have been identified as a potential horticultural development area. The location of the Raukokore catchment is shown in *Figure 53*.

Figure 53: East Coast WMA and Raukokore catchment

The key river catchments in East Coast are the Waiaua River, Torere River, Motu River, Haparapara River, Kereu River and the Raukokore River catchments. Small floodplains are located at the mouth of each river. The floodplains provide most of the farmable land in the WMA.

There are also a large number of smaller streams that run from the hills to the sea.

The Motu River and specified tributaries of that river are locations in the region where it is a prohibited activity to apply for a resource consent to take water. This generally applies to the river upstream of the SH35 road bridge.

The East Coast rivers that have defined allocation limits are as follows (from the Availability Report).

Stream	Q5 7D low flow (l/s)	Allocable flow (l/s)	Allocated flow (l/s)	Remaining allocation (l/s)
Maraetea Stream			30.8	
Puremutahuri Stream	34	3.4	15	0
Waiorore Stream	9	0.9	14	0
Whanarua Stream	31	3.1	3.1	0

There are currently fourteen water take consents in the East Coast WMA, of which seven are for irrigation.

While the number of consents is small, the catchments with allocation limits are fully allocated or over-allocated.

Default allocation limits apply to other water bodies where water takes are allowed (see Section 2.2.5). Some surface water can be allocated from these catchments (Raukokore is an example), but large quantities of surface water are unlikely to be available. In addition, because the rivers and streams are hill-country fed, they are likely to experience low summer flows and may require storage to improve reliability.

There is some potential for groundwater development. Part of the East Coast WMA shares the Tirohanga groundwater management zone with the Waioeka/Otara WMA (18% of the management zone is in the Waioeka/Otara WMA). The allocable groundwater for this part of the East Coast WMA is 4.35 million cubic metres/year.

There has not been any assessment of allocable groundwater for other parts of the East Coast WMA. However, in other areas, most accessible groundwater is likely to be associated with the river deltas. The East Coast WMA is predominately greywacke basement which forms the Ruakumara Range. The greywacke basement rocks are generally not a productive aquifer, except where they are highly fractured.

To date, the limited number of deep wells installed have produced relatively small flows of water. However, lack of groundwater development has most likely been constrained by the uncertainty around and cost of finding groundwater, limited access to capital and issues with the development of Māori owned land rather than a lack of groundwater per se.

4.7.2 Future development

The gross potential irrigable area in the East Coast WMA is approximately 4,800 hectares. The majority of the potential irrigable area is in the coastal floodplains, as shown in *Figure 54*. The most significant future demand for water is likely to come from irrigation of high value horticultural crops.

The availability of groundwater is uncertain, because detailed groundwater studies have not been completed for the majority of the East Coast (the Tirohanga area is an exception).

Because of this uncertainty, most irrigation development will probably focus on abstraction from rivers or streams, with storage, if needed, to maintain supply reliability.

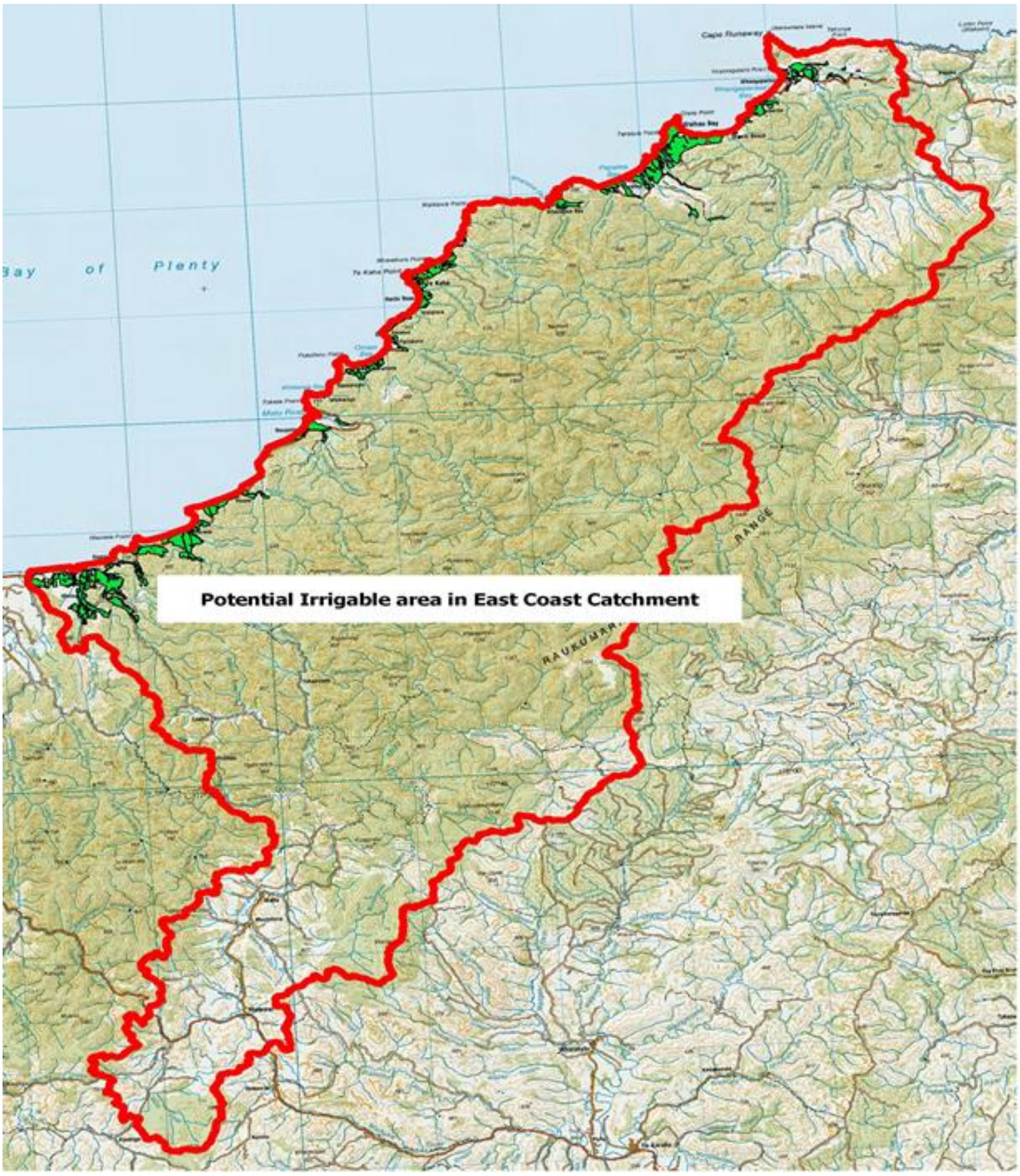

Figure 54: Potential irrigable area in East Coast WMA

Omaio, near Te Kaha, has been identified as a key location for potential land use development; there is a proposal to convert 150 hectares of low productivity land into high value kiwifruit orchards. The proposal would create 100 new jobs for the community. In addition, there is a current proposal for an irrigation scheme in Te Kaha.

4.7.3 Raukokore catchment irrigation potential

The Raukokore catchment was selected as a representative case study catchment in the East Coast WMA.

Currently, there are no irrigation consents for Raukokore listed in the BOPRC database. Current water use has not been defined, but will consist of unconsented and permitted use such as for domestic, rural and stock water supplies.

Current land use is primarily dryland sheep and beef farming. However, the Raukokore area has potential for high value horticultural development, with water supplied from the Raukokore River.

The Te Whanau a Maruhaeremuri Hapū Trust is currently undertaking a full feasibility and design study to investigate irrigation for up to 640 ha of land at Raukokore. The irrigation scheme is to enable development of high value horticultural land.

Development of the scheme will lead to a further influx of population (to support horticultural industries) as well as provide a community water supply and provide irrigation for dairy farms in this area.

The Tablelands Water Scheme in Ōpōtiki is a similar scheme to the proposed Raukokore Scheme. It irrigates approximately 300 ha of horticultural land.

The performance of the Tablelands Scheme suggests that there is potential to increase the EBIT performance significantly in Raukokore[27]. The Tablelands scheme resulted in 60 full time new positions in the immediate area and approximately 450 new jobs throughout the industry (based on one full time equivalent across the industry per 15,000 trays of fruit produced) were created.

4.7.4 Summary

- The majority of the potential irrigable area is in the coastal floodplains within the East Coast WMA.
- The Raukokore area has potential for irrigated horticultural development and has been chosen as the representative catchment of this study.
- Currently there are no irrigation consents for the Raukokore catchment. Default allocation limits have been applied to the Raukokore River.
- The Te Whanau a Maruhaeremuri Hapū Trust is currently undertaking a full feasibility and design study to investigate irrigation for up to 640 ha of land at Raukokore. The irrigation scheme is to enable development of high value horticultural land.
- There are other irrigation development proposals for other parts of the East Coast WMA, including at Ōmaio and Te Kaha.

[27] From 2018 Te Whanau a Maruhaeremuri Hapū Trust application for PGF funding for Raukokore irrigation, originally sourced from Te Tumu Paeroa.

4.8 Rotorua Lakes WMA

4.8.1 Irrigation demand

There are about 12,000 ha of potentially irrigable land (based on the criteria given in Section 2.2.2). However, due to the high elevation around most of the WMA, the viability of horticulture is limited.

In the Rotorua Lakes WMA, there are very few irrigation consents. Irrigation demand is minimal due to the relatively high rainfall in the area. The need for irrigation in the future is likely to be very low.

The average and 90th percentile of modelled irrigation water demand for pasture is 126 mm/year and 266 mm/year respectively. This shows that irrigation may be beneficial for optimising pasture growth for perhaps 30 days per year on average. Farmers have other options available to them for making up pasture growth shortfalls and investment in irrigation infrastructure may therefore not be economically viable.

Irrigation would be beneficial for a 1-in-10 year level of drought, to meet soil moisture deficits for about 60 days per year. However, the cost of irrigation for such limited use is likely to be higher than other alternatives to maintaining production.

According to the Availability Report, the Awahou, Hamurana, Waiohewa, Waiowhiro and Waitetī catchments have some allocation available.

No groundwater availability assessments have been completed for the Rotorua Lakes WMA except for a small part of the Rerewhakaaitu area that shares a groundwater management zone with the mid-Upper Rangitāiki FMU. Despite that, currently, 1.2 m3/year have been allocated from groundwater in the Rotorua Lakes WMA.

4.8.2 Water quality

The latest water quality results (2016/2017)[28] from BOPRC are summarised in Table 34. The health of each lake is indicated by its annual Trophic Level Index (TLI). The higher the number, the poorer the water quality in the lake. The TLI combines measurements of total nitrogen, total phosphorus, water clarity and Chlorophyll-a into one number.

Apart from Lake Rotoehu and Lake Tarawera, the water quality of most lakes has improved or is stable compared to the previous tests. As of 2017, only four lakes achieve their target TLI set in the Regional Natural Resources Plan (RL O1).

Table 34: Water quality in Rotorua lakes district

Location	Target TLI (RL O1)	2016/17 TLI	Trend
Lake Rotoehu	3.9	4.6	Declining
Lake Rotoiti	3.5	3.8	To be investigated
Lake Rotomā	2.3	2.3	To be investigated
Lake Rotorua	4.2	4.1	Stable
Lake Ōkataina	2.6	2.9	Stable
Lake Ōkāreka	3.0	3.4	Stable
Lake Tikitapu	2.7	2.6	Stable
Lake Rotokakahi	3.1	3.8	To be investigated
Lake Tarawera	2.6	3.1	Declining
Lake Rotomahana	3.9	4.0	Stable

[28] Rotorua Te Arawa Lakes Annual Water Quality Results. BOPRC Annual Report 2016-2017.

Location	Target TLI (RL O1)	2016/17 TLI	Trend
Lake Ōkaro	5.0	4.9	Improving
Lake Rerewhakaaitu	3.6	3.5	Stable

Under rules RL R1-R7 of the RNRP, development in the catchments of Lakes Ōkāreka, Rotoehu, Ōkaro, Rotorua and Rotoiti is restricted to activities that do no increase the annual average export of nitrogen or phosphorus from the property compared to the property benchmark. In practice this restricts the conversion of land from forestry to pastoral farming or horticulture, from sheep and beef farming to dairying, or intensification of dairying.

Plan Change 10 further restricts development in the Lake Rotorua groundwater catchment by requiring a reduction in the catchment load to 435 tonnes of nitrogen per annum (tN/yr) from 755 tN/yr (values based on OVERSEER 5.4). Generally, under the rules existing activities will need to reduce in intensity and there is limited ability to develop underutilised land unless nitrogen discharge allocations are purchased.

Furthermore, the water quality policies in the Regional Policy Statement (RPS) identify the above 12 lakes as catchments at risk and require the establishment of contaminant limits within those catchments. It is anticipated, at this time, that the RPS water quality policies will be included in the Rotorua Lakes WMA limit-setting process.

Land use intensification in the Rotorua Lakes area would be significantly restricted by all of these water quality provisions.

4.8.3 Summary

- The need for irrigation is likely to be low.
- Some surface water allocation is available.
- Groundwater availability has not yet been assessed for the Rotorua Lakes area.
- Water quality of the lakes within the WMA is in general not at the desired level and some lakes are experiencing a decline in water quality.
- Existing provisions in the RNRP restrict development in the catchments of Lake Ōkāreka, Rotoehu, Ōkaro, Rotorua and Rotoiti and Water Quality Policies in the RPS signal restrictions in the catchments of the other seven lakes.

4.9 Summary

The current study has found that the Lower Rangitāiki catchment and combined Waioeka and Otara WMAs have abundant surface water and groundwater. In these areas, the surplus surface water alone could cater for the modelled potential expansion.

The Wairoa catchment, combined Whakatāne and Ōhiwa/Waiōtahe WMAs and the combined Mid- and Upper Rangitāiki catchments have some surface water and groundwater available, the modelled potential expansion would need all of the surplus surface water and some amount of groundwater.

The Tarawera WMA and combined Pongakawa and Waitahanui catchments have no spare surface water. The Tarawera WMA has an ample amount of groundwater to support the modelled expansion, while the combined Pongakawa and Waitahanui catchments would struggle to keep the current ratio of irrigated area to dryland after expansion. The study indicated that the surplus groundwater could support around 2,200 ha of horticultural irrigation out of about 7,300 ha of expanded horticultural land.

The Kaituna catchment faces the opposite situation to the Tarawera WMA; there is no groundwater allocation left but there is plenty of surface water to support the modelled expansion.

Within the Raukokore catchment of the East Coast WMA, there are no irrigation consents. However, the Raukokore area has potential for high value horticultural development, with water supplied from the Raukokore River. There is a full feasibility and design study for an irrigation scheme in this area, which enables development of high value horticultural land. There are similar irrigation development proposals in the East Coast region at Te Kaha and Ōmaio.

Some surface water allocation is available in the Rotorua WMA, but the need for irrigation is likely to be low. In this WMA, apart from Lake Rotoehu and Lake Tarawera, the water quality of most lakes has improved or is stable. However, as of 2017, only four lakes achieve their target TLI and so more work and time will be needed for further improvement, and land use intensification is unlikely.

Figures 55, 56 and *57* below summarise current allocation and surpluses (or headroom) relative to allocation limits for surface water and groundwater respectively for each case study catchment or WMA.

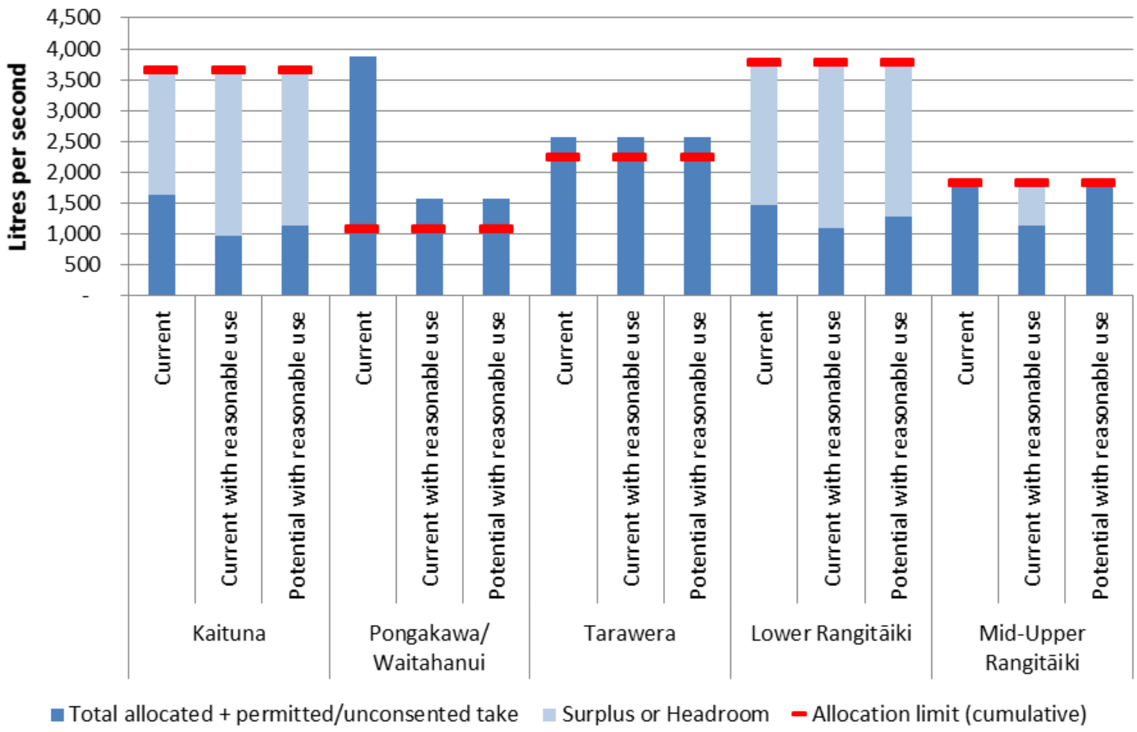

Figure 55: Current allocation and surpluses (or headroom) relative to allocation limits for surface water

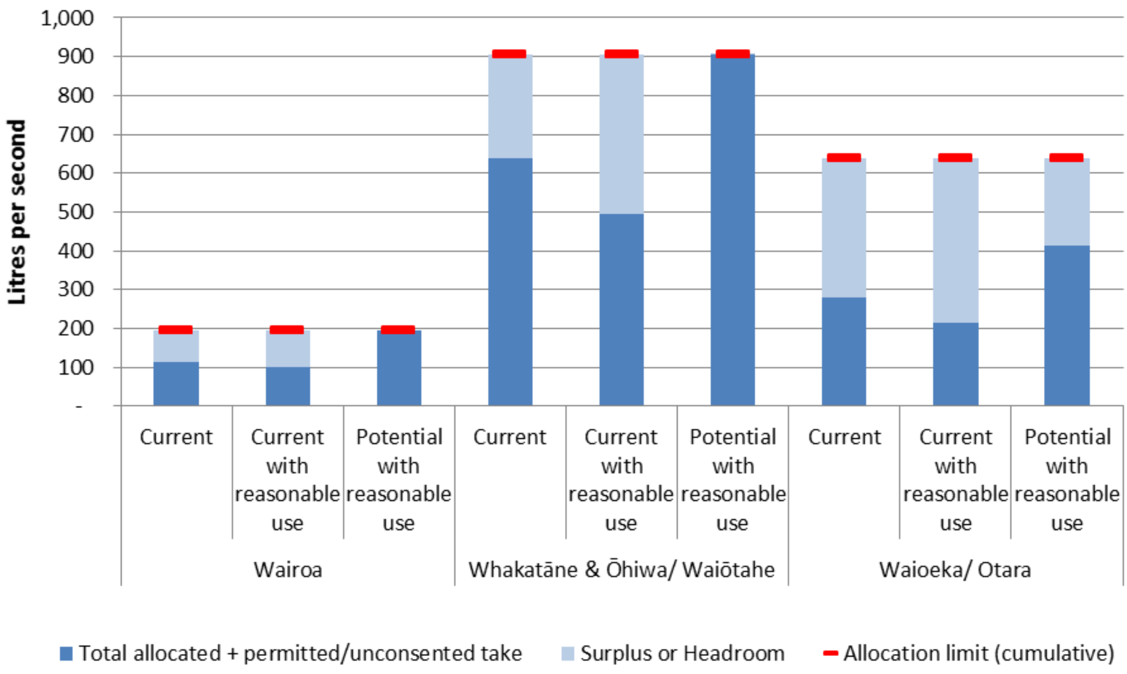

Figure 56: Current and potential supply and demand (with and without reasonable use adjustments)

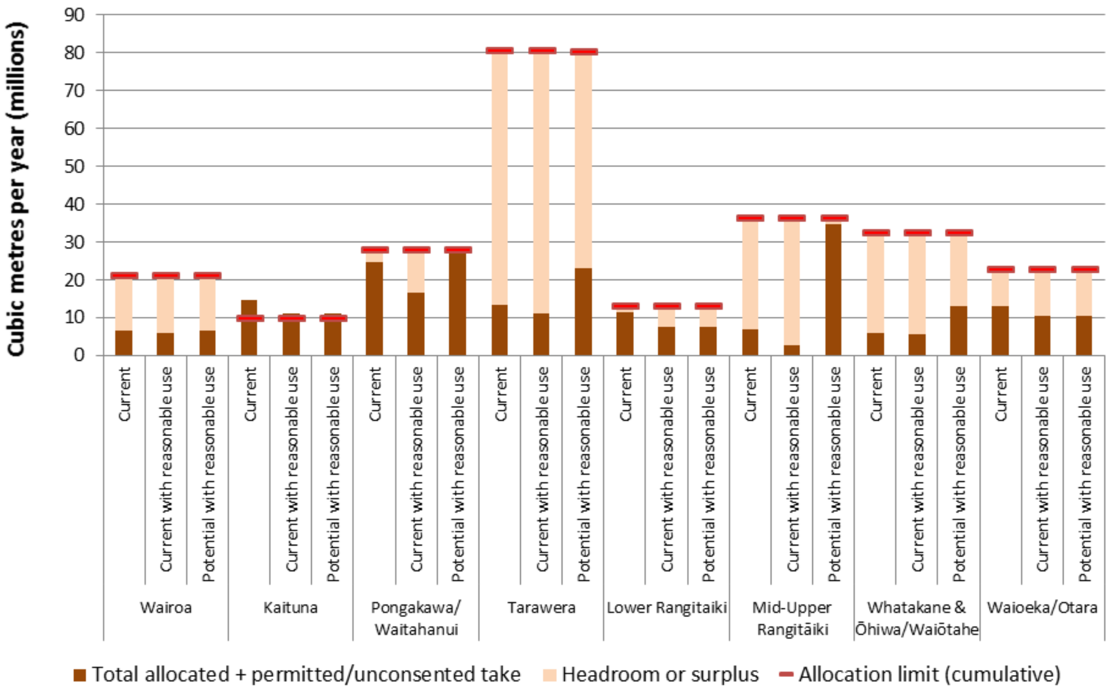

Figure 57: Current allocation and surpluses (or headroom) relative to allocation limits for groundwater

5 WORKSHOP FEEDBACK

5.1 Summary of workshops

Between 20 and 40 people, including BOPRC staff, attended each of the workshops. Participants came from a range of sectors including manufacturing, farming, horticulture, Māori interests, environmental and local government.

A brief workshop outline was sent with invitations to a wide range of invitees, including some that received invites via other invitees. A three-page summary of key Aqualinc irrigation case study results, including a current land use map, for each case study area, was sent to workshop invitees.

BOPRC staff (either Ian Morton, Glenys Kroon or Santiago Bermeo) gave presentations showing how the project was driven by the Regional Growth Strategy. A key project objective was to 'Find out if water quantity is a constraint to economic growth'. The current process for improving water management was summarised, including:

- Proposed Plan Change (PC9), as described in section 1.5.
- Catchment-specific limits, potentially superseding PC9 default limits, will be set through WMA processes between now and 2025.

Ian McIndoe outlined Aqualinc's findings for each case study[29], covering:

- Current water demand based on consented and non-consented water takes.
- Current ground and surface water resources, and any water surpluses (or deficits) relative to the PC9 allocation framework, and the scope for efficiency gains via a 'reasonable use test'.
- Potential additional irrigable areas.
- Potential impacts from the new irrigable areas, including economic, employment and nutrient loss impacts.

Participants worked together at their respective tables in two facilitated sessions to consider:

1. The irrigation case studies with potential new irrigated land in the case study catchments.
2. The broader economic freshwater opportunities for the case study catchments.

Each group selected a scribe and a reporter. They were asked to give feedback as 'pros, cons and information gaps'. Feedback from the two sessions is summarised below.

[29] Except for the Kaituna-Pongakawa-Waitahanui and Rangitāiki workshops, where BOPRC staff presented the findings.

5.2 Pros

- Increased employment and social well-being
- Increased local and regional economic activity
- More robust economy
- Improvements in social infrastructure – housing, schools, healthcare
- Opportunities for financial investment
- Increase in land use intensification/ productivity
- Increase in industry
- Better use of existing infrastructure & technology
- Generally reliable water supplies
- Use of better technology and associated efficiency gains
- Better understanding of water resources

5.3 Cons

- Capital requirements
- Earthquake risks to infrastructure
- Potential soil wetness and flooding
- Potential effects on surface water flows
- Increased nutrient losses to surface water and groundwater
- Conflicts between consented water users and others
- Changes in land use could affect utilisation of existing infrastructure
- Visual effects to landscapes
- Community support stresses, e.g. housing, community infrastructure
- Seasonality of workforce and housing required

5.4 Information gaps

- Understanding of why current water uptake is slow
- Locations and availability of deep groundwater
- Relationship between consented takes and actual use locking up water
- Surface water- ground water interactions
- Effect of industry and irrigation growth on communities and community integration
- Community limits and aspirations around water quality
- Quantification of permitted and unconsented takes
- Information on crop response to irrigation, water use efficiency

- Information on water uses for other industries
- Issues around land tenure
- Issues around climate change
- Lack of understanding of biodiversity
- Treaty settlements and relationship to water

5.5 Wider opportunities

- Opportunity to develop the Māori economy.
- Aquaculture
- Aquaponics
- Use of geothermal energy
- Added value manufacturing and processing industries (food and beverage)
- Tourism around water
- Freshwater sports
- Micro-hydro

5.6 Barriers

- Lack of "Champions" to get things started.
- Access to information
- Access to capital
- Public perception and opposition to development.
- Regulation – local and central government, RMA.
- Water quality – iron, manganese
- Pollution and environmental effects
- Willingness of landowners to change
- Lack of skilled staff.
- Limited supporting community infrastructure.
- High costs associated with intermittent use for irrigation or frost protection.
- Conflict between seasonal and full time workers.

A significant implication of climate change will be sea level rise and coastal inundation. For the purpose of this study, sea level rise and coastal inundation will result in the loss of productive land.

Figure 58 illustrates projections of unmitigated (i.e. in the absence of additional pumping, higher stop banks, etc.) sea level rise and coastal inundation in the Bay of Plenty (based on projections in Stephens (2017)[30]).

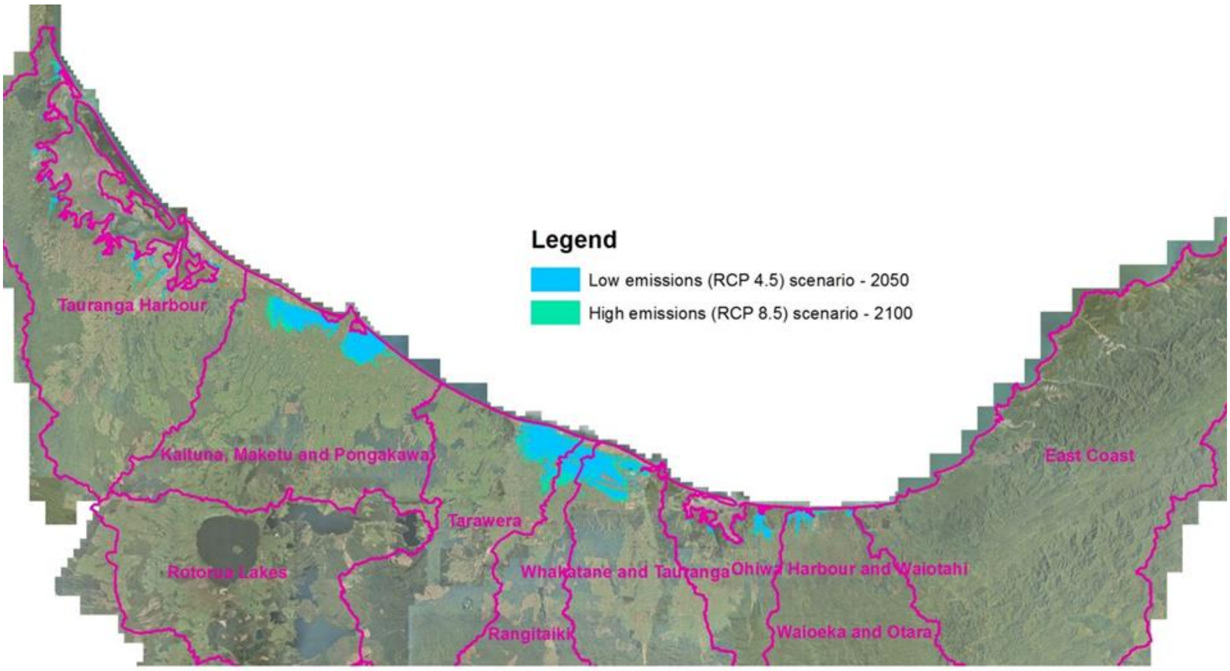

Figure 58: Potential sea level rise due to climate change

Areas most affected would be the Rangitāiki Plains (the lower parts of the Tarawera, Rangitāiki and Whakatāne WMAs) and the areas around the Maketū and Waihī Estuaries (Kaituna-Pongakawa-Waitahanui WMA).

In total, an area of 20,500 hectares would be affected (under the high emissions scenario by 2100), 65% of which is currently in dairy farming and the remainder in a range of other land uses. These areas are already relatively wet, not generally irrigated and generally not suitable for horticulture. Less than 3% of existing water take consents are within these areas.

Other significant implications from climate change include potential changes in the availability of, and demand for, fresh water. However, these have not been assessed.

[30] Stephens, S. (2017) *Tauranga Harbour extreme sea level analysis.* Report prepared for the Bay of Plenty Regional Council. NIWA, Hamilton.

7 LIMITATIONS AND UNCERTAINTIES

When interpreting the outputs and results of this study, a number of data limitations and uncertainties need to be considered.

1. BOPRC consent data and allocation limit data:

   - Several consents had missing irrigated areas. For these consents, irrigated areas were estimated based on other sources (e.g. land use data set, aerial photos, etc.).

   - Many groundwater consents don't specify an annual maximum but in the consent database, an annual maximum is derived from daily maximums. It has become apparent that this extrapolation may be excessive in some cases. This study has assessed the extent of this problem for frost protection and irrigation but not municipal and industrial consents (which can be large). This issue may be overstating current allocation and underestimating current availability.

   - There are no availability assessments for some parts of the region (e.g. Rotorua groundwater, East Coast groundwater).

   - Availability assessments exclude streams without flow gauging and may exclude large discharges from non-consumptive uses (e.g. the Kaimai Hydro scheme in Wairoa).

2. The scale of the analyses at WMA or catchment scale will not pick up specific localised (e.g. stream, river or aquifer specific) issues, and is coarser than assessments that would be done for individual consents.
3. It has been assumed that if water is available it will always be accessible, which may not necessarily be the case. Matters affecting accessibility include distance to source, quality issues that prevent intended use (like groundwater quality, saltwater in lower parts of catchments, impact of groundwater abstraction on surface water flow (mid-upper Rangitāiki), intricacies of hydro schemes discharge regimes (Rangitāiki and Wairoa), etc. The analysis has not looked at all of those.
4. Different irrigation demand models (e.g. Irricalc, Hydrus, SPASMO) will provide slightly different answers at times.
5. Estimates of permitted or unconsented fresh water use were applied to all properties in each category regardless of whether they had consented water takes or not. That means that there will be a degree of double counting, as properties with consented takes could include the equivalent permitted take within their consented takes.
6. There is some irrigation in the region from sources other than individual consented takes. These include municipal supply, irrigation schemes, permitted takes and unauthorised takes. Although some estimates of these values are available, they are subject to some uncertainty.
7. The value of unirrigated horticulture developments is not included in the assessments of economic opportunities.
8. The analysis does not assess the financial viability of new land uses. In particular, it does not take into account the cost of acquiring land, conversion costs or the opportunity cost of existing land uses.

8 CONCLUSIONS AND RECOMMENDATIONS

8.1 Is Freshwater (quantity) a Constraint to Economic Growth

The Phase 1 analysis showed that while there is sufficient overall water availability to meet realistic potential demand, availability and accessibility to the resource in individual WMAs and with surface water and groundwater differs.

Phase 1 found that while some WMA's such as Rangitāiki have surplus allocation, overall, there is currently about a 5,000 litres/sec over allocation of surface water. Phase 1 noted that while groundwater in some WMA's is over-allocated, there is a large surplus of groundwater available, in the order of 10,700 litres/sec (or 337 million cubic metres per year).

Phase 2 examined water supply and demand at a more detailed level.

At the Phase 2 catchment/WMA level, the following was identified (assuming reasonable use).

Table 35: Water supply status for current and future use, assuming reasonable use is applied to existing consents

WMA/ catchment	Current		Future	
	Surface water	Groundwater	Surface water	Groundwater
Whakatāne & Ohiwa	Surplus	Surplus	Fully allocated	Surplus
Waioeka & Otara	Surplus	Surplus	Surplus	Surplus
Lower Rangitāiki	Surplus	Surplus	Surplus	Surplus
Mid/upper Rangitāiki	Surplus	Surplus	Fully allocated	Surplus
Wairoa	Surplus	Surplus	Fully allocated	Surplus
Tarawera	Over allocated	Surplus	Fully allocated	Surplus
Pongakawa & Waitahanui	Over allocated	Surplus	Fully allocated	Shortfall
Kaituna	Surplus	Over allocated	Surplus	Fully allocated
Raukokore	Surplus	Unknown	Fully allocated	Unknown
Rotorua	Surplus	Unknown	Surplus	Unknown

Table 35 tells us that in most of the WMAs/catchments examined in the study, there is either a surplus of surface water, or groundwater, or both, to support growth opportunities from fresh water.

In some cases, surface water resources are fully allocated or over allocated, but sufficient groundwater allocation is available to cater for potential needs for fresh water.

The exception is in the Pongakawa & Waitahanui catchment, where potential future need cannot be fully met by the amount of water available from surface water or groundwater.

The use of surface water could be further improved through allocating water on the basis of reasonable use, implementing water user groups, and irrigation rostering.

There may be localised availability or access issues (i.e. below the WMA or catchment scale) that could be addressed through small scale infrastructure like shared bores, water user groups, irrigation rostering, distribution network where surface water is some distance away.

8.2 Economic growth opportunities created from fresh water

In most areas, the majority of potential water demand is expected to come from irrigation expansion, particularly for horticultural development and supporting industries. Feedback from the workshops indicated that irrigation does not automatically follow land use intensification in the BOP region. Irrigation is most likely to be used as drought insurance on high capital input enterprises, to ensure the expected quality and quantity of crops can be produced in drought years.

The potential expansion in irrigation for surface water and groundwater is given in *Table 36*.

Table 36: Potential expansion in irrigated area (hectares)

WMA/ catchment	Future expansion (ha)		Total expansion (ha)
	Surface water	Groundwater	
Whakatāne & Ōhiwa/Waiōtahe	910	1845	2755
Waioeka & Otara	861	0	861
Lower Rangitāiki	1187	0	1187
Mid/upper Rangitāiki	3054	10579	13633
Wairoa	209	236	445
Tarawera	0	2692	2692
Pongakawa & Waitahanui	0	2275	2275
Kaituna	684	0	684
Raukokore	640	Unknown	640
Rotorua Lakes	Minimal	Minimal	Minimal

The expansion in irrigated area will potentially provide the benefits shown in *Table 37*.

Table 37: Potential EBIT and employment expansion

WMA/ catchment	EBIT ($millions)	Employment (FTEs)
Whakatāne & Ōhiwa/Waiōtahe	453	2,330
Waioeka & Otara	162	2,290
Lower Rangitāiki	32	1,040
Mid/upper Rangitāiki	909	14,300
Wairoa	115	390
Tarawera	227	3,460
Pongakawa & Waitahanui	152	4,320
Kaituna	75	1560
Raukokore	64	900
Rotorua Lakes	Not determined	Not determined

Potential changes in nutrient leaching are presented in *Table 38*.

Table 38: Potential change in nutrient leaching

WMA/ catchment	N (Tonnes/year)	P (Tonnes/year)
Whakatāne & Ōhiwa/Waiōtahe	-382	0
Waioeka & Otara	-78	-1.4
Lower Rangitāiki	-83	-0.6
Mid/upper Rangitāiki	74	-5.5
Wairoa	1.2	-0.1
Tarawera	-86	0
Pongakawa & Waitahanui	-752	6
Kaituna	-300	3.4
Raukokore	Not determined	Not determined
Rotorua Lakes	Not determined	Not determined

Generally, there is expected to be a reduction in nitrogen leaching resulting from conversions of pastoral-based enterprises to horticulture. However, increases are expected in Mid/upper Rangitāiki due to intensification of pastoral enterprises.

8.3 Is there a need for irrigation infrastructure in the region?

Because overall water availability generally exceeds current and future water demand, there is not a need for large-scale infrastructure, such as large storage and distribution schemes to meet **foreseeable water needs.**

Traditionally, water schemes have been small scale (such as the 300 ha Tablelands Irrigation Scheme and the Braemar Water Scheme). We expect that to continue. Infrastructural projects will tend to be relatively small-scale and localised, or carried out on an individual basis driven by constraints on physical access to water.

An example is the potential irrigation of a proposed horticultural development at Raukokore. Other possibilities are small piped distribution systems to supply water to locations without riparian access to surface water.

While, in general, surface water resources are fully allocated or close to fully allocated in most catchments, groundwater is not fully allocated, and much of the new development will need to be supplied from groundwater. However, feedback from the workshops indicated that access to groundwater in sufficient quantity and quality is a major concern. Community wells and piped water may be a solution to this problem, which could be addressed through small scale infrastructure projects.

8.4 Addressing barriers to freshwater-based development

Although fresh water is generally not short in the BOP region, expansion of water-demanding land uses (such as horticultural development) is occurring relatively slowly. This means that other barriers are constraining growth.

The case studies and feedback from the workshops shows that there are information gaps that could be impacting on water uptake for regional development.

Knowledge around the locations and availability of deep groundwater of an acceptable quality is an issue. While drilling wells is the most certain way of proving groundwater quantity and quality, the financial risk to individuals is a disincentive. This is something that BOPRC could help to address by carrying out further groundwater investigations.

The impact of groundwater use on surface water resources and conversely, the impact of surface water on groundwater resources is of concern. As rules for groundwater-surface water interactions are included in the Regional Plan, these impacts are accounted for. However, local effects may require a different approach. This is likely to be an issue that water consent applicants have to address.

For irrigation, knowledge about the climate-plant-soil relationship and crop water needs for irrigation is limited. Unlike the other key irrigation areas in New Zealand, crops can be successfully grown in BOP without irrigation. Irrigation is therefore more likely to be drought insurance, rather than a necessary input to a production system. How much water is required and how often for various crops and local conditions is needed to inform those contemplating irrigation.

Improved knowledge around crop water needs will also enable current consents to be refined in the future, to ensure allocation is based on reasonable use. Those with excess water could be reduced and those with insufficient water enhanced to ensure allocation better matched demand.

Most regional councils in New Zealand have produced irrigation water requirement guidelines to inform irrigators of likely water needs. BOPRC is in the best position to lead the production of irrigation guidelines for the region.

Reasonable use of water for permitted and unconsented takes and for commercial and industrial use should also be addressed. While the Plan specifies maximum allowable takes for permitted use, we have assumed lower takes to reflect actual use. Feedback from the workshops suggests that further quantification of these takes is required and made available.

Associated with irrigation water requirements is the economics of irrigation and whether irrigation is worthwhile. The decision to irrigate is based on many factors, but the primary factor is usually economics. Information on crop responses to irrigation is limited in BOP. The primary sector groups such as Horticulture NZ, Dairy NZ, and Beef & Lamb need to fill information gaps around irrigation responses and promote their sectors.

How water is allocated may need to be reviewed. Currently, there is crossover between irrigation needs and frost protection needs, with some consents covering both. Water requirements for irrigation and frost protection need to be quantified separately.

An issue that has been highlighted is the “locking up” of allocation resulting from the large difference in water allocated and water used. Allocation is available to consent holders every year, but may only be used in dry years, or used minimally in most years. This situation arises because of the ‘insurance’ aspect of water use. BOPRC needs to ensure that water allocated matches water needs. While water is not generally in short supply, there may be catchment tributaries where water is short, and alternatives need to be considered.

Water quality is of concern. Community values and aspirations around water quality have been highlighted as a potentially significant constraint in the future, as water quality limits are set throughout the region. In the absence of such limits for most of the region, it is not possible to ascertain the significance of these constraints at this point.

The performance of existing irrigation infrastructure and application efficiency was not examined in this study. However, there will be potential to assess irrigation system performance and improve application efficiency. That is best done by irrigators themselves, or contacted to irrigation firms or consultants specialising in irrigation system evaluations. Irrigation NZ has been coordinating testing programmes using summer students. If irrigation reasonable use test were applied, efficiently functioning irrigation systems will be important to avoid production losses in drought years.

There is clearly a gap in knowledge of the effect of industrial, commercial, and agricultural and horticultural growth on communities. While growth was seen as beneficial, the lack of knowledge around these effects needs to be addressed.

Iwi relationships with land and water, land tenure and treaty settlements were raised as concerns. While the case-study approach did not address these issues, they have been noted and must be considered.

Climate change could impact on water demand and the fear of water shortages could be a barrier to freshwater-based development.

Appendix A: Feedback from Workshops

A.1 Tarawera

A.1.1 Feedback on Aqualinc's irrigation case study

Pros

- Social and economic benefits to the district
- Leveraging of existing infrastructure
- Increased employment, economic activity, increased diversity, increased export markets
- Improved land use from converting dairy to horticulture
- Drive towards most efficient use of water and land
- Increase in productivity per hectare
- Potential for tradeable water rights
- The ability of technology to achieve efficiencies
- Diversity of horticultural crops supported by water

Cons

- Earthquake consequences can damage irrigation infrastructure and change drainage patterns
- Soil limitation to wetness and flooding, not confident that these have been considered in the analysis
- Nitrogen and phosphorus loads to surface and groundwater and ability of river to absorb contaminants
- Conflict between recreational users and consent holders
- Effects on existing dairy and infrastructure investment
- Visual effects of shelter screening for horticulture
- Driving primary land uses rather than (lower impact) tourism
- Groundwater surface water interaction, is the model as good as it can be? Impact of water takes on wetlands
- Infrastructure stresses linked to labour, housing, rates.
- Regional inflation

Information gaps

- Knowledge of the interaction between surface and ground water (modelling needed)
- Unclear of the effects on mauri of water resource. Need for a cultural impact health index
- Understanding of industry growth and water bottling demand
- We've not set any community limits and aspirations and what this means for water quality and quantity proposals
- Employment and GDP assumptions

- Better understanding of different land uses
- Updated model of surface and ground water
- Better understanding of seasonal labour
- Quantifying permitted activity takes
- How has Opus irrigation study (2013) informed the analysis. Need more information about irrigation and crops that would grow in this area
- Potential for tradeable water rights
- Tenure status of land, small blocks, Māori Land and what is practicably available for production
- Irrigable area expansion figures - are they realistic?
- Consent vs realty, per day/year i.e. not just relying on consent allocation data
- Land use assumptions, what is the basis for this analysis, maybe a little positive
- Where are people going to come from - Whakatāne? How does that impact on planning for Councils?
- Is capital there to drive development? Capital sources constraints? **
- The amount of investment required for suggested kiwifruit land use change is about $1 Billion
- Information on alternative land uses e.g. sheep & goat milk, fodder crops
- Using solar or geothermal to create heating and cooling rather than water
- Links to geothermal and solar technologies to optimise industrial initiatives
- Iwi rights and interests. This could be a positive opportunity for Māori
- Difference on patterns of irrigation.
- Differences between capital given that Tarawera would be a top up rather than full on use

A.1.2 Feedback on wider freshwater economic opportunities

Opportunities

- Huge potential for aquaculture and aquaponics using local geothermal resource (e.g. tuna/eels). This high value industry could provide full employment with seasonal crossover with kiwifruit labour
- Local geothermal resource puts Kawerau in a global competitive advantage
- Geothermal energy good for greenhouse gas mitigation
- Manufacturing and processing industries producing value added products not commodity, building on good transport infrastructure and easy regulation pathway (1000 jobs potential).
- Kawerau is only 90 km from port and rail for forest-based industries,
- Build on opportunities for industry to share resources (i.e. Symbiosis Kawerau)
- Tourism - building on the wider Eastern Bay offerings
- Tarawera river flow is reliable compared with Canterbury
- Opportunity for water sharing between different users down stream
- Food and beverage processing
- Other arable opportunities for diversification
- Improved allocation limits

Barriers

- Barriers to aquaculture, freshwater species of fish that are not currently in New Zealand e.g. tilapia
- Public perceptions on new aquaculture species
- A lot of regulation around aquaculture
- Cost of abstraction including geothermal
- Skilled technical staff for geothermal abstraction
- Capital infrastructure*
- Possibility of conflicting work flow requirements seasonal workers
- Growth in tourism relies on good water quality
- Accommodation and staff to service tourism and hospitality industry
- Historic over allocation – matching need/location
- Issue of being share equitability
- Assumption that water is a public good
- Exiting water use rights - how are others going to get it if we use first in first serve allocation system.
- Regular vs intermittent use - uncertainty for need for irrigation when it used only for short periods. Makes cost vs benefit not great
- Red tape associated with RMA, particularly for smaller players; costs both financial and time
- Central and local government unclear
- Location to overseas markets
- Social licence especially with foreign ownership e.g. water bottling. Is this negative perception fair?

Information gaps

- Industry has not got to the bottom of why and how they use water in farming, how much is used for stock, for cooling, washing, irrigation. This understanding will drive more efficiency with water use.
- Identify 'litres of water per $ return' for a range of land uses
- Intensive poultry water use
- Integration of any new developments with existing community
- Industry and town requirements
- The value of tourism, aquaculture on GDP
- Access to information and data, and expertise within local industry
- Whether having a litre per $ return
- Knowledge of water resources
- Understanding of what the water requirements are is unclear

A.2 Whakatāne Ohiwa/Waiotahe

A.2.1 Feedback on Aqualinc's irrigation case study

Pros

- Creation of jobs will create economic growth, Regional GDP*
- Wonderful potential for financial growth ***
- Great employment opportunities***
- More robust and diversified economy, plus supporting existing industry and services
- Economic and social cohesion benefits, better housing, health care infrastructure
- Opportunity to create training education which will result in good social return
- Build governance and leadership
- Huge opportunity to develop Māori economy and lead where appropriate
- Opportunity for land use change that may have less environmental impact
- Modern technology to irrigate more efficiently
- Attract more industry into our district*
- Far better understanding of water resources, becoming more knowledgeable over time

Cons

- Concerns around seasonality of workforce, housing required
- The ability to secure employees to match growth, seasonal vs full time
- Not convinced the data is robust.
- Environmental impact through intensification***
- Nitrates to water ways and aquifers, increased contamination potential
- Concern of quality of water available that is available for irrigation
- Risk of contaminating aquifers, and impact on other ground water connections
- Local body politics and resourcing. Is there a structure around this for necessary resourcing?
- Who is going to fund irrigation?
- Recent irrigation studies and proposals have been very dairy dominant
- We need to build in resilience to have diversification from dairy to other land uses
- Cost of extracting deep ground water and getting it to where it is needed
- Allocation stampede of first in first serve
- The current allocation process needs reviewing as those with resource consents only use a small portion -perhaps we need to consider water trading, but there is no easy mechanism to do this
- Costs associated with drainage work where soils are not naturally free draining.
- Changes to the visual environment - changing the natural character through increased canopy coverage
- The possibility of foreign funding leaving the district

Information gaps

- Resource consent barriers
- Monitoring and security – have we learned from Canterbury?
- Cost of getting moving – who is going to fund this?
- Where does capital come from?
- Who holds stewardship over water, and ensure that water is managed fairly
- Are we ready to press on? Who has the handbrake, how as a community can we get started on embracing the opportunities?
- What are the effects of climate change – short and long-term? *
- Difficult to measure the environmental impacts in monetary terms
- Linkage between surface and groundwater; effects of groundwater takes on surface water bodies
- What is the quality of water we are taking rather than discharges?
- Can we marry needs such as piping water from Edgecumbe to Galatea?
- We need information that quantifies water required per kilogram of product
- Look at actual use of water, consented and non-consented.
- What do we do with information from water meters? Can we use data better to manage resources?
- Information on water use efficiency.
- How much water is available where? Data needs to be more specific.
- Is the right water located in the areas where it is needed?
- What crops and land uses are suitable near water allocation, particularly high value crops?
- Looking at multi-use opportunities
- What are the risks and barriers of increasing irrigation?
- Monitoring and measuring of farmers and orchardists on the ground
- Need to know landowner aspirations including small blocks and commercial farmers
- Are we gathering information from overseas, learning from other countries with similar climates?
- Anyone looking at introducing dams for water storage?
- What is the value of jobs to the community - part time, low wage workers?
- Community capacity building, looking at models that may be working or have not worked
- As a community we need to start with identifying what we agree on
- Communication and education on water resources – who, how?
- How do we balance the interests of different interest groups?
- We need to understand cultural issues, rights, values, and allocation
- Iwi cultural and social values are important and should be integrated into this project. We will have better outcomes if we incorporate Māori values. These values should be included in future workshops to reflect views of the three iwi in this area
- What about other water activities, fishing tourism, how does it affect ecology in rivers, biodiversity?
- Technology, digestible information and support
- Lack of understanding of biodiversity

- Are we focusing on money more than culture?

A.2.1.1 Feedback on wider freshwater economic opportunities

Opportunities

- Tourism – eco-tourism with water-based activities - rafting fishing, swimming, educational tourism,
- leveraging our clean green images ****
- Attract more water sports activities
- Aquiculture as a form of protein harvesting***
- Hydroponics and associated ability to recycle water
- Micro-hydro power, particularly in isolated areas
- Look at ways to adding value e.g. niche alcohol, gin flavours
- Iwi opportunities in new developments
- Industry employment, diversification, broader supporting businesses
- Growth for the region
- Health of people in the region
- Locally owned high value crops and processing that improves returns to the community
- Non land-based uses and related industrial potential

Barriers

- Water management and access to the water, what this might look like in the future
- Environmental impact of opportunities
- Pollution, environmental and visual effects
- Pastoral irrigation is pretty easy compared to kiwifruit orchards, not an equal playing field
- Short sighted regulations that can impact on the quality of water
- Willingness of landowners to change; many farmers are 60+ and reluctant to take up new activities
- Limited access to finance for young people to buy land
- Lack of local capital investment, and reliance of capital from outside the district*
- Complexities of land ownership
- RMA implementation
- Governance and leadership, taking this forward with different interested parties
- Infrastructure – access to markets
- Access to the water and conflicting interests
- Lack of consultation between stakeholders and vested interests
- Getting consensus so everybody can work together
- Inadequacy of information on development options and process
- Long term sustainability includes major infrastructure provision

Information gaps

- Interaction between multiple uses – need a framework where a number of people want the same water
- No people in the workshop from aquaculture or tourism sectors
- Putting a dollar value of water from tourism, recreation, cultural value, so that we can guide the use and limits of water
- Where is the water and how can we access it?
- Capital investment required
- How much consultation research has gone into developing data?
- How does general population see this?
- Understanding Treaty settlements and awareness, as many settlements encompass access to water?